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Protecting Disaster Rescue and Recovery Workers

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This chapter describes worker protection strategies and health surveillance activities in terms of temporal phases of disaster and emergency management. Disaster safety management capacities and coordination plans must be developed before a disaster occurs to deal with the complexities of hazard assessment and control, worker education and training, worker illness and injury surveillance, and access to healthcare services. These activities are performed by diverse groups of occupational and environmental health professionals.

INTRODUCTION

Defining Disaster

A *disaster* is defined as a serious disruption in the functioning of society that poses a significant level of threat to life, health, property, or the environment and requires outside assistance to manage or cope with it.[1] There are several ways of classifing disasters and crisis events. Disasters may be caused by human action or by forces of nature, including extreme weather events (such as hurricanes, tornados, and cyclones), geological disturbances (such as earthquakes and volcanic eruptions), and epidemics of disease (such as of Ebola virus disease). A *complex humanitarian disaster* is a situation in which populations are displaced due to armed conflict, dramatic political change, or other causes.[2] Technological or industrial disasters may occur from human neglect, error, or by deliberate and harmful actions.

Hazard assessment is of prime importance for all types of disasters. Common hazards to anticipate in planning include:

- Bulky or sharp debris
- Fallen trees
- Downed but energized power lines
- Weakening and possible collapse of structures
- Displaced wild animals, such as rodents, reptiles, and insects
- Chemical or gas releases, such as from broken pipelines or storage containers
- Bloodborne pathogens from injured and bleeding victims, including those infected with HIV and hepatitis C virus
- Flooding and destructive forces of water
- Water damage and mold
- Fires with heavy smoke and dust
- Diesel exhaust from large equipment used during prolonged recovery activities.

Box 31-1. Framework of the U.S. Federal Government Response to Disasters

The National Preparedness System outlines an organized process for all people in a community to engage in preparedness activities and achieve the National Preparedness Goal.[1,2] The five mission areas of preparedness are Prevention, Protection, Mitigation, Response, and Recovery. Each mission area is comprised of core capabilities organized by a planning framework with a unified approach and common terminology.

The National Response Framework (NRF) aligns key federal coordinating roles and responsibilities for emergency response in a scalable fashion. It operates in partnership with state and local government agencies, nongovernmental organizations, and the private sector.[3] In 2016, the NRF was updated to emphasize that a whole community works together, integrating all sectors, to meet the needs of those affected by disasters.[4]

The NRF has a Worker Safety and Health Support Annex, coordinated by the Occupational Safety and Health Administration.[5] Expert technical assistance comes from industrial hygienists, sanitary engineers, occupational medicine physicians and nurses, and other health and safety professionals.

The scope of activities within this annex addresses capabilities to identify, characterize, and control health and safety hazards, the use of personal protective equipment (PPE), on-scene worker risk communication, training, and medical evaluation. Technical assistance can also be requested concerning long-term medical surveillance, immunizations and prophylaxis, and support of the psychological resiliency of emergency response workers. All response operations use an incident command system (ICS) that is coordinated by the National Incident Management System (NIMS), which emphasizes local control of an incident with support from federal and state government agencies. This system provides a "consistent approach to operational structures and supporting mechanisms, and an integrated approach to resource management."[6]

The National Oil and Hazard Substances Pollution Contingency Plan (NCP) governs the national response capability and overall coordination for oil spills and hazardous substance releases. The U.S. Coast Guard is the lead agency when a discharge occurs in a coastal zone, whereas the Environmental Protection Agency (EPA) is the lead agency when spills occur inland. The NCP is a part of the National Response System, which involves multilayered networks of federal, state, local, and tribal government agencies as well as industry. The system includes the National Response Center, On-Scene Coordinator, the National Response Team, and Regional Response Teams.

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National planning has also considered terrorism scenarios involving chemical, biological, radioactive, nuclear, or explosive (CBRNE) substances, which could cause massive disruption or destruction.

The framework of the U.S. federal government response to disasters is described in Box 31-1.

Events Influencing Policy and Research for Worker Protection

Large-scale and complex disasters occurring in 2001 highlighted the need to organize disaster safety management and ensure that worker safety and health is integrated into the management of incidents.[3-6] On September 11, 2001 (9/11), terrorists hijacked and crashed four commercial jet airplanes, two into the Twin Towers of the World Trade Center, one into the Pentagon, and one into a field in Pennsylvania.[7] Hundreds of firefighters were killed while attempting to rescue thousands of people below the point of building impacts, causing intense emotions among the response community.[3] Erratic credentialing procedures, personal protective equipment (PPE) supply shortages and design challenges, disrupted telecommunication systems, faulty

instrument readings (due to intense smoke), and the lack of unified authority thwarted efforts to characterize the environmental contamination and better inform efforts to protect workers.[3,4] Inconsistent interpretation of environmental sampling data and advice about safe exposure thresholds emerged, creating confusion, distress, and mistrust of the public institutions managing risk and uncertainties. Shortcomings in on-scene safety information, training, and enforcement made it difficult to control internal perimeters or hazard zones established to differentiate needs for training, fit-testing and proper use of PPE, and practices for worker protection (see Figure 31-1).[4]

In 2011, President Barack Obama signed into law the James Zadroga 9/11 Health and Compensation Act of 2010, which established the World Trade Center Health Program.[8] This federally funded healthcare entitlement, exposure registry, and research program has since been extended to 2090. Healthcare services are delivered through a "center-of-excellence" model, with standardized annual medical monitoring examinations and expert treatment services for qualifying conditions. Program beneficiaries include eligible responders, clean-up workers, and others adversely impacted by the 9/11 disaster. The program also conducts health surveillance and research addressing emerging conditions that may be linked with 9/11 exposure, atypical disease mechanisms leading to treatment resistance, and health burdens impacting the quality of life over time.[9]

Soon after 9/11, journalists in Florida and New York and U.S. senators received postal letters containing anthrax spores mixed in a powder-like substance, leading to a massive public health and law enforcement effort to tracke these bioterrorism events. Investigations found that anthrax spores were contaminating postal-service hubs that process mail throughout the Washington, DC–New York City corridor. The risk of fulminant disease from anthrax infection led to mass distribution of antibiotics, including for workers wearing PPE, lest there be undetected breaches.[10] There was confusion about divergent methodologies and authorities for measuring and interpreting environmental and occupational exposure to the anthrax-laden powder. These events led to planning for CBRNE scenarios and worker protection to be ready to

Figure 31-1. Recovery workers at the World Trade Center site in September 2001. (Photograph by Earl Dotter.)

deal with terrorism from such agents. Federal resources supported these efforts, and the Department of Homeland Security was established, headed by a cabinet-level secretary.[11]

These events stimulated research at the National Institute for Occupational Safety and Health (NIOSH), including on personal protective technology. Contributing to national preparedness for emergency responders, NIOSH published seven special test procedures for respiratory protective devices (RPDs) for chemical, biological, radiological, and nuclear hazards.[12] Advances in research are enabling sensors to indicate when the air-filtering cartridge of an RPD has reached the end of its service life and needs to be changed.[13] In addition, since 2005, NIOSH has funded a standing committee on PPE for workplace safety and health to enable input of stakeholders on PPE research, standards development, and user guidance.[14]

In 2003, the emergence of severe acute respiratory syndrome (SARS) threatened healthcare workers in Southeast Asia and Canada, challenging healthcare institutions and government agencies to improve infection control and respiratory protection for emerging pathogens.[15] Subsequent outbreaks of influenza spurred greater attention to pandemic influenza preparedness, due to the susceptibility of human populations and variations in viral transmission and pathogenicity.[16] The possibility of an impending pandemic stimulated the public health community to address the readiness of the healthcare sector to respond to a pandemic. Readiness concerns included appropriate selection and use of PPE, optimization of vaccination campaigns, and pre- and postexposure prophylaxis. Innovations in PPE are needed to reduce fit-testing requirements for RPDs and improve their comfort and tolerability in healthcare settings.[17,18] More work needs to done to assess how well PPE conforms to design specifications after market. Risk-based, evidence-driven guidance needs to be applied to link workplace hazards during an emergency response to appropriate standards and to identify the appropriate PPE to meet standards to keep workers safe.

In 2005, Hurricane Katrina led to the inundation of New Orleans, unmasking many health and response disparities. Lessons from this disaster led to the Post-Katrina Emergency Management Reform Act of 2006, which reorganized the Federal Emergency Management Agency and expanded its authority to address gaps in emergency response.[19,20]

In 2010, millions of gallons of oil spilled into the Gulf of Mexico after the Deepwater Horizon oil drilling rig exploded and sank. Lessons learned from previous responses led to the early development of guidance to protect workers. Near real-time adjustments were made in these recommendations because of timely field assessments of potential hazards on shore and off, including the physical hazards onboard marine vessels, heat stress, chemical dispersants involved in oil containment and cleanup, and the psychosocial hazards attendant to variations in work crews and safety culture.[21-24] Communication of risks to workers was made a top priority, and environmental and health data was made available on the Environmental Protection Agency (EPA) and NIOSH websites throughout the spill response.

A deadly fire and explosion at the West Fertilizer Plant in Texas in 2013, which killed 15 people, injured 260, and caused massive community damage, was determined to have been caused by a failure of proper planning and training.[25] The report of the U.S. Chemical Safety Board on this disaster helped to raise community, labor, industry, and government awareness about the dangers of fertilizer grade ammonium nitrate and the needs for community awareness, storage regulation, and hazardous-materials training for voluntary firefighters.

The epidemic of Ebola virus disease, mainly in 2014, which devastated three countries in West Africa, infected and killed more people—including more healthcare providers—than any previous Ebola outbreak.[26,27] This experience showed that access to PPE is not enough and that policies and procedures need to be in place for training response workers and emergency medical providers in the donning and doffing of PPE.[27,28] Heat stress was an important healthcare worker safety factor in the warm and humid West African climate and could result in problems with coordination and cognitive function leading to errors in judgment and unsafe use of PPE. Given the serious nature of this infection, just-in-time research was performed to provide updated guidance on selection of PPE and use of cooling devices. Research included testing

garments for fluid resistance and blood penetration under mechanical pressure and testing the length of time PPE ensembles could be used before core body temperature rose to unsafe levels.[29]

Responses to the 9/11 attacks, Deepwater Horizon oil spill, Ebola virus disease epidemic, and the Zika virus disease outbreak have highlighted the important need for disaster-science research on the health consequences of novel exposures that arise during disaster response and to evaluate the effectiveness of preventive measures.[30-32] Research before, during, and after disasters can lead to improved effectiveness of emergency responses, lower injury and illness occurrence among responders, and inform future response strategies. However, the unpredictability of what emergencies will occur and when makes it difficult to conduct research during disasters. Challenges include lack of baseline health data for responders, access to study populations and the disaster site, and rapid funding mechanisms. Often the most important data, including initial exposure sampling and a roster of responders, is not collected due to the heightened but narrow focus on immediate response and inadequate planning and response culture. Additional operational challenges include obtaining timely approvals from human research subject protection boards and other entities that constrain federal collection of data, such as the Office of Management and Budget, based on the Paperwork Reduction Act of 1980.

NIOSH has recently established the Disaster Science Responder Research Program to enable starting occupational safety and health research quickly after a disaster occurs and to support pre-event disaster research.[32,33]

Description of Emergency Response Workers

Typically, the definition of emergency response workers has included firefighters, emergency medical services workers, and law enforcement personnel. However, depending on the nature and scale of the incident, additional workers contribute to the emergency response activities and include many types of professionals and skilled laborers, including electric utility workers restoring power and road crews freeing up transportation routes blocked by fallen trees and other debris (Box 31-2).[34] For example, during the Deepwater Horizon oil spill, commercial and subsistence fishermen were recruited to assist with the cleanup. Nontraditional responders, who are required for a fast response to emergencies, need additional training. Essential services are those that maintain community operations and minimize disruption from loss of power, sanitation, potable water, safe food and medicine, and needed services (such as transportation). Workers providing essential services during a severe infectious epidemic are likely to function as emergency responders and include healthcare providers, healthcare support personnel, behavioral health and social service personnel, public health investigators, and representatives of nongovernmental faith-based or civic organizations who directly assist affected people. Workers are often untrained for the roles they must perform in response to large-scale disasters, including managing distraught persons in quarantine or

Box 31-2. Functions of World Trade Center Responders

Traditional Workers
- Emergency service workers
- Federal disaster responders
- Firefighters
- Law enforcement personnel
- Urban search and rescue

Nontraditional Workers
- Building cleaners
- Building trades
- Civil service workers
- Counselors
- Engineers
- Environmental assessment workers
- Media representatives
- Mortuary workers
- Nonemergency healthcare workers
- Pastoral care workers
- Public officials
- Sanitation workers
- Transport workers
- Veterinarians
- Volunteers

Source: Moline J, Herbert R, Levin S, et al. WTC medical monitoring and treatment program: Comprehensive health care response in aftermath of disaster. Mount Sinai Journal of Medicine 2008;75: 67–75.

isolation, dependents of essential-service workers, and others, such as children, older people, medically fragile and institutionalized persons, and pets, service animals, and livestock.

DISASTER SAFETY MANAGEMENT

Before a disaster occurs, it is essential to build the capacities and flexibility required to protect disaster-response workers. Collectively, these functions and capabilities have been termed *disaster safety management*.[4] As workers from many disciplines and organizational entities are likely to become involved in disaster response and recovery, the following core tasks must be coordinated:[1,4,22,35]

- Identifying and monitoring site-specific hazards (scientifically measuring and interpreting findings)
- Determining and implementing site-specific exposure control strategies
- Monitoring and reporting health and injury surveillance for disaster workers
- Facilitating worker protection education and training on scene (just in time)
- Ensuring appropriate site access controls and credentialing, especially for unaffiliated volunteers
- Ensuring adequate supply and effective use of PPE
- Ensuring access to appropriate medical and behavioral healthcare services.

Effective worker protection requires coordination and cooperation among all entities involved. Appropriately qualified and experienced occupational safety and health personnel must be assigned to the tasks listed previously. Safety and health plans need to be professionally designed, monitored, and tailored to specific worksite conditions. Controlling exposures to occupational hazards is the fundamental method of protecting workers. Disaster safety management needs to provide ongoing real-time guidance to disaster incident leadership at all levels of government, healthcare, and business sectors to ensure robust standards are met to reliably protect responders. Capacity building occurs both within and across organizations (Table 31-1).

The Emergency Responder Health Monitoring and Surveilliance (ERHMS) system contains specific recommendations and tools for protecting the health and safety of responders in all phases of a response, including predeployment, deployment, and postdeployment (see Figure 31-2).[22] Medical monitoring and surveillance in ERHMS can identify exposures and/or signs and symptoms early in an emergency situation in order to prevent and mitigate adverse physical and psychological effects. Data collected during the response can help identify which, if any, responders would benefit from medical referral and possible enrollment in a long-term health surveillance program.

Occupational Health Surveillance

In its broadest sense, *occupational health surveillance* refers to the "systematic collection, analysis, and interpretation" of health and exposure data for the purposes of identifying cases of occupational illness or disease, monitoring trends of occupational illness or injury, and monitoring exposure to workplace hazards.[36] (See Chapter 6.) Surveillance also includes the

Table 31-1. Building Emergency Response Capacity

Individual	Organizational and Community

• Medical evaluation (physical and mental health)
  • Fitness for duty
  • Medical baseline
• Attainment of credentials
• Education
• Training exercises
• Fitting of PPE ensembles
• Pre-mission briefing
	• Establishment of personnel tracking system
	• Identification of health and safety officers
	• Training exercises
	• Selection and fitting of PPE ensembles
	• Communication and coordination with local, state, and federal emergency response entities

Note. PPE = personal protective equipment.

Figure 31-2. Lifecycle of a worker and workforce deploying to a disaster. (Source: U.S. Environmental Protection Agency. Emergency Responder Health Monitoring and Surveillance. National Response Team Technical Assistance Document (TAD). Washington, DC: U.S. Environmental Protection Agency, 2012. Available at https://www.nrt.org/sites/2/files/ERHMS_Final_060512.pdf. Accessed November 29, 2016.)

timely dissemination of information to people who can implement effective prevention and control measures. It is a critical function in protecting emergency response workers and includes activities in both hazard surveillance and medical surveillance. Hazard surveillance, medical surveillance, and screening are also critical functions of the Worker Safety and Health Support Annex and are tied to public health and medical activities (Emergency Support Function No. 8 [ESF8]) of the National Response Framework (Box 31-3).[19]

Hazard Surveillance

Environmental sampling and monitoring are critical functions during disaster response, recovery, and remediation phases of a disaster. The goal of hazard surveillance is to characterize work-related exposures to prevent or control (limit) responder exposures. A good

Box 31-3. Public Health and Medical Services (ESF8) from the National Response Framework

- Assessment of public health/medical needs
- Health surveillance
- Medical care personnel
- Health/medical/veterinary equipment and supplies
- Patient evacuation
- Patient care
- Safety and security of drugs, biologics, and medical devices
- Blood and blood products
- Food safety and security
- Agriculture safety and security
- All-hazard public health and medical consultation, technical assistance, and support
- Behavioral healthcare
- Public health and medical information
- Vector control
- Potable water/wastewater and solid waste disposal
- Mass fatality management, victim identification, and decontaminating remains
- Veterinary medical support

archival source of information about prior disasters and associated release of toxic substances is the Hazardous Substances Emergency Events Surveillance System, maintained by the Agency for Toxic Substances and Disease Registry.[37,38] In more defined workplace settings, personal exposure monitoring can be conducted to better assess individual exposures, but this is often not practical in a disaster setting. This hazard information is utilized to develop strategies to limit responder exposures and inform medical surveillance activities.

Medical Surveillance

Medical surveillance is the analysis of health information to identify cases of occupational injury or illness or a change in biological function among workers in order to evaluate workplace controls or identify opportunities for workplace interventions to prevent occupational illness or disease.[36,39] Examples of medical surveillance activities include reviews of (a) Occupational Safety and Health Administration (OSHA)-required injury and illness logs from emergency response operations and (b) health data from predeployment, intradeployment, and postdeployment medical evaluations.

Medical Screening

Medical screening is an initial examination conducted to detect unrecognized disease or organ dysfunction before an individual would normally seek medical care.[36,39] The primary purpose of medical screening is to limit disease progression by providing early diagnosis and treatment as well as by limiting continued hazard exposure. Results can be considered individually or aggregated to create an understanding of novel health effects or novel relationships between exposures and health effects.[40,41]

Varying Roles of Occupational and Environmental Safety and Health Professionals

The occupational or environmental safety and health professional may assume various roles in protecting emergency response workers and/or the general public (Box 31-4). Roles often differ by specific profession (such as physician, nurse, industrial hygienist, or sanitary engineer), credentialing, and experience. The National Incident Management System identifies a safety officer who is responsible for assuring personnel safety, monitoring hazardous and unsafe situations, preparing a site-specific safety and health plan, monitoring the incident, and advising the incident commander. Various roles include scientific exposure assessment and site characterization, design and implementation of hazard control strategies, worker safety education and training, health surveillance, direct patient care, and medical monitoring. In addition, these professionals may provide indirect support to workers through technical consultation, team leadership, or as an official liaison to the disaster safety management infrastructure at varying management levels in the field or at headquarters. Such roles require a working knowledge of data collection and analytical techniques (such as root cause, fault tree analysis, failure mode and effect analysis, and basic statistics) to identify high-risk safety conditions, operations, and practices and develop trend analysis and statistical reports. Knowledge and experience would also be required to manage and lead other safety and health professional staff members, which would include human resource–related activities, work/rest scheduling, task management, conflict negotiation, and other skills pertaining to interpersonal relations, team leadership, and psychological resiliency on scene and postevent.

Under the National Response Framework, the Department of Health and Human Services coordinates federal support for public health and medical activities during a disaster (ESF8; Box 31-3).[1] Environmental and occupational health and safety professionals may also be asked to handle a variety of functions listed in Box 31-5, especially as they pertain to temporary housing (including shelters) and work facilities to ensure safe food, water, waste disposal, shower/wash stations, and vermin control.[35] Understanding the variety and interrelationship of roles will help to ensure coordination during all phases of emergency management (preparedness, response, and recovery).

Box 31-4. Public and Environmental Health Issues in Disasters

Emergency management and public health share a philosophy of preventing injury and illness whenever possible. In terms of disaster preparedness, a helpful approach is to analyze the systems or pathways of the goods, services, utilities, and linkages that allow a community (or larger population unit) to function. Some experts have termed this a *lifeline vulnerability assessment*.[1] A community is able to function on a daily basis because of its lifelines, albeit the essential infrastructure.

Emergency planners should anticipate the likely disaster hazards that might occur within their jurisdictions, accounting for risks imposed by local industry, commercial transportation routing, population density, economic diversity, land use, and regional weather or geological patterns. The types of hazards include dangerous weather (hurricanes or tornados), earthquakes, flooding (rainfall exceeding river capacity or levee or dam breach), power loss, fire, widespread infectious disease (such as influenza), and industrial or commercial transportation incidents (such as chemical spills and explosions involving toxic materials).

Risk communication is a critical function in disaster response. Information needs to be disseminated to and understood by all persons attempting to gain access to, or remain within, a disaster-stricken area. Carbon monoxide poisoning can occur from power generators (such as for heating) used within enclosed spaces. There are risks of injury from debris strewn about or falling from unprotected heights, or inadequate structural integrity of affected buildings. Downed wires may still be energized, posing threats of electrocution. Wild or stray animals, reptiles, or poisonous insects may be threats. There are risks of serious infection from improper wound care or poor sanitation. In addition, there are risks associated with exposure to extremes in temperature (heat or cold). Guidance should be widely disseminated about proper methods of sanitizing contaminated surfaces, handling flooded ventilation systems, addressing mold problems, recognizing allergies (such as to mold), handling of dangerous power tools (such as chain saws), appropriately using personal protective gear, and disinfecting private well water.

Within the first days to weeks of a disaster, regardless of whether people are living in their primary residences or in shelters, they need access to potable water, safe food, essential medicines, healthcare, housing, electrical power, and proper sanitation. Special populations, such as frail elderly people, children, and rurally isolated people, must be considered. Surveys of the community will be required to ascertain the adequacy of these resources and to identify additional needs for outreach services to assist those less able to mobilize from their homes. Needs assessments are typically conducted within days to weeks of a disaster and involve door-to-door surveys and often a population sampling method.

Other systems also need to be evaluated. Health and safety monitoring within makeshift housing (shelters), evacuation centers, temporary medical facilities, and schools can indicate the magnitude of the disaster impact and can affect how and if people can access necessary resources. Sheltering facilities can be evaluated for potential problems with water or food supply, improper food handling or sanitation practices, and decisions regarding high-occupancy spacing and child safety. Such inspections can identify immediate health and safety threats as well as potential catalysts for problems, including supervision of children and housing and visitation for pets. Understanding the characteristics of the underlying population, in conjunction with the environmental conditions, can drive public health messages. Staff members of facilities will likely also be experiencing stress from the event itself and from the occupancy demands within the facility. Providing risk communication and staff training via a Site Safety Officer or overriding organization (such as the Red Cross or Salvation Army) can help to clarify roles and tasks, cross-training, and control of staff work/rest cycles.

Targeted health screening and disease surveillance measures are needed to monitor population health and to help optimally direct scarce resources. This screening or assessment must be connected to clinical services able to identify and stabilize chronic or newly emerging illnesses, injuries, and mental or behavioral health problems. The event scenario and potential human exposure(s) will inform the content and duration of such health screening and surveillance activities. Shorter term health monitoring in high-occupancy facilities will assist in early detection and mitigation of infectious disease outbreaks. Exposure to certain chemicals or ionizing radiation may require longer term monitoring for latent disease or adverse reproductive impacts.

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OSHA Standards Applicable to Emergency Response and Preparedness

The Occupational Safety and Health Administration (OSHA) has identified several health and safety standards relevant to emergency preparedness and response activities.[42] Providing a complete list of applicable OSHA standards is impractical. However, many of these standards have special importance to healthcare professionals, given their requirements for medical evaluation and/or medical consultation. Substance-specific standards

Box 31-5. Emergency Response Activities Designed to Protect Worker Safety and Health During the Deployment Period

- Deployment of an appropriately credentialed safety officer
- Establishment of site security and control (perimeter control and designated hazard zones)
- Establishment of evacuation routes and procedures
- Registration of emergency response workers
- Site characterization (potential exposures) and job hazard analysis (personal and environmental sampling and investigation and statistical reporting)
- Design, implementation, and evaluation/continual refinement and communication about the health and safety plan (HASP)
- Official enforcement of the HASP (compliance)
- Establishment and maintenance of OSHA 300 log to report injuries and illnesses
- Monitoring of crew shift length for adequacy of rest, hydration, and nutrition
- Treatment for any emerging physical or mental health problems
- Monitoring for trends with health and injury surveillance
- Reviewing and approving the medical plan, ensuring healthcare services (ICS 206)
- Maintaining a Unit/Activity Log (ICS 214) for OSHA 300 injury/illness reporting
- Supervision of other safety personnel
- Familiarization with process to coordinate with overall disaster response management.

(with medical surveillance components) may also apply depending on whether the incident involves the release of a toxic industrial chemical.

Knowledge of the regulatory requirements for medical evaluation and consultation is essential to effectively protecting worker safety and health. Medical evaluations of emergency response and recovery workers should at least meet applicable regulatory requirements. For example, under the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, the medical evaluation consists of a medical and work history with special emphasis on symptoms related to (a) the handling of hazardous substances and health hazards and (b) fitness for duty, including the ability to wear any required PPE under conditions that may be expected at the worksite (such as temperature extremes).[43] This standard also describes the frequency of the medical evaluation, such as prior to assignment or as soon as possible upon notification by an employee that he or she has developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards. In addition to developing and conducting medical evaluations, occupational safety and health professionals may also have a role in training workers. For example, under the OSHA Bloodborne Pathogens Standard, training is required for workers with exposure to blood or other potentially infectious materials.[44]

The regulatory requirements for emergency preparedness and response represent the minimum required to protect workers. Many of the applicable OSHA standards were not designed with consideration of the emergency response environment. For example, although emergency response operations have been characterized as noisy, use of hearing protection could adversely impact the ability of emergency responders to communicate with one another.[3,45] Not all responders are equally covered by OSHA standards. For example, state and local government employees performing emergency response, such as firefighters and law enforcement, are not covered by OSHA regulations in jurisdictions without a State Occupational Safety and Health Plan. Finally, additional considerations, such as mental and behavioral health needs, may also be necessary to more fully meet the medical needs of emergency response and recovery workers.

Hazard Control and the Site-Specific Worker Health and Safety Plan

The OSHA HAZWOPER standard (29 CFR 1910.120) requires a written site-specific worker health and safety plan (HASP) for engaging in cleanup operations conducted at uncontrolled hazardous waste sites, corrective actions involving hazardous waste cleanup operations at sites covered by the Resource Conservation and Recovery Act, such as treatment, storage, and disposal and emergency response operations for the release or threatened release of hazardous substances.[43,46-48] (See Chapter 18.) The key elements of the HASP include hazard analysis

and site-specific requirements for training, PPE, medical surveillance, air monitoring, site control, decontamination, emergency response plan, confined space entry program, and a spills containment program.

TIME PHASES FOR EMERGENCY AND DISASTER RESPONSE ACTIVITIES

The National Planning Framework organizes emergency and disaster response activities in three functional time phases: *preparedness*, *response*, and *recovery* (Table 31-2).[1]

1. *Preparedness*: The preparedness phase includes activities related to building capacity in order to effectively respond to an emergency. Planning, training, acquiring equipment, and evaluating the effectiveness of emergency response capabilities through training exercises are all a part of building capacity.
2. *Response*: The response phase begins once an incident has occurred. During this phase, emergency response personnel are deployed to the site of the incident in order to mitigate its effect on life, the environment, property, the economy, and society overall. Responders engaged in immediate rescue operations tend to take greater risks in the chaotic disaster work setting in the service of saving or sustaining the lives of those directly affected. Little time is available to assess the hazards before rescue efforts begin.
3. *Recovery*: The transition between response and recovery operations may not always be clear. In general, recovery operations begin once immediate lifesaving activities are complete and potentially life-threatening hazards are stabilized. The short-term recovery phase focuses on returning the area involved in the disaster to a functional state of self-sufficiency, with attention given to helping individuals, households, businesses, and critical infrastructure meet basic needs. Depending on the incident, the long-term recovery phase may last for months or even years.

Table 31-2. Disaster Safety Management Life Cycle

Preparation	• Educate, train, and equip workers (anticipated hazards and command/control operations) • Establish medical baseline and readiness to deploy • Exercise and evaluate systems
Response	• Assess the situation (identify hazards and control strategies) • Deploy resources and capabilities • Coordinate activities and functions • Demobilize assets (people and equipment)
Recovery	• Short term (identify needs and provide resources) • Long term (epidemiological study and medical surveillance)

These time phases are useful for characterizing and coordinating the major functional elements of disaster management, such as transportation, communication, and public health and medical services (Boxes 31-3 and 31-5). *Deployment* typically refers to mobilizing assets (resources and capabilities) to help manage the disaster. The assets typically include skilled personnel and specialized equipment. The assets are safely returned as early as possible in the response phase termed *demobilization* to enable resource tracking and accountability for both resources and provisions guiding mutual aid and assistance.

Workers are involved in all of these phases. The charge to the occupational safety and health professional is to protect the health and safety of the workers participating in the emergency response, recovery, remediation, and cleanup activities. Depending on the activity, the occupational safety and health professional may have worker protection responsibilities to an individual worker (such as direct patient care) or to an organization (such as population-based medical monitoring or health surveillance). Many aspects of disaster safety management require diverse skill sets. Qualifications will differ with respect to the tasks required, and expertise from several disciplines will need to be coordinated to ensure that workers are protected.

Individual (Worker) and Organizational (Employer) Preparedness

The workplace can be significantly harmed by a disaster, an act of terrorism, or another traumatic incident. The scope and scale of anticipated events may require a thorough systems-level vulnerability analysis, from raw material supply chains to market delivery of final product or services, including disruption in transportation routes required for workers to be on the job.[48] Preparedness encompasses the period of time before a worker or an organization is engaged in emergency response activities. At the individual level, a worker must acquire and maintain appropriate education, training, and certification (credentials) specific to his or her potential deployment roles. Before disasters lead to lawsuits, emergency responders may feel at risk as targets of future litigation for "on-the-fly" decisions and actions that they must take while in the midst of the emergency response. Medical, emotional, and cognitive readiness are important dimensions of workforce health protection planning.

At the level of organizational preparedness, activities focus on ensuring that qualified workers are ready and appropriately outfitted with personal protective ensembles for deployment. Activities are also designed to build an integrated response capacity within an organization and within a community (Table 31-1). Effective disaster safety management requires appropriate infrastructure and interagency planning and coordination before the emergency arises. Predeployment and preparedness activities shape and influence the overall success of the emergency response efforts and, in turn, the disaster recovery process.

While the field of emergency management encourages an all-hazards approach to planning, it is not uncommon to organize the core plan around the more likely emergency events, such as an industrial explosion or fire, a facility collapse, violence by a disgruntled employee, or a natural disaster that destroys or disrupts business operations, such as by flooding, hurricane-strength winds, or an earthquake. The advent of infectious disease epidemics, such as SARS or H1N1 (swine) influenza, place additional life demands on workers who must care for ill or dependent family members, especially if schools are closed by public health officials to slow down the spread of infection. While business continuity is a key component of such planning, worker safety and health must be incorporated into strategic thinking. The cost of not doing this can be quite high, including loss of specialized workers with a corresponding need to recruit and train new staff members, interim loss of productivity; and workers' compensation costs for job-related injury, illness, or disability, as well as other potentially cascading organizational effects, such as loss of morale.

The day-to-day stress in the workplace can impact health from more cumulative factors within worksites, such as how a job is designed, organizational structure, management style, management and coworker commitment to safe work practices (safety climate), and the availability of adequate resources and support to achieve the mission.[49] (See Chapter 14.) Disasters and large-scale emergencies also create competing life demands on a worker to ensure the safety and welfare of loved ones who may also be affected. Disasters erode normally protective supports, increase the risks of diverse problems, and tend to amplify pre-existing problems of social injustice and inequality within affected populations.[50] The disaster may provoke new social problems for residents and local business employers by separating families, disrupting social support networks, and compromising critical infrastructure, such as the ability to provide essential goods and services (water, food, medical care, power, and housing/facilities).

Integrating Psychological and Behavioral Risk Management

Worker safety and health practitioners must integrate psychological and behavioral risk management strategies into crisis and contingency planning; these require knowledge of the psychological and behavioral consequences of the disaster, terrorism, or other traumatic incident (Box 31-6).[51,52] Traumatic incidents and disaster exposure can increase the risk of distress reactions or dysfunction, behaviors increasing risk to health and safety, or psychiatric illnesses. One

Box 31-6. Lessons Learned from Prior Disaster Response to Anticipate Psychological and Behavioral Health Hazards and Service Needs

- It is difficult to prepare responders for everything they might encounter.
- Even seasoned responders can face situations and issues that cause uneasiness and distress.
- It is not unusual for responders to be asked to work outside their areas of expertise.
- Concerns about family members and friends rank high on responders' lists of priorities.
- Timely, accurate, and candid information should be shared to facilitate decision-making.
- Managers, at every level, need to consider the health, safety, and resiliency of workers on the job as part of situation awareness and for staged planning (which implies needs for occupational health and wellness monitoring).
- Resiliency is an integral component of occupational safety and health, which requires preplanning to maximize worker recovery.
- Self-care plans and peer-support activities are essential to mission completion.
- Everything possible should be done to safeguard responders' physical and emotional health.
- Responders do not need to face response challenges alone. They may share their experiences with friends, teammates, family members, and colleagues.
- It is especially difficult for responders to maintain emotional distance when they witness the deaths of children.
- Organizational differences among groups of responders and cultural differences between victims and responders can impede the timely and efficient provision of emergency services.
- Individuals may be thrust into leadership roles for which they have had little to no formal training.

should anticipate needs for psychological interventions in the workplace and plan to ensure that possible intervention measures are based on empirically defensible or evidence-based practices and are conducted by qualified individuals.[53] Interventions include leadership initiatives, administrative policies, and enhancing services by partnering with other organizations that can help provide and/or train others to provide psychosocial support services, such as management of stress, anger, and grief as well as crisis intervention counseling.[54]

Predeployment Medical Evaluation

The fitness-for-duty determination should establish a baseline status and take physical, psychological, and behavioral health into account to determine whether the worker will be able to perform anticipated essential job functions at the disaster site without posing a threat to self, others, or the overall emergency response. This includes an assessment of (a) the adequacy of medical control, (b) fitness, and (c) functional implications for responders with chronic health conditions—especially those related to long work hours, hot environments, disrupted sleep, and nutritional opportunities and when power is in short supply, such as that needed for refrigerated medication or CPAP machines. This determination should be made in compliance with medical and legal standards, as outlined in the Americans with Disabilities Act.[55] Some emergency response workers may already be enrolled in medical surveillance programs as a part of their routine employment.[56,57]

Emergency Deployment

Emergency deployment encompasses the time period when a worker is actively engaged in responding to an incident. Very little time may be available for preparation of personnel prior to deployment (usually a week or less). Individuals preparing to deploy should receive a premission health and safety briefing that includes guidance about anticipated hazards (physical, chemical, biological, and interpersonal/psychological). Predeployment situational awareness should be provided via updated reports and/or materials designed for rapid dissemination. During the deployment period, characterization of hazards in the environment begins. For example, environmental and personal sampling may be employed to understand the composition and concentration of hazardous materials released in a dust cloud after structural collapse and/or structures may be evaluated for instability. Given that the predeployment medical evaluation is based on an understanding of likely or anticipated hazards, the occupational safety and health professional should gather information about any hazards to which the deployed

worker may be exposed. This information will be an essential consideration when designing and implementing a medical screening program for use during the postdeployment period.

Similarly, PPE selection is an iterative process because preselected PPE ensembles may not adequately address unanticipated hazards and because hazards may change as the emergency evolves. In addition, most PPE is designed to function during a short-term incident. However, workers responding to the World Trade Center incident reported equipment failure and fatigue and heat exhaustion due to sustained PPE use during the extended response period.[3] Emergency response personnel are often required to work extended hours in high-risk environments, where alertness and attention to detail are absolute requirements for safe work practices. Elevated stress and fatigue can lead to faulty decision-making, unsafe work behaviors, and increased exposures to health hazards.[58] Optimally, the responder has emergency plans and systems in place to handle concerns about the safety and welfare of family members and other loved ones to avoid both fractured attention on the job and increased likelihood of accidents, improper work practices, and poor decision-making.[59,60]

Demobilization

Demobilization is a process that provides closure to the deployment period for both the responder and the organization. At the individual level, it includes the exit interview for the responder and verifies information collected about possible exposures, health or injury events, and follow-up contact information. Information is shared regarding mission successes and challenges for operational continuity (lessons learned), potential health effects, and available health services and resources. Deployment-related illness and injury data should be aggregated and analyzed with respect to geography, process, and time to help inform the need for postevent medical surveillance or epidemiologic investigation. From the organizational perspective, demobilization focuses on the withdrawal of deployed assets, including workers and their equipment.

Postdeployment

The postdeployment period begins once responders return to their routine work and extends forward in time as long as is practicable to understand health and safety impacts from disaster response work. Characterizing the health and safety impacts from disaster response work is generally accomplished through hazard surveillance combined with follow-up assessment and clinical services, such as physical examinations, medical screening, and psychological resiliency services. Responders should be kept abreast of the availability of these resources, as well as any entitlements or legal rights. Prior responders are encouraged to report and answer surveys regarding emerging adverse health events potentially related to deployment. Under the Worker Safety and Health Annex of the National Response Framework, OSHA has the responsibility to coordinate the federal response in "providing technical assistance, advice, and support for medical surveillance and monitoring as required by regulation (such as asbestos and lead) and evaluating the need for longer term epidemiological follow up and medical monitoring of response and recovery workers."[19]

The need for medical screening or more extensive health surveillance may be triggered through hazard surveillance activities conducted during the response as well as the emergence of concerning health effects in significant numbers of responders. Although it is not possible to describe a medical screening program suitable for all types of emergency response operations, design and implementation should adhere to some standard elements:[36]

- Assessment of workplace hazards
- Identification of target-organ toxicities for each hazard
- Selection of a screening test for each health effect
- Development of action criteria
- Standardization of the testing process
- Performance of testing
- Interpretation of test results
- Test confirmation
- Determination of work status
- Notification
- Diagnostic evaluation
- Evaluation and control of exposure
- Recordkeeping.

The nature of the emergency response environment presents several challenges to successfully designing and implementing an effective medical screening program, as described next.

ASSESSMENT OF WORKPLACE HAZARDS

The hazards of an emergency response may not yet be fully characterized or effectively communicated to clinical occupational safety and health professionals. Given that medical screening is often administered to workers without symptoms or at a point when overt disease is not fully recognized, it is essential that the screening program address likely health effects. Assessments of likely health effects are most reliable when based on knowledge of the hazard exposure.

Identification of Target Organ Toxicities, Selection of Screening Tests, and Development of Action Criteria

Even when hazards have been characterized, they may be diverse and complex. For example, hazard surveillance of the region impacted by hurricanes Katrina, Rita, and Wilma in 2005 identified exposures of noise, dust, asbestos, silica, formaldehyde, and carbon monoxide.[45] The variety of hazard exposures of emergency response workers can lead to an overly broad medical screening evaluation with a consequent decrease in the program's performance with respect to specificity and positive predictive value. Thus, care should be taken to identify target organ toxicities, select appropriate screening tests, and develop action criteria for test results.

Standardization of the Testing Process, Performance, Interpretation of Test Results, and Test Confirmation

Emergency response and recovery operations involve the coordination of multiple worker populations, employers, and organizational authorities. Demobilization of workers from the emergency response environment can include the dispersion of response workers over a large geographic area and/or the distribution of workers among various employers. Differences in geographic distribution and employers can give rise to differences in access to postdeployment medical screening as well as differences in medical personnel performing testing. During the 2014 Ebola virus disease epidemic, the Centers for Disease Control and Prevention recommended that local public health officials monitor healthcare workers, other volunteers, and travelers returning from West Africa and issued specific guidance on how to evaluate screening for Ebola virus disease. Despite these logistical difficulties, elements of the testing process should be standardized to maximize its utility to the medical surveillance program and workers.

Determination of Work Status, Notification, and Diagnostic Evaluation

The decentralization of emergency response workers can also lead to variations in clinical evaluations, such as effectively addressing work status, performing diagnostic evaluations, and notifying workers of clinical results and injury and illness trends. It can also impede the effective communication of hazard surveillance data. Despite these logistical difficulties, determinations of work status, notification, and diagnostic evaluation should be standardized.

Evaluation and Control of Exposure and Recordkeeping

The chaotic nature of the emergency response environment, the diversity of responding entities, and the decentralized worker population postdeployment make accurate evaluation and control of exposures and recordkeeping especially difficult. Basic requirements, such as knowing who worked at the site, how long they worked there, what they did, and whether they wore PPE, are essential to correlating workplace exposures with occupational injury and illness and communicating health and safety information to responding organizations and workers.

Workers engaged in emergency response and recovery activities should receive some level

of medical assessment upon demobilization, depending on the nature of the incident and the hazards identified/assumed. The medical baseline established during the predeployment medical evaluation is fundamental to allowing comparisons in health status before and after emergency response operations.

It is also important to establish a site registry of workers that includes a review of site records to help identify who was present, for how long, doing what (job duties and possible exposures), and use of PPE.

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