Chapter 34

MASS CASUALTY PREPAREDNESS AND RESPONSE

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Vulnerant omnes, ultima necat.
"Every hour wounds, the last one kills."

INTRODUCTION

When a catastrophic event results in patient volume, injury severity, or both greater than a medical system is designed to manage at any given time, it is identified as a mass casualty situation, or MASCAL in military terminology. The only generally accepted commonality among these incidents is that they generate more patients and care requirements within a span of time than a response system can manage with available resources at the normally accepted standard of care. According to the World Health Organization (WHO), "Mass casualties following disasters and major incidents are often characterized by a quantity, severity, and diversity of injuries and other patients that can rapidly overwhelm the ability of local medical resources to deliver comprehensive and definitive medical care."[1]

Terms sometimes used interchangeably with MASCAL are tragedy, disaster, catastrophe, and calamity, and although none of these have exact definitions either, there are distinctions. A tragedy is any event that causes great suffering, but that could involve one person or a hundred, and is certainly viewed through the lens of each person being physically or emotionally impacted. Other terms often relate to relatively large-scale events causing significant or widespread damage. However, none of them have to involve casualties. If an entire region's communications system becomes disabled or destroyed, it might be considered a calamity, but no casualties would be directly generated by such an event, regardless of whether its cause is a natural solar flare or a terrorist attack. Collapse of a major bridge might be considered a disaster for the people who depend upon it for personal transportation, commerce, and delivery of goods and services to specific areas, but if no people were on it at the time, it might not result in a mass casualty incident (MCI).

Additionally, what might cause an MCI in a rural community may be routine in a major urban area with a robust emergency medical services (EMS) system and several trauma centers. Multiple-casualty incidents can be effectively and efficiently managed when the processes and resources are in place to do so according to the standard of care accepted by the prevailing culture. The purpose of this chapter is to propose a systematic approach to mass casualty response for the military medical officer (MMO) and suggest considerations for effective medical response operations.

SCOPE OF THE PROBLEM

The scope and nature of MCIs are determined by myriad variables: cause (human-made or natural); magnitude (small or large); scope (confined or widespread); population density (urban or rural); duration (short or long); second-order effects (environmental hazards, transportation limitations, communications capabilities, medical infrastructure, etc); and many more. Total number of casualties (few or many), rate of patient encounters (fast or slow), mechanisms of injuries (trauma or no trauma), distribution of severity (minor to critical), and location or setting (local or remote) also greatly affect the ability of any given healthcare system to manage an MCI.

Causes of MCIs are a convenient way to categorize these occurrences, for example, natural versus manmade (the latter can be further divided into accidental and intentional). Natural disasters include relatively sudden phenomena such as avalanches, earthquakes, and tornadoes; rapidly developing situations such as cyclones and hurricanes, floods and tsunamis, wildfires, winter storms, and volcanic explosions; or progressively worsening circumstances such as extreme heat, drought, and medical epidemics. Accidental manmade events may be precipitated by engineering failures; explosions at industrial and residential sites; or damage to tanks containing hazardous material (HAZMAT) being transported by truck, rail, or ship. Other manmade incidents may be intentionally caused by active shooters or other perpetrators of interpersonal violence, by crashing aircraft into buildings or detonation of explosives, by purposefully causing an industrial or transportation HAZMAT release, or by intentional widespread dissemination of chemical, biological, or radiological (CBR) materials through a dispersion device or a "dirty bomb." Every one of these actions may result in a wide spectrum of effects, depending on multiple other factors.

Explosive events illustrate event magnitude well because they can be retrospectively quantified based on observations of their effects. The truck-bomb detonated in front of the Murrah Federal Building in downtown Oklahoma City on April 19, 1995, had a blast energy equivalent to 2.2 metric tons of trinitrotoluene (TNT). There were 164 immediate deaths and 680 people injured,[2] many of whom walked to a nearby hospital, significantly impacting the care delivered in the hospital's emergency department to more seriously injured casualties transported later by EMS.[3] By contrast, the natural explosion of Mount Saint Helens in Washington State on May 18, 1980, generated a blast energy estimated at 24 million metric tons of TNT-equivalents.[4] Nonetheless, this event killed 57 people,[4] so magnitude by itself does not necessarily tell the complete story. The volcano was located in a rural area and the population at risk had significant warning time.

Scope and population density are related concepts. Although large geographical areas or multiple locations may be affected by one or more catastrophic events, the number of casualties will in part be determined by how many people are present. Relatively few people were killed or injured during the Tunguska event of June 30, 1908, when a meteorite estimated to be about the size of a football field exploded in the atmosphere above a sparsely populated region of Siberia with a blast energy equivalent to a 1950s-era thermonuclear device.[5] On the other hand, an actual nuclear device detonated over urban Hiroshima, Japan, on August 6, 1945, immediately killed about 66,000 people and injured an additional 69,000. Each figure was more than a quarter of the population of the city.[6] However, even population density must be considered within the context of the entire event. Drought over a large geographical region might lead to casualty numbers one or more orders of magnitude greater than an out-of-control fire in a city.

Scope also impacts the burden on a given healthcare system. As tragic as the events of September 11, 2001, were, the separated crash locations of New York and Virginia meant that more resources were available at each site than there would have been if all the hijacked aircraft had crashed in one location. Furthermore, these related but separate incidents—at least the two that generated nonfatal casualties to treat—occurred in sizable metropolitan areas where robust trauma systems were in place to manage the large total numbers of injured victims.

Event duration is important with respect to resource depletion. Many healthcare systems may be able to manage the first few, first dozen, or even first hundred casualties—depending on rate of presentation (see discussion below)—but may not be able to sustain a previously acceptable level of care if resources are used at a rate faster than they can be replenished. Even on an individual scale, running out of blood products, for example, limits what can be done for just one casualty who requires more than is available at any moment. On a larger scale, ongoing natural events (eg, multiple consecutive storms, persistent flooding, uncontrollable fires, epidemics) and other situations such as war can produce casualties faster than they can be adequately managed locally or redistributed out of an affected system, use supplies faster than they can be replaced, and exhaust personnel faster than they can be relieved.

Permissive operating environments are those in which host nation military and law-enforcement agencies have control of the population and the intent and capability to assist operations the responding military intends to conduct. Nonpermissive environments are those where host nation forces are either incapable of maintaining control of the population or are hostile to the responding military's intent. MCIs may occur in either. Those resulting from direct-action combat engagements will be discussed later in this chapter. Complex humanitarian emergencies (CHEs) are a special category that can affect millions of people through many mechanisms, such as violence, disease, starvation, and adverse environmental conditions, over many years and sometimes decades.[7] CHEs may be characterized by any combination of the following[8]:

- widespread damage to societies and economies;
- extensive violence or loss of life;
- massive displacements of people;
- need for large-scale, multifaceted humanitarian assistance;
- hindrance or prevention of humanitarian assistance by political and military constraints; and
- security risks for responders.

The US and other militaries are often called upon to respond to these disasters[9] (which clearly meet Lumley and Ryan's definition of a catastrophe "where the social fabric of society is disrupted and the medical infrastructure fails"[10]). Sometimes a US military intervention within a nonpermissive environment is required; Operation Restore Hope to Somalia in the early 1990s is a prime example.[11]

IMPACT ON HEALTHCARE SYSTEMS

Disruption or incapacitation of the medical infrastructure is just one of the many second-order effects of disasters. This certainly occurred in Hiroshima and Nagasaki, with widespread destruction of each city by detonation of nuclear weapons. On a smaller scale, this also occurred in Joplin, Missouri, when a category EF5 tornado ripped through the city and severely damaged the only two medical facilities for miles.[12]

The impact of the total number of casualties depends on the availability of space, personnel, equipment, supplies, process efficiencies, and surge capacity of the medical system. Surge capacity is the ability of any system to rapidly accommodate a large increase in throughput. Medical surge capacity involves a continuum with three distinct stages[13]:

1. **Conventional capacity**. Traditional and normal patient-care facilities and staff meet their normal goals in providing care (status quo).
2. **Contingency capacity.** Minor adaptations are made that may have minimal impacts on standards of care, but adaptations are not enough to result in significant changes to standards of care.
3. **Crisis capacity.** A fundamental, systematic change to a system in which standards of care are significantly altered.

The rate of casualty contacts is an important determinant of responsiveness—both in the field as responders encounter victims, and in treatment facilities as casualties arrive on their own or are brought in by bystanders or EMS—as part of the demand side of the supply-and-demand balance. The more compressed the number of casualties per unit of time, the more difficult it will be for any system to manage without needing to alter the standard of care to do the most good for the most people. This concept also relates to event duration, insofar as more casualties might be adequately managed if they arrive over an extended period of time.

One key ability of a system to respond to an MCI is to limit—to the extent possible—the number of patients and the rate of patient encounters for any given resource, so that each component of the response is still able to conduct relatively normal operations with conventional capacity, or satisfactorily adjust to the abnormal circumstances employing its contingency capacity. Every day across the United Sates, some emergency departments efficiently manage 500 patients per 24 hours, while others struggle to effectually care for 50.

Effective casualty management at any location often depends on dividing the workload into manageable pieces. Appropriate staging of casualties and employment of various transportation resources can make casualty movement more efficient. Distributing patients to many different facilities based on moment-to-moment receiving capacities, as well as matching injury type and severity to medical and surgical capabilities, can make the entire system more efficient and effective, especially if no one site is forced to transition from contingency mode to crisis mode.

The cause of the event often dictates what types of casualties are generated. Many cause injuries in one form or another, but even within the general category of trauma, several factors should be considered. For instance, an active shooter will mostly inflict penetrating trauma on the victims. Casualties with gunshot wounds to the neck or torso, but without obviously fatal head wounds, will usually benefit from transport to a trauma center, even if it is 20 minutes further away than a less-capable hospital. Because penetrating extremity wounds can often be stabilized in the prehospital setting, transportation to a facility even farther away might be appropriate for these casualties.

Casualties from an active-shooter event (ASE) have similar injury patterns to those seen in combat environments. Rates of casualty generation often depend on the skill and motives of the gunman, density of the targeted population, and type of weapon used.[14] In one epidemiological study, the most commonly used weapon was a pistol (60%), followed by rifles (27%), and shotguns (10%).[15] ASEs in the United States occurred 160 times between August 2016 and February 2018, with casualty numbers ranging from 0 to 53.[15] The median mortality rate during ASEs is 2, and the median number injured is 4. Business settings were reported as the most frequently attacked (37%), followed by schools (34%), and outdoor settings (17%).[14]

During explosive events, mechanisms of injury include thermal injury from the fireball; direct effects of the blast overpressure (ie, primary blast injury); blunt trauma from bodily displacement; and penetrating wounds from ballistic objects. Building collapse can also cause crush trauma to many casualties at once. Explosions and fires in civilian settings may be caused by intentional means (eg, arson or improvised explosive devices [IEDs]) or unintentionally (eg, vehicular crashes, industrial accidents, or faulty electrical wiring). They may also be caused by natural sources (eg, lightning strikes that initiate wildfires). Explosions in confined spaces or involving structural collapse are associated with greater morbidity and mortality.[16] Building collapse leads to inhalation injuries, crush injuries, and higher fracture rates in survivors.[16,17]

Many circumstances determine casualty numbers in conventional explosions, including confined space versus outdoors, size of the explosive charge, proximity of victims to the explosion, and presence of intervening barriers or body armor.[18] The most prevalent post-blast injuries among survivors are multimodal trauma, often with occult internal injuries due to the effects of blast overpressure. Explosive injuries tend to simultaneously affect multiple body regions and organ systems. Blast-related injury patterns include burns, retained foreign bodies, barotrauma, amputations, and traumatic brain injury, among others.[19]

MCIs that occur at mass gatherings have been associated with high rates of morbidity and mortality.[20] Mass gatherings pose several logistical problems for responders, including high crowd density, crowd control, restricted points of entry and movement, difficult access to victims, low security-to-medical personnel ratios, poor fire safety measures, and limited on-site medical care.[21] From 1982 to 2012, 290 mass gathering MCIs were reported, with multiple etiologies and resultant injury mechanisms. The majority (55.9%) of these MCIs involved the movement of people under crowded conditions, leading to stampede. Special hazards such as airplane mishaps, vehicular crashes, and pyrotechnic displays occurred in 19.6%. These categories of injuries were followed in frequency by structural failures (13.1%), intentional manmade events (9%), and toxic exposures (2.4%).[22]

Myriad other accidental and natural events cause trauma as well, but not all MCIs involve trauma. Healthcare systems must be prepared for disease epidemics and the potential consequences of HAZMAT or CBR exposures. Equipment resources could be severely stretched if hundreds of victims in one area required mechanical ventilation after an intentional release of an organophosphate chemical or botulinum toxin. The same might be true following accidental release of a corrosive gas.

Epidemics and pandemics often develop slowly relative to other natural and manmade MCIs. Over the course of time, however, they can consume enormous amounts of resources, and finding solutions in the forms of antimicrobial prophylaxis and treatments for emerging pathogens, particularly when developing new vaccines, can be a lengthy process. CHEs are often initiated by drought or other reasons for population displacements, but MCIs on smaller scales may occur in multiple locations with epidemics in temporary camps or interpersonal violence in fights for scarce survival resources.[23]

Events affecting large geographical areas might cause a variety of effects. Winter storms generate cold injuries and hypothermia, and also often lead to increased numbers of motor vehicle crashes, falls, power-tool injuries, carbon monoxide exposures, dehydration (if access to water is prevented for days), and exacerbations of chronic illnesses due to degraded access to necessary healthcare services and prescription refills.[24]

How the severity of illnesses or injuries is distributed throughout the casualty population affects the resource burden at any one location within the responding system. Some event types typically generate more severe injuries than others. For example, the majority of initial survivors from explosions in open areas are often discharged from emergency departments,[19] whereas explosions inside commuter buses or trains usually generate a higher proportion of critical or severely injured casualties.[25–27] Building collapses often increase the number of immediate fatalities,[2] but extrications over an extended period of time will decrease the rate of patient encounters.

The location of the event is an important consideration in both planning and response, which are critically dependent on the capacity and capabilities of the medical infrastructure and the prevailing standard of care acceptable to the population impacted. The level of care deemed appropriate within one culture may not be the same as within another culture. Americans generally expect a high level of care available to all, and persons in countries with socialized healthcare may expect some rationing of resources during the course of even normal operations. Those from impoverished nations may not expect much, and may prefer alternative approaches to healthcare not typically available from the US military operating in their country.

MCIs may occur in any setting: motor vehicle crashes, aircraft or shipboard mishaps, combat operations, or in military support of civilian communities (domestic or international settings). Geographical distribution of casualties may range from concentrated clusters of survivors in an ASE[14,15] to widespread areas in an earthquake.[28,29] Medical response to MCIs may occur during deployments in urban or geographically isolated settings. Military medical assets may be prestaged in anticipation of combat-related casualties in conflicts around the world or called upon to augment or fill an MCI response capability in non-combat scenarios as events dictate. Military assets must also be ready to participate in a community response while at home station.

GARRISON PREPAREDNESS AND RESPONSE

Permanent military bases, particularly in the United States, are integral to the communities surrounding them. Military personnel and their families often live off base and civilians commonly work on base. Many military bases are small cities in themselves, and their approach to emergency management should mirror that of other governmental organizations. According to the Federal Emergency Management Agency (FEMA), "Emergency management is the managerial function charged with creating the framework within which communities reduce vulnerability to hazards and cope with disasters [and] protects communities by coordinating and integrating all activities necessary to build, sustain, and improve the capability to mitigate against, prepare for, respond to, and recover from threatened or actual natural disasters, acts of terrorism, or other man-made disasters."[30] Emergency management is a multidisciplinary function operating within the National Response Framework (essentially the country's disaster plan, in which authorities, responsibilities, and functions of agencies at all levels are delineated).[31] FEMA has outlined the following eight principles of emergency management:

1. Comprehensive: emergency managers consider and take into account all hazards, all phases, all stakeholders, and all impacts relevant to disasters.
2. Progressive: emergency managers anticipate future disasters and take preventive and preparatory measures to build disaster-resistant and disaster-resilient communities.
3. Risk-driven: emergency managers use sound risk management principles (hazard identification, risk analysis, and impact analysis) in assigning priorities and resources.
4. Integrated: emergency managers ensure unity of effort among all levels of government and all elements of a community.
5. Collaborative: emergency managers create and sustain broad and sincere relationships among individuals and organizations to encourage trust, advocate a team atmosphere, build consensus, and facilitate communication.
6. Coordinated: emergency managers synchronize the activities of all relevant stakeholders to achieve a common purpose.
7. Flexible: emergency managers use creative and innovative approaches in solving disaster challenges.
8. Professional: emergency managers value a science and knowledge-based approach based on education, training, experience, ethical practice, public stewardship, and continuous improvement.[30]

Emergency Management Cycle

Establishing comprehensive general and MCI response programs involves hazard vulnerability assessments, which identify pre-event risks and mitigating factors for reasonably foreseeable disasters, and estimate the associated seriousness of the potential impact of such events on the population and infrastructure. Operational planning for MCIs is optimally predetermined and deliberate, with an "all-hazards approach" across all phases of the emergency management cycle: mitigation, preparedness, response, and recovery (Figure 34-1). This includes developing contingency plans for provisioning, staffing, and training MCI response teams, as well as establishing interagency relationships before urgent or emergent needs arise. Scenario-based training should be added where setting-specific disasters might occur (eg, coastal areas should prepare more for hurricanes and tsunamis, some inland regions flood more than others, certain areas are more prone to earthquakes, and many people live close to industrial sites).[32] While these preparations ideally should occur prior to deployment in a crisis, expedient "just-in-time" training may be required for unprepared responding personnel.

Notification of the need for an MCI response can come with "some warning" or as a "no warning" request for assistance. "Some warning" may occur when an event and its effects can be anticipated, such as in the case of hurricane landfall predictions with likely flooding and possible epidemics. "No warning" may occur in earthquakes or terrorist attacks.[33] In some circumstances, preparation and predeployment of medical assets may be staged in or near a region anticipating a natural event, if there is sufficient deployment time before and protection of those assets as the event unfolds. Organizers of prearranged mass gatherings should always prepare and exercise primary, alternate, contingency, and emergency response plans.[34]

The mitigation phase focuses on eliminating or lessening the impact of disaster-related events and subsequent complications that may result. Factors influencing disaster mitigation include capability of local and regional assets along with medical system resilience to the types of events that could be encountered. Mitigation effectiveness depends on the availability of information on potential hazards, impact risks, and existing or obtainable countermeasures.

The mitigation phase includes long-term policies, programs, and activities designed to anticipate and reduce the adverse effects of unavoidable natural disasters, predictable accidents, and even some intentional events. One example of a casualty mitigation effort is a community evacuation policy for hurricane-prone locations. Another method for mitigating disaster impact on response capacity is establishing memoranda of agreement or understanding between nongovernmental organizations and governmental agencies to provide mutual aid or supporting functions in the event of disasters.[35]

The medical objective for the preparedness phase is to have local governments, civil agencies, and individuals create plans to enhance emergency manage-

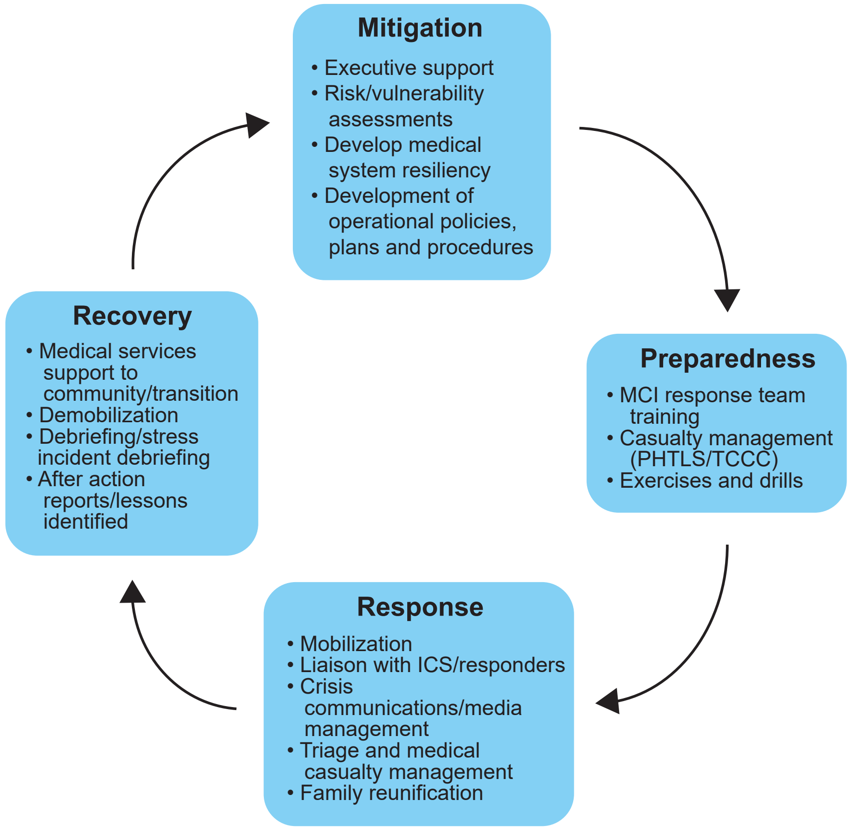


Figure 34-1. Emergency management cycle.
ICS: incident command system; MCI: mass casualty incident; PHTLS: Prehospital Trauma Life Support; TCCC: Tactical Combat Casualty Care

ment operations. These plans are used to develop a constant level of readiness and MCI-response capability via multidisciplinary and interagency collaboration. Medical preparedness measures include training in the incident command system (ICS), updating mutual-aid agreements, operational planning with equipment checks and supply inventories, refamiliarization with communications systems, practicing emergency personnel-recall procedures, and conducting exercises to practice casualty care and patient tracking. Having appropriate response mechanisms, procedures, training, and logistical support in place before an event enhances the ability for medical personnel to respond as effectively as possible to any emergency situation. These measures can be described as operational readiness to deal with disasters; this readiness can be enhanced by rehearsals, developing long-range and short-range strategies, and building early warning methods to protect the population at risk and activate response teams.

Preparedness also involves ensuring that strategic caches of equipment, medical supplies, and other essential items are maintained for regional catastrophe response. Pre-staged equipment near high-risk areas decreases the lift requirements for medical assets responding from outside the affected area. In addition, pre-identified alternative insertion locations and backup care and staging areas provide options in case primary medical treatment sites are rendered unusable.

If the necessary preparations have not been made, the responding medical team is unlikely to effectively meet the immediate needs of the affected population. Personnel who do not conduct prehospital response as part of their normal duties should seek training such as the Prehospital Trauma Life Support course.[36] Communities likely to be affected could also be trained in programs such as basic first aid and Stop the Bleed.[37] Specialized training may also be required for interagency operations, such as medical support of law enforcement in ASEs, as well as other agency contingent roles or functions.

The aim of MCI response is to provide immediate support to reduce morbidity and mortality in the affected population. This is accomplished by providing emergency services including search and rescue, extrication, extraction, stabilization, and evacuation of casualties until more permanent and sustainable solutions can be realized. The response phase focuses on immediate civilian-community or military-garrison actions, which, almost by definition, must occur using functional resources from the affected region. Local resources may be subsequently augmented by governmental, nongovernmental, or ad hoc volunteer teams pre-staged or deploying from a distance. All agencies must be able to respond effectively with experienced leaders and trained personnel, deploy quickly with adequate means of conveyance and logistical support, and possess appropriate interagency communication systems, optimally having rehearsed procedures for emergency settings.

In addition to potential casualties directly generated by an event, patients with exacerbations of chronic medical conditions may present seeking care in large numbers. Community infrastructure may be significantly impacted by a disaster through loss of healthcare access, public health services, or basic utilities, and patients with chronic medical conditions may decompensate due to loss of medications or require services such as outpatient dialysis or oxygen therapy.[38] Gaps in a locally impacted health system may be filled by dedicated teams, including relief of local medical staff, augmentation of local medical facilities for surge capacity, dissemination of provisions, mass prophylaxis or immunization programs, establishment of preventive health measures, and medical support of responders deployed away from their home bases. During these activities, important considerations include how working conditions, such as sanitation, cold or heat stress, dehydration, and psychological stress, may affect responder health. Addressing these issues will decrease the likelihood of adverse effects on team members and consequent loss of manpower.

The recovery phase focuses on rebuilding and restoring the affected community. Recovery begins right after the emergency, and recovery activities may occur concurrently with response efforts. The recovery phase's duration depends on community resilience, remaining infrastructure, and extent of additional resources brought into the region. Medical response teams may transition operations to temporarily support the affected community until return of local medical system functionalities. After action reports (AARs) are compiled during the recovery phase to help improve processes and team performance for subsequent operations. These activities then loop back to the mitigation phase.

Incident Command System

An ICS is a standardized incident management concept of command and control that allows an integrated organizational structure across agency and jurisdictional boundaries. The basis for the ICS was developed in the 1970s following a series of devastating California wildfires. AARs from these events assessed that outcomes were suboptimal due to unnecessary duplication of constrained resources, lack of standardized communication between responding agencies, ineffective tactics, and inadequate coordination of efforts.[39]

MCI response missions are coordinated through common ICS principles, which provide a unified command structure and a response framework that is not specific to the disaster type, location, or scope. This "all-hazards approach" is best employed in operations where multiple governmental and nongovernmental agencies interact concurrently in the same setting.[39] Tactical field collaborations occur more efficiently within an ICS. Personnel from different organizations are integrated in defined functional roles regardless of an individual's rank within an individual agency. Positional authority may be granted to personnel with the appropriate skill requirements to meet mission objectives. An ICS provides the flexibility to rapidly activate and establish an organizational structure around needed MCI response functions.

The ICS organizational structure is developed in a modular fashion based on the nature and size of an incident, from a localized to a regional, multijurisdictional response. The specific structure established for any MCI is based on management needs and personnel available to fill functional sections or positions, such as command, operations, planning, logistics, and administration or finance (Figure 34-2). The organization's configuration is assembled under the authority of the incident commander, who should be the most qualified and appropriate person as the situation dictates. The operations section directs all tactical response to achieve incident objectives. The planning section is responsible for collecting, evaluating, documenting, and synthesizing information to produce actionable plans. The logistics section is responsible for obtaining, maintaining, and accounting for essential personnel, equipment, and supplies. It is also responsible for support services such as facilities, transportation, communications, food, and medical services for incident responders. The finance or administration section is responsible for funding operations, cost analysis, contract negotiation, and timekeeping.

Medical operations are generally assigned to the operations or logistics section under the ICS frame-

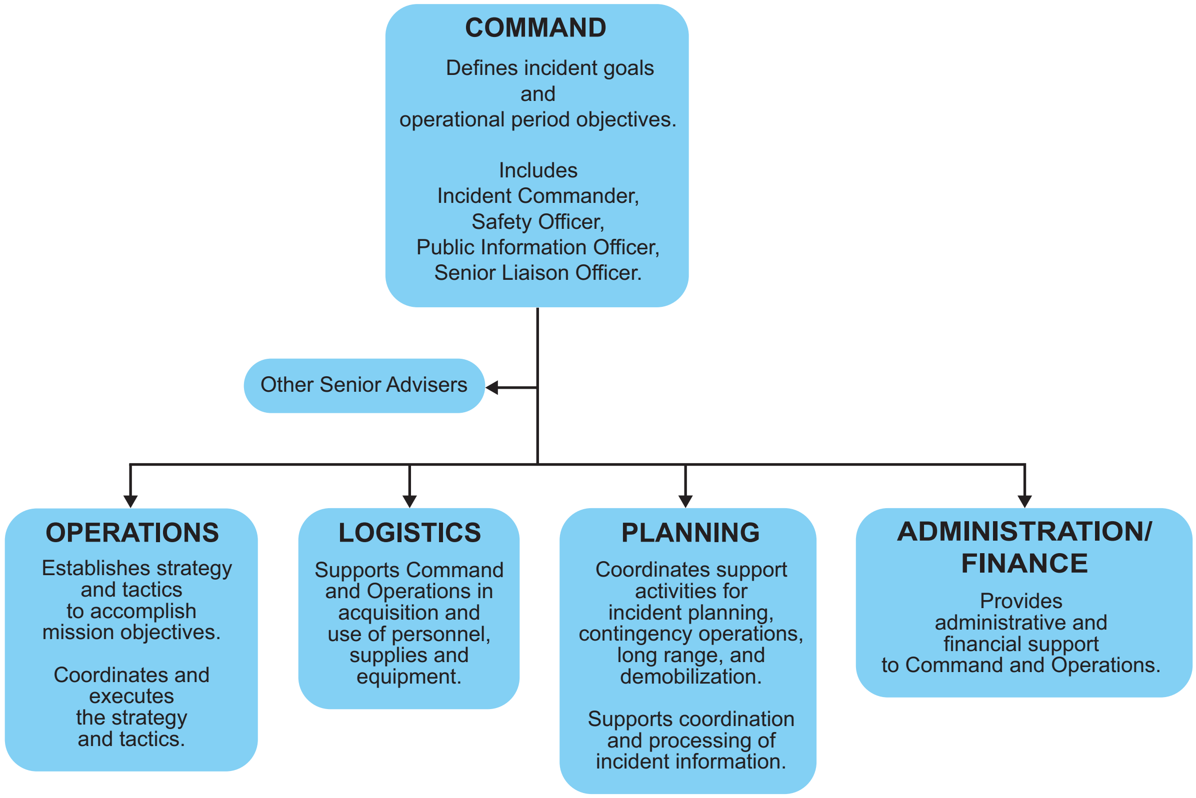


Figure 34-2. Incident command system functional structure.

work. The primary mission of medical responders is to deliver efficient care to the largest number of victims possible. If focus strays from mission-critical functions, tactical response efforts may be diffused or duplicated at the scene. Having personnel use an ICS event checklist or job-action sheet (Exhibit 34-1) ensures a frame of reference to guide response efforts within a unified command structure.

DEPLOYED ROLES FOR JOINT HEALTH SERVICES

When healthcare infrastructure and personnel must be brought with deploying forces and set up in countries where insufficient or inadequate resources exist locally, military doctrine dictates a tiered system to manage casualties at any point of injury (POI) through a global system of en-route care and interval stops at mobile or fixed locations, each fulfilling various roles in the continuous management of casualties. Deployed military medical capability is designated in four roles (formerly called "echelons") of care capabilities[40] (Chapter 14, Introduction to Health Service Support, has a detailed description of the medical roles of care in these settings). En-route care includes care rendered as casualties are moved from POI to definitive care.

Role 1 medical response generally consists of embedded individual or team medical assets within military units who stabilize casualties at the POI and move them to designated casualty collection points (CCPs). Medical supplies are limited at Role 1 and there is no capacity for holding patients, so casualties must be evacuated for further care via ground, air, or water assets as soon as possible. Particularly in Afghanistan, evacuation by air was more commonly employed due to distances and terrain involved and the risks from IEDs on ground evacuation routes.

To augment Role 1 near the POI, Role 2 capability is commonly delivered by medical assets that are mobile enough to be moved periodically to match operational requirements. These platforms are modular and typically include emergency medical resuscitation and surgical intervention assets. Role 2 Light Maneuver teams or units provide advanced medical capabilities where they can be rapidly accessible or deployable with short notification. Limitations of Role 2 staging locations include potential mismatching of resources in asymmetric warfare settings and denied environ-

EXHIBIT 34-1

JOB ACTION SHEET EXAMPLE

EMERGENCY PLAN
Operations Section
Job Action Sheet
Medical Services Subsection
Triage Unit Leader

TRIAGE UNIT LEADER
Positioned Assigned To: ______________________________
You Report To: ______________________________(Treatment Areas Supervisor)
Operations Command Center: ____________________ Telephone: _______________
Mission: Sort casualties according to priority of injuries, and assure their disposition to the proper treatment area.

Immediate

- ☐ Receive appointment from Treatment Areas Supervisor.
- ☐ Read this entire Job Action Sheet and review organizational chart on back.
- ☐ Put on position identification name badge.
- ☐ Receive briefing from Treatment Areas Supervisor with other Treatment Area unit leaders.
- ☐ Establish patient Triage Area; consult with Transportation Unit Leader to designate the ambulance off-loading area.
- ☐ Ensure sufficient transport equipment and personnel for Triage Area.
- ☐ Assess problem, triage-treatment needs relative to specific incident.
- ☐ Assist the Patient Areas Supervisor with triage of casualties, if requested by Treatment Areas Supervisor.
- ☐ Develop action plan, request needed resources from Treatment Areas Supervisor.
- ☐ Assign triage teams.

Intermediate

- ☐ Identify location of Immediate, Delayed, Minor Treatment, Discharge and Morgue areas; coordinate with Treatment Areas Supervisor.
- ☐ Contact Safety & Security Officer about security and traffic flow needs in the Triage Area. Inform Treatment Areas Supervisor of action.

Extended

- ☐ Report emergency care equipment needs to Materials Supply Unit Leader. Inform Treatment Areas Supervisor of action.
- ☐ Ensure that the disaster chart and admission forms are utilized. Request documentation/clerical personnel from Labor Pool if necessary.
- ☐ Keep Treatment Areas Supervisor apprised of status, number of injured in the Triage Area or expected to arrive there.
- ☐ Observe and assist any staff who exhibit signs of stress and fatigue. Report concerns to Treatment Areas Supervisor. Provide for staff rest periods and relief.
- ☐ Review and approve the area documenter's recordings of actions/decisions in the Triage Area. Send copy to the Treatment Areas Supervisor.
- ☐ Direct non-utilized personnel to Labor Pool.
- ☐ Other concerns:

ments, where injuries occur in unexpected locations outside the "reach" of air assets, creating redundancy when assets are placed in close proximity to each other, resulting in overflying of some locations, and creating security risks if enemy forces attack these positions.

Role 3 medical treatment facilities (MTFs) are relatively fixed in position, and are similar to stateside hospitals with more resources and capability to manage the demands of MCIs than even Role 2 Enhanced facilities. Resources at Role 3 typically include teams of providers, often enough to work shifts; specialized providers and support personnel; and greater availability of blood products, advanced diagnostic imaging, and laboratory assets. Additional capabilities may include neurosurgery, vascular surgery, or other surgical specialties.

Role 4 MTFs provide definitive care with resources such as medical and surgical subspecialties, rehabilitation, and prosthetics. These facilities are generally outside of theater boundaries and provide support to the population at risk on an area basis subject to the limitations of evacuation assets to reach the facility. Role 4 care is typically found in large overseas MTFs (eg, Landstuhl Regional Medical Center) and US-based hospitals and medical centers. Distribution of extraordinary casualty numbers to appropriate facilities throughout the United States—whether the need arises from a domestic disaster or combat casualties returning from overseas—may be managed through the National Disaster Medical System, which is the administrative system under the US Department of Health and Human Services (DHHS) for coordination of resources across jurisdictions throughout the United States.[41]

Despite the tiered structure of deployed capabilities, casualties do not necessarily flow through the four roles in a sequential manner. For example, some casualties may be evacuated directly from the POI to a Role 3 facility, or from a Role 2 forward surgical capability directly to a Role 4 hospital to begin more definitive care.

None of the roles provide every service a casualty might require, and none possess unlimited surge capacity. Therefore, medical personnel should be aware of local medical resources and engage with host nation hospitals in the area whenever available and politically feasible. Regardless of whether deployment occurs overseas or in the United States, conducting site surveys, establishing interpersonal relationships, and preparing written working agreements with medical facilities for specialty care and surge overflow incorporates these resources into medical contingency plans, and thereby establishes a regional capability regardless of country.

Defense Support to Civil Authorities

Stark contrasts may be seen in the response capability of different communities. Industrial nations with robust EMS and healthcare systems may be able to absorb and effectively treat significant numbers of casualties; however, rural or low-income locales may not have adequate health system infrastructure to deal with critical conditions or any significant volume of casualties.

The United States has a tiered domestic disaster response, with local efforts committed first until resources are exceeded. Requests for state aid are then made to support local efforts. When local and state efforts are overwhelmed, the federal government may be asked for national-level assistance. Once a declaration of federal disaster is made, the president of the United States may task the DHHS, the Department of Defense (DoD), or both to provide domestic assistance to local and state assets. When the DoD provides this support, it is known as defense support to civil authorities.[42,43] The DoD may also provide specialized support capabilities such as CBR, nuclear, or high-yield explosive disaster response. Examples of DoD domestic disaster response include assistance to Colorado in 2013 for flooding, to the mid-Atlantic and northeastern United States in 2012 for Superstorm Sandy, to Kansas in 2007 after a tornado struck Greensburg, and to the Gulf Coast in 2005 for Hurricane Katrina.

Unique or robust support commonly provided by the military includes transportation, logistics, communications, and rapidly deployable medical care. Transportation and logistical support is often the key capability needed in an area affected by a disaster, either because local or regional assets were disabled or destroyed, or because sufficient resources were not present even before the event.[9] Due to a constant state of readiness, military transportation assets and logistical support can be provided relatively quickly once approvals flow down from the National Command Authority (ie, the president of the United States and the secretary of defense), but approval and mobilization commonly takes 3 to 4 days.

Disasters may drastically impact communication infrastructure in an affected community by damaging wireless or radio towers, causing sustained power outages, and overwhelming networks burdened with too many users. Devastation of the communications infrastructure leaves responding agencies and local populations unable to dispatch medical resources, coordinate resource allocation, or relay critical updates.[44] Embedding self-contained communications capability with deployed units addresses these gaps. Intact communications allow for timely incident system status assessments to be used for initial and subsequent reports from the scene. These updates provide situational awareness to decision-makers. Status updates may also provide alerts to impacted citizens to guide them to temporary medical facilities, shelters, or evacuation destinations.[45] Military communications technology is some of the best in the world, and has the advantage of being designed for use in austere and harsh environments, so it is often helpful to regions with poor infrastructure or degraded capability.

US medical, surgical, and public health assistance can be deployed using a variety of teams from the DHHS or the DoD, but consideration must be given to what will be needed when. For instance, following an earthquake, a region may have a pressing need for acute trauma care when the request for US assistance is made, but that requirement will decrease over time as casualties are either saved or die. By the time trauma teams arrive 4 or more days after the event, they may no longer be needed.

Foreign Humanitarian Assistance

DoD assets may be used in support of foreign disaster relief operations when the following three criteria have been met: the military provides a unique service, international civilian capacity is overwhelmed, and the host nation requests assistance. DoD components provide disaster assistance under presidential directive when the secretary of state requests assistance to support another federal agency, or in emergency situations in order to prevent loss of life.[46,47] Recent examples of DoD international disaster assistance include deployments to Southeast Asia in 2013 for Operation Damayan after Typhoon Haiyan (Yolanda) impacted the region, to Japan in 2011 for Operation Tomodachi after a magnitude 9.0 earthquake and subsequent tsunami, and to Haiti in 2010 for Operation Unified Response following a magnitude 7.0 earthquake.

Noncombat illnesses and injuries depend on the nature of the event. Injuries may include penetrating, blast, blunt, thermal, crush, or immersion injuries —or combinations of these. Physical injury represents the major cause of mortality and morbidity for larger MCIs, though secondary morbidity results from public health impacts.[40,48–51]

Natural disasters can have an especially devastating effect on the population. An annual average of 21 earthquakes over the last 30 years have resulted in a request for international assistance or a declaration of a state of emergency. Many factors in addition to earthquake magnitude influence the MCI casualty distribution. These include the time of the day the event occurred, distance of the population from the epicenter, secondary events triggered by the earthquake, urbanization grade, building standards and regulations, and access to medical care.[28] Death tolls from major earthquakes range from fewer than five to nearly a quarter million.[51]

The majority of conditions in casualties presenting in the first 3 days of an earthquake are due to trauma such as lacerations and musculoskeletal injuries. Crush injuries and subsequent complications pose significant additional challenges for medical management in austere conditions. In addition to acute renal failure, multiple organ systems can be affected. Complications from crush injuries include compartment syndromes, electrolyte abnormalities, arrhythmias, hypovolemic shock, sepsis, acute respiratory distress syndrome, disseminated intravascular coagulation, and cardiac failure.[52] After this acute injury period, the majority of care shifts to a nontrauma profile with a sustained increase in demand for medical services lasting at least 10 days following the earthquake.[52]

From 1980 to 2000, an average of 11,800 deaths per year were attributed to cyclones (hurricanes or typhoons). The average number of cyclone effects on individual nations was 46 per year, with many of these storm systems affecting multiple nations. Conversely, several nations experience multiple storms each year. For example, in 2004, the United States was struck by five hurricanes, four of which made landfall in the state of Florida. A less recent but massive cyclone in 1991 killed about 150,000 people in Bangladesh alone.[53] Secondary weather effects from cyclones include flooding (storm surges), landslides, and tornados. Minor injuries including lacerations, blunt trauma, and puncture wounds are common with cyclone-related incidents, and 80% of these injuries are restricted to lower extremities.[38]

CHEs may be created by US military combat operations, when collateral damage dramatically impacts large civilian populations. On the other hand, most civilian morbidity and mortality during CHEs is due to potentially preventable infectious diseases, malnutrition, and interpersonal violence.[54,55] Impacted civilians may present for care during or immediately after combat operations.

Combat Operation Injury Patterns

Modern combat operations have transitioned from massive armies facing off with defined front lines to asymmetric warfare amid low-density, nonlinear, remote, disbursed operations (eg, Afghanistan) and complex urban conflicts (eg, Mogadishu).[56] Smaller conflict sizes have resulted in fewer overall US and coalition casualties, but substantial losses have occurred among the units actually engaged.[56]

Damage sustained depends on the mechanism of injury in each case. Recent rates for wound locations are head (8%), eyes (6%), ears (3%), face (10%), neck (3%), thorax (6%), abdomen (11%), and extremities (54%).[57] Injuries resulting from exsanguinating hemorrhage are often immediately lethal, and thus may benefit from rapid and effective intervention, but up to 50% of these casualties may die without immediate treatment. Approximately 20% of deaths from hemorrhage occur from injuries in body areas where the bleeding might have been controlled by simple direct pressure.[56–58] Attention and direction of line commanders in mitigating this risk to forces has been demonstrated to be effective when implemented consistently throughout a combat unit.[59]

Peacekeeping operations have an estimated mean wounded-in-action rate of 3.16 per 1,000 troops per year. The estimated wounded-in-action rate for individual operations ranged from 0.49 to 12.50. In 188 casualty-generating incidents examined, an average of 3.8 troops were wounded and 0.86 killed.[59] The widespread use of enhanced vehicular shielding and individual body armor has subsequently led to increased survival from combat-related injuries. Nonetheless, protection of the head and torso has increased the proportion of extremity injuries, which have recently been described as comprising approximately 50% of all combat wounds.[60,61]

Combat-related injury patterns have changed over the last century, with an increased trend of injuries due to explosives compared to those caused by small-arms fire.[62–65] In World War I, for example, 65% of all recorded combat casualties resulted from gunshots.[61] This decreased to 35% during the Vietnam conflict,[62] and recent estimates of casualties from direct-fire weapons in the Iraq and Afghanistan theaters are 16% to 23%.[57,60] On the other hand, IEDs have been used with great effectiveness, and have increased in sophistication in both combat and noncombat settings. Recent estimates for combat-related MCIs caused by IEDs are approximately 18% of all treated casualties.[61] Traumatic amputations and penetrating extremity trauma following explosions may cause massive hemorrhaging, but on-scene application of single or multiple tourniquets by the casualty or a buddy has increased survival rates.[58] See Chapter 35, Chemical, Biological, Radiological, Nuclear, and Explosive Threats, for further details on conventional combat-related injury patterns.

Overwhelming numbers of casualty estimates (> 500,000) are projected in nuclear conflicts. Even single improvised nuclear devices in one location would cause a very high-magnitude MASCAL situation and likely disrupt the responding medical infrastructure at the same time.[66] Modeling of a range of scenarios has been completed, with various nuclear detonation yields (0.1–10 kilotons), heights of burst (ground and air), and weather conditions in several major US cities.[67] Nuclear or radiological devices cause injury through blast, thermal, light, and ionizing radiation effects. Potential for significant radiation exposure may exist with little or no evidence of physical trauma.[66] Radiological effects are determined by exposure time, distance from source, and any shielding that may have been present.[67]

UNIVERSAL MASS CASUALTY PRINCIPLES

The effects of trauma-causing MCIs occur in a trimodal distribution. The initial phase occurs with onset of the event or immediately afterward and is characterized by high mortality rates due to injuries. In the minutes to hours after onset, the second phase entails early trauma management. During the first 24-hour period, most fatalities occur and the majority of casualties are recovered. Medical care may be limited to on-scene stabilization at or near the POI for casualty management. In these circumstances, a greater emphasis is placed on the rapid evacuation of casualties to designated temporary staging areas or definitive treatment facilities. In the third phase, days to weeks after the disaster, efforts are directed at treating injury complications (eg, sepsis, multiple organ failure, and psychological problems). Having to move casualties long distances out of an affected area, either because the local system is overwhelmed or other facilities are more capable, can have an effect on these patterns.[68]

Regardless of the nature of the event, casualties presenting during MCIs surpass ordinary medical system capacity and require coordinated efforts to sort and prioritize available resources to meet the needs of as many casualties as possible. Based on the magnitude of the MCI, “minimum acceptable care” principles may apply. Austere conditions are said to exist when medical personnel, supplies, or equipment are limited, or when adverse conditions impact the ability to provide “normal care” to casualties.[68] Successful critical-care stabilization has been demonstrated in military and civilian operations with careful management of limited or constrained resources through planning, rehearsals, and continuous reevaluation; using equipment and supplies appropriate for each situation; leveraging evacuation assets in terms of type, timing, and transportation destinations; and employing the right people with the right skills at the right time across the complete continuity of care.[69]

MCI response first occurs at the local level and relies on unaffected medical assets at or near the scene. The remaining functional infrastructure becomes the initial part of the regional medical system of care for the MCI. Local medical resources may be severely impacted by the disaster through loss of hospital or emergency services staff, equipment, or hospital-based facilities. Once conventional capacity is exceeded, a number of factors influence the level of response to MCIs. These include well-developed plans, remaining functional infrastructure, operational resource allocation, effective triage, accessible staging areas, organizational communication, and clear chain of command. Coordination of medical response among personnel and facilities depends on the physical location of affected areas and distance to staging areas or medical facilities. External teams can deploy in an attempt to fill functional and logistical gaps in care delivery.

A tactical approach for MCI management includes a well-considered plan (Exhibit 34-2) and preestablished practices to provide interim medical services to an impacted healthcare system through resource deployment, field care principles, and designated medical facility reception. This approach includes specially trained responders and links field operations with medical facilities through an overall ICS structure. Assumptions for optimal MCI management include an effective triage process, field stabilization, and viable evacuation routes with ample transportation assets. However, this approach is based on the availability of sizable amounts of resources accessible or obtainable in a timeframe that will affect outcomes. Constrained resources will likely result in degraded system performance. In such situations, MCI tactics should be adapted to best meet specific situational needs. Duplicating or obstructing services through poorly coordinated efforts is a risk when deployed teams lack situational awareness on the ground.

Situational awareness involves consideration of mission objectives and rules of engagement. Other considerations include security issues from possible enemy activity or other threats to responders (eg, secondary IEDs, fire or flood, unstable structure) and number of personnel available plus knowledge of their individual and collective skill sets. Terrain, weather, time of day, time available to accomplish the mission while maximizing casualty outcomes, and the effects on the local civilian population (and the effects from civilians on the ability to deliver care) are also important factors. Estimates of the resources that will likely be required; known need for specialty resources (eg, decontamination teams); and the possibility of cascading events or new incidents in separate locations are just a few of the many considerations for responders.

Scene Management

A rapid situational analysis defines the circumstances of the MCI, and is paramount to guiding responders. This "rapid needs assessment" is critical to avoiding a "ready–fire–aim" approach. It establishes a baseline for decision-making and resource allocation (Exhibit 34-3). Responder team safety is a primary concern to preserve mission capability. MCI scenes will likely be chaotic, with normal operations disrupted. Effective responses require a systematic approach to deal with rapidly changing situations. Situations may become unstable at any time, posing new threats to responders. Dangers depend on the cause of the disaster and range from manmade security threats to environmental threats. Security threats may involve advancing hostile forces, an active shooter, or secondary explosive devices. Moreover, civil unrest often accompanies societal instability, leading to looting and violence as

EXHIBIT 34-2

MASS CASUALTY INCIDENT PLANNING CHECKLIST

- Does MCI plan cover the tasks and responsibilities of all the organizations and personnel likely to be involved in the response?
- Is staff familiar with implementation of the MCI plan?
- Do involved organizations and personnel have an ongoing, mandatory MCI training program?
- Has the MCI plan been validated for expected type and volume of casualties? How?
- Are MCI responder tasks assigned in terms of positions rather than individuals?

MCI: mass casualty incident

EXHIBIT 34-3

MASS CASUALTY INCIDENT RAPID SITUATIONAL ASSESSMENT

- Determine the magnitude of the disaster or MCI response mission.
- Establish priorities and objectives for action.
- Evaluate the capacity of the local response (including resources and logistics).
- Determine external resource needs and prioritize actions.
- Plan execution of mission objectives (duration, scope, exit strategy etc).
- Know your role.

MCI: mass casualty incident

secondary security concerns.[70] Acute environmental threats include unstable building structures, hazardous materials or smoke exposure, potentially injurious debris, gas leaks, flooding, downed electrical lines, and stray animals, among others. Cascading events may lead to explosions, fires, and building collapses.

Mitigating risks—to the extent possible consistent with mission completion requirements—allows personnel to focus on locating casualties and extracting them from the POI to a CCP for triage. Many casualties may be located in multiple locations with restricted access and possibly obstructed from view, thus requiring ad hoc or professional search teams. Securing the location and scene support should occur as soon as feasible to prevent secondary casualties among bystanders or responders. Deciding between stabilization at the POI or rapid victim movement must be balanced with the risk assessment of ongoing and potential hazards.

Support for civil MCI response may be needed from volunteers, utility agencies, fire departments, law enforcement, local military units, or activation of specialty services (eg, urban search and rescue teams). Each of these agencies and services augments response personnel, secures scene hazards, and brings skills to help access casualties safely and expeditiously. Availability of these services and trained volunteers varies among domestic and international settings. In domestic disasters, the DHHS coordinates three programs that maintain registries of healthcare volunteers: the Emergency System for Advance Registration of Volunteer Health Professionals,[71] the Medical Reserve Corps,[72] and the NDMS.[73] National Voluntary Organizations Active in Disaster[74] and the WHO[75] are resources for international settings.

Volunteer efforts by individuals or organizations pose unique challenges. A rush of volunteers following a disaster without overall coordination can overwhelm a response system and make the situation worse.[76] Managing any volunteer response force is difficult, due to a variety of backgrounds and lack of experience among the volunteers. Additionally, well-meaning but untrained volunteers can increase the risks of personal injury, general and medical liability, and mission failure. Poorly prepared volunteers may present without proper medical screening or appropriate immunizations; with inadequate clothing or equipment; and lacking accommodations or shelter, food, and prophylactic medications.[77] These volunteers potentially become dangers to themselves or existing casualties and can drain limited resources from response efforts. Verifying credentials requires significant logistical support in the midst of chaotic situations. Prescreening volunteers provides a viable alternative.[76]

Rapid Needs Assessment

There is no exclusive set of criteria for initially measuring event magnitude and severity because every MCI presents a unique set of circumstances. Determining what has happened, what the impacts are, and what dangers exist is completed during the preliminary scene survey (see Exhibit 34-3). This survey should include casualty estimates with cursory injury pattern distribution, assessment of transportation assets including viability of access from base to scene to treatment destinations, and assessment of the functionality of receiving centers.[74]

Casualty estimates serve to guide MCI medical responses, and have been modeled in a number of different scenarios and calculated in real-world experiences. Cause, magnitude, and population density allow for casualty projections at an affected location.[28,65,78–81] Casualty estimates for combat-related and noncombat-related MCI events have changed over time and vary with each incident.

Triage

MCI injuries span the full spectrum of trauma, with human effects ranging from expected emotional reactions to severe psychological trauma, and minor abrasions to "total body disruption." The approach to acute resuscitation of combat-related versus noncombat-related injuries differs due to the unique aspects of combat: high energy and lethality of wounding instruments, multiple concurrent mechanisms of wounding, predominance of penetrating injury, persistence of threat in tactical settings, austere resource-constrained environment, and often delayed access to definitive care.[51] However, injury patterns considerably overlap in terrorist attacks and combat-related injuries, and classifying injury patterns assists in preparation for casualty care. A sample of potential injuries that may be encountered in MCI scenarios is listed previously in the scope and impact sections (although individual injury characteristics have been extensively evaluated in the literature and detailed descriptions are beyond the scope of this chapter).

Effective MCI management is based on the principles of triage to prioritize treatment or transport and allocate resources. Triage systems allow a measure of order in an otherwise tumultuous situation in which most factors may be out of the control of responders. Internal and external considerations influence this sorting process. The restraints of capability, time, and distance to stabilization or definitive care require responders to continuously adjust processes based on prevailing conditions. Triage may be performed at the POI, at one or more CCPs, or at fixed facilities depending on where casualties are found or present.

Less seriously injured persons may or may not seek immediate medical evaluation and may leave the scene. They may seek their own care at nearby medical facilities or find their own means of conveyance to other destinations. These casualties "self-sort" and may present as pedestrians, via personal vehicles, or on vehicles of opportunity such as buses or trucks. This may result in many less severe casualties flooding local medical facilities before more severely injured, nonambulatory casualties can be transported from the scene. Casualties who are still present at the scene when trained personnel arrive may be "globally sorted" by instructing all mobile victims to move to a designated area. This allows observation of these casualties at one location while triage teams sort remaining casualties who cannot move under their own power.

Triage algorithms or protocols are used to assess the physiologic status of each casualty. In the United States, casualties are traditionally sorted into five color-coded categories: immediate (red), delayed (yellow), minimal (green), expectant (blue), and deceased (black). The last two categories are by no means standardized, and black is sometimes used to identify expectant casualties. The term "expectant" is often used for casualties responders "expect to die," thus relegating them to comfort care alone when resources are limited. A hemodynamically unstable patient with penetrating trauma to the head and a Glasgow coma score of 3 may be expectant and potentially mortally wounded. However, some expectant patients may be otherwise classified as immediate if resources are available. The authors believe the term should be reserved for casualties who responders "expect to reevaluate" for the possibility of more aggressive care once required resources become available. If resources do not become available, and casualties cannot be saved, they should remain expectant until they are pronounced dead.

Injuries categorized as immediate (red) require acute interventions to avoid mortality or further morbidity. Injury patterns in this category include uncontrolled internal or external hemorrhage, tension pneumothorax, and acute airway compromise, as well as threats to eyesight and limb salvage. Procedures for treating an immediate casualty may include tourniquets, compression, or hemostatic dressings; needle thoracentesis or sealing open pneumothoraces; and simple airway interventions such as placing a nasopharyngeal airway or rolling casualties into the recovery position.

Delayed (yellow) casualties present with injuries in need of intervention, but they are stable or can be stabilized until definitive care is available. Examples include head and torso injuries for which nothing can be done in the field, open fractures, and spinal injuries. Medical management for delayed casualties may include fluid resuscitation, fracture stabilization, analgesic medications, and antibiotic administration when indicated.

Minimal (green) casualties present with injuries that are not deemed to threaten life, limb, or eyesight. These include minor abrasions, lacerations with controlled bleeding, simple dislocations and fractures, and minor burns. These casualties can be managed effectively with minimal medical care, or they may self-treat, thereby bypassing the healthcare system entirely or presenting to a primary care location on another day.

A number of protocols can be employed to assist the triage process in the prehospital setting and in civilian and military hospitals.[82–92] However, evidence favoring any particular system is limited; the majority of published articles communicate expert opinion only or the results of simulations and exercises. Extrapolating outcomes through retrospective analysis of trauma registries has also been used to assess various triage algorithms, but these findings may be limited because most casualties were not injured in MCIs, and even fewer were managed in situations when the standard of care had to be adjusted for limited resources.[78]

Widely used MCI triage algorithms include "SALT" (sort, assess, lifesaving interventions, and treatment and transport)[91]; "START" (simple triage and rapid treatment) for adults[84]; and "Jump-START" for pediatric patients, which recognizes distinctions between adult and pediatric physiology at triage decision points (Table 34-1).[85] General principles of out-of-hospital triage and treatment, regardless of system used, are as follows:

- interventions should be limited to immediate life-saving maneuvers, because resuscitation

TABLE 34-1

COMPARISON OF TRIAGE ALGORITHMS

SALT	Category	START: Adult	Category	JumpSTART: Pediatric	Category
Global Sorting		☐ Walking	Minor	☐ Walking	Minor
☐ Still/Obvious life threat - assess 1st		☐ No respirations after head tilt	Expectant	☐ No respirations/no pulse	Expectant
☐ Wave/Purposeful movement - assess 2nd ☐ Walk - assess 3rd		☐ Respirations: above 30	Immediate	☐ Respirations: above 45/ below 15	Immediate
Individual Assessment ☐ Life Saving Interventions -Hemorrhage control, open airway, decompress chest		☐ Perfusion: No radial pulse/cap refill 2+ sec	Immediate	☐ No respirations with peripheral pulse - give 5 rescue breaths - respirations resume	Immediate
Minor Injuries Only - Yes	Minor	☐ Mental status: unable to follow simple commands	Immediate	☐ No spontaneous respirations after intervention	Expectant
Minor Injuries Only - No	Delayed				
Likely to Survive Given Current Resources - Yes	Immediate				
Likely to Survive Given Current Resources- No	Expectant				
☐ Treatment/ Transport		☐ Stable RPM	Delayed	☐ Perfusion: No peripheral pulse/ cap refill 2+ sec	Immediate
				☐ Mental Status: AVPU ☐ AV	Delayed
				☐ PU	Immediate

RPM: respirations, pulse, and mental status
AVPU: awake, verbal, pain, unresponsive
Data sources: (1) Benson M, Koenig KL, Schultz CH. Disaster triage: START, then SAVE—a new method of dynamic triage for victims of catastrophic earthquake. *Prehosp Disast Med*. 1996;11:117–124. (2) Romig L. Pediatric triage: system to JumpSTART your triage of young patients at MCIs. *J Emerg Med Serv*. 2002;27:52–58,60–53. (3) SALT mass casualty triage: concept endorsed by the American College of Emergency Physicians, American College of Surgeons Committee on Trauma, American Trauma Society, National Association of EMS Physicians, National Disaster Life Support Education Consortium, and State and Territorial Injury Prevention Directors Association. *Disaster Med Public Health Prep*. 2008;2:245–246.

will consume limited resources and should be reserved for salvageable cases;
- patients in shock do not tolerate movement well, so resuscitation should be accomplished in an ongoing manner before and throughout transportation;
- casualties' conditions may change at any time, so they should be reassessed regularly and priorities reassigned as indicated; and
- urgent interventions must never be delayed by documentation.

Time is critical in an MCI. Focusing too much on treatment during the triage phase limits the number of casualties who can be assessed and provided with necessary interventions in the field.

Other potential pitfalls can impede the triage process at the POI or CCP. Failure to consider HAZMAT or CBR contamination, IEDs placed near or on casualties, retained ordnance, or rescues requiring specialized expertise and equipment pose risks to medical teams. Lacking a coordinated and rehearsed team approach limits effective engagement with casualties. Inadequate medical size-up by the initial team will have repercussions for appropriate deployment and allocation of resources and staffing. Indecisive leadership causes obvious problems for subordinates carrying out the mission. Military rules of engagement may also affect triage operations if they restrict what care is authorized for noncritical casualties who may not be US or coalition personnel.

Once casualties are triaged at the scene, they should be brought to a CCP, where they may be re-triaged into treatment areas. Many civilian and military hospital-based emergency departments employ facility-based triage protocols that define expected time intervals for patient evaluation, such as the Emergency Severity Index.[86] However, this type of algorithm assumes a fully staffed and functional emergency department without resource constraints, thus allowing maximal resuscitation efforts of critical "full code" patients even if they have a poor prognosis. Expenditure of significant resources in personnel, time, and supplies may not allow for those resources to be used on other casualties under MASCAL conditions.

No matter what system is used at any location, not all the information necessary to make a completely accurate assessment will be available for all victims at all times. "Over-triage" occurs when casualties are assessed to be more serious than they are. This results in allocation of scarce resources that could be used for other patients. "Under-triage" occurs when casualties are deemed to be less serious than they are, which can lead to potentially unnecessary morbidity and mortality.[83] There are no universally accepted best-practice cut-offs for over- or under-triage, which are analogous to excessive sensitivity or inadequate specificity. Over-triage is more common when children are affected in MCIs, or when inexperienced personnel or bystanders make triage decisions.[87,89] Most cultures would accept some excess over-triage that stresses the system in order to minimize the rate of under-triage that misses casualties who need emergent or urgent treatment.

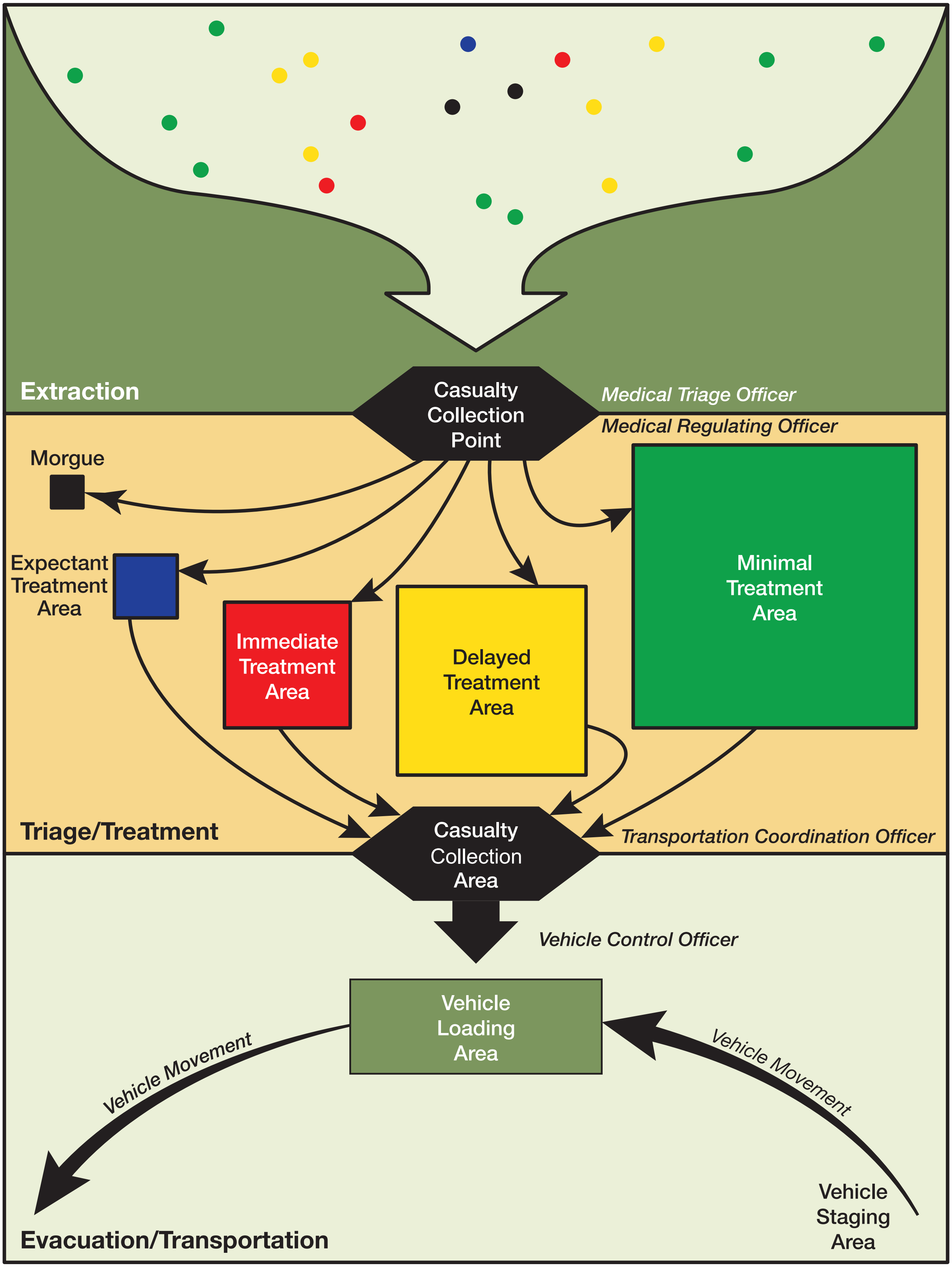
In resource-constrained situations, critical care efforts are reserved for immediately salvageable casualties so that multiple victims can be effectively managed. MCI triage protocols provide a structure to focus triage decisions in an objective manner rather than subjectively assigning treatment based on personal opinion or biases. This improves inter-user reliability and reduces over- or under-triaging that might divert appropriate resources from more critical injuries.[88] However, different triage systems were developed from different problem sets, so they may not be universally applicable. For instance, the START methodology was developed for response to injuries sustained during earthquakes.[84] It gained very wide acceptance, but it may not be as effective for other situations (eg, ASEs) or nontrauma scenarios.[90] SALT[83] has been recommended as a US national standard,[91,92] but has not yet been shown to improve outcomes in actual MCIs.

Casualty Collection Points

Functions at CCPs include triage, field treatment, and evacuation staging. Maintaining casualty flow depends on rapid assessment, initial stabilization, and appropriate disposition. The location of a staging area should be near enough to the MCI to be effective without posing undue risk to medical staff. These areas should have well-designated ingress and egress points, a decontamination area, and access to nearby transport areas for air, ground, or water evacuation. Patient flow should be linear to designated category areas listed above to mitigate against choke points (Figure 34-3). Casualty movement through the triage site should not backtrack through the treatment areas.

The triage officer oversees the triage team at the entry control point. Initial movement of casualties is directed toward the established treatment areas for stabilization or observation based on triage categories. Every member of the triage team should be familiar

Figure 34-3 (*right*). Generic casualty-flow schematic of mass casualty incident response operations.


Extraction
Casualty Collection Point
Medical Triage Officer
Medical Regulating Officer
Morgue
Expectant Treatment Area
Immediate Treatment Area
Delayed Treatment Area
Minimal Treatment Area
Triage/Treatment
Casualty Collection Area
Transportation Coordination Officer
Vehicle Control Officer
Vehicle Loading Area
Vehicle Movement
Vehicle Movement
Vehicle Staging Area
Evacuation/Transportation

with the triage protocols in use and train through functional drills to facilitate effective casualty movement.[32] Distribution of casualties may require changing personnel numbers to meet the rate of casualty arrival as staffing and space allow.

Treatment areas should be aligned with the triage categories of immediate (red), delayed (yellow), and minimal (green)—where resuscitation, stabilizing procedures, and first aid may be given, respectively—if all of them are necessary and can be established prior to casualty arrival. Depending on circumstances and available resources, expectant (blue) casualties should be located near the critical-care (red) area for rapid access if future resources permit field interventions.

Working areas should be spacious enough to manage anticipated number of casualties, be sheltered from the environment, have adequate illumination, and be climate controlled if feasible. Each area can be expanded and contracted as required to meet demand and efficient distribution of resources.

Additional considerations include the following questions:

- How should the area be secured?
- Does the location allow for easy access by litter teams bringing in casualties?
- How large should treatment areas be, and is there room for expansion if needed?
- Do treatment areas have optimal access to medical supplies?
- Does each area have unrestricted access to the transportation staging area?
- Where is the location for decedent casualties?

Medical regulators provide administrative oversight for patient tracking, provide overall casualty status updates (number and condition), and coordinate record-keeping during MCI operations. Information is relayed from respective medical recorders who identify, tag, and register patients in their treatment areas to the regulators who control evacuation. Casualties may be identified with any method that is reproducible and familiar to responders. Patients may be tracked by high-tech or low-tech methods, ranging from electronic medical records specifically designed for disasters,[93] to a paper and plastic system similar to that used by air-traffic controllers,[94] to a system of placing numbers on the casualties' foreheads with indelible markers. Chosen methods should be consistently used throughout the MCI event.

Treatment teams should be comprised of medical personnel with appropriate levels of training to meet the medical requirements of the triage category assigned. The immediate area treatment teams should be familiar with interventional and resuscitative procedures in resource-constrained conditions. Other treatment areas can be staffed with providers and medics who do not have the same level of emergency skills, but who are able to care for delayed and minimal casualties and identify deterioration in their conditions.

Maintaining a dynamic triage process, where casualties are reassessed throughout the treatment areas, allows for recategorizing and changing treatment and evacuation priorities based on clinical status. Several special considerations affect triage flow. Situations with imminent threats may require "reverse triage," in which casualties with minor problems in the green and yellow categories receive precedence in order to rapidly evacuate greater numbers from the scene for maximum overall survival, or first treating and returning to duty casualties who might play critical roles in stabilizing hazardous conditions, such as firefighting or combat security.

From a safety standpoint, security and decontamination procedures should be in place at the CCP to prevent injury of personnel and thereby compromise the MCI response mission. Security checkpoints should be used for screening unidentified personnel escorting casualties, clearing potential weapons and removing unused ammunition, and searching for unexploded ordnance and IEDs before casualties enter the CCP.

Decontamination stations are employed for suspected HAZMAT or CBR contamination. Decontamination teams should be well versed in procedural methods, have the appropriate level of personal protective equipment, and be familiar with hot, warm, and cold zones. Hot zones are designated areas around the immediate area of CBR contamination or incident scene. Entry into this zone should be through a controlled access point for accountability purposes and avoidance of contamination spread. Decontamination takes place in the warm zone, which is an area established around the hot zone as a buffer between the hot and cold zones. The cold zone is a contamination-free zone established around the warm zone where emergency operations can be directed and supported.

Finally, several functions may be stationed near the CCP to avoid disrupting triage and treatment operations. These include mortuary services, a bereavement area, public affairs access point for media control, and family notification and reunification areas.

Incident magnitude may range from a few critical patients in ASEs to several hundred patients in hurricanes or earthquakes. Needed resources for large numbers of casualties presenting simultaneously may necessitate several dedicated triage teams and multiple CCPs. Transportation delays may occur due to inadequate vehicle numbers or types, inclement weather, damaged and blocked roadways or inaccessible sites, or ongoing disaster-induced obstructions (eg, fire, water, ice and snow). In these cases, CCPs may become impromptu field medical stations where casualties will be managed for potentially extended periods of time.

Transportation Management

More severe casualties may be immediately transported from the scene instead of being brought to CCPs, depending on available resources and tactical conditions. Destinations may become "saturated" quickly, and transport routes may become inaccessible, requiring some receiving facilities to be bypassed for alternative sites. Situational awareness of the entire system allows provision of care and appropriate disposition for the greatest number of casualties presenting to be triaged. As patients are moved through the system of care, triage and re-triage occur based on changes in the status of the patient and the system.

Just as triage is performed for treatment, it should also be applied to casualty transportation. The US military uses urgent, priority, routine, and convenience evacuation categories to indicate how soon a casualty requires the next step in care. On a tactical level (essentially ground and rotary-wing evacuation), "urgent" signifies the need for care within the next hour (previously 2 hours by doctrine, until the secretary of defense mandated 1 hour in 2009[95]). "Priority" indicates evacuation is needed within 4 hours, and "routine" indicates 24 hours. "Convenience" refers to casualties who can be transported on the next vehicle with space available. On a strategic level (involving fixed-wing assets operated by the US Air Force), "urgent" communicates a request for evacuation as soon as possible, "priority" indicates within 24 hours, and "routine" means on the next aircraft with space available, but generally within 72 hours.

Other aspects of transportation triage must also be considered. One consideration is that evacuation categories do not necessarily have to align with treatment categories. Although most casualties who remain in the immediate treatment category after field interventions will likely be placed in the urgent evacuation category, those designated for delayed treatment based on what can be done for them in the prehospital setting might be assigned any of the urgent, priority, or routine evacuation categories based on how soon they need additional care. Another consideration involves prioritizing patients within a transportation category. For instance, if ten patients are awaiting urgent evacuation and only one helicopter with open berths arrives, the transportation officer must choose which two or three of the ten will be loaded on the aircraft. Patient condition, capabilities of the medical crew, capabilities and capacity of the intended destination, transportation time, and potential detrimental effects of movement must all be taken into account.

Casualty destinations are suggested based on proximity, but the closest facility may not always be the most appropriate.[95–98] The closest facility might not be the one that can be reached in the shortest time, and it might not be capable of receiving more casualties without degrading the level of care delivered to all patients. In general, transportation time should be minimized both for casualty care and to place vehicular assets back in service quickly. However, at any moment in the course of the response, some casualties should be taken to medical facilities farther from the incident to avoid resource saturation or to access specialty services that may be further away. If any casualties have to be transported to closer but less capable facilities for initial stabilization, redistribution to regional trauma or referral centers may occur later.

As casualties are moved away from the scene of an MCI or transported from one medical capability to another, it is important not to turn a MASCAL at one location into a MASCAL at another location by overwhelming any given receiving facility. At the same time, it is the responsibility of the sending MMO to ensure the transportation mode and the platform used is the most appropriate for the casualty and the tactical situation. The MMO must ensure that the evacuation vehicle is sufficiently staffed and equipped to manage any specialty equipment (eg, a ventilator) and to perform intervention for any reasonably foreseeable deterioration. Additionally, personnel at the receiving facility must be fully informed of the casualty's problems, what management has already been undertaken and what the results were, and what issues still need to be addressed. All documentation of care rendered prior to arrival and during treatment at the sending facility must accompany the patient or be securely transmitted to the receiving facility. (Continuation of care during transportation between treatment roles is discussed in detail in Chapter 39, Casualty Transport and Evacuation.)

SUMMARY

Effective management of MCIs requires planning, coordination, and communication. Goals of the responding assets are to bring medical and other essential resources to casualties when affected infrastructure cannot support a desirable standard of care for all those in need. MASCAL situations continue to arise in both garrison and deployed settings, caused by natural phenomena and armed conflict, whether mitigation and response resources are available or not. Individuals, teams, units, communities, states, and nations must be prepared to respond quickly and effectively if excess morbidity and mortality—physical or psychological—is to be prevented, moderated, or avoided. Military medical personnel must be vigilant and continuously prepared for the wide variety of operations in which they may be tasked, from local incidents (motor vehicle crashes, ASEs, etc) to defense support to civil authorities, foreign humanitarian assistance, and combat operations. Medical and surgical skills must be developed and practiced. Specific capabilities must be built into healthcare systems from backpacks to tents to constructed MTFs, and then integrated into surrounding communities or host nations when feasible. Potential requirements to increase capacity for surges in casualty rates must be considered in every setting.

MCIs are by definition situations in which not every casualty can be treated in the way they would be if unlimited resources were available, but these incidents can be managed in a reasonable and acceptable manner for the exigencies of each individual situation. MMOs must be ready to advise leadership on capabilities and preparations, respond with interventional skills and knowledge of how they fit into the overall healthcare system, and embrace change to improve processes far into the future.

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