Allocating Scarce Resources in Disasters: Emergency Department Principles

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Decisions about medical resource triage during disasters require a planned structured approach, with foundational elements of goals, ethical principles, concepts of operations for reactive and proactive triage, and decision tools understood by the physicians and staff before an incident. Though emergency physicians are often on the front lines of disaster situations, too often they have not considered how they should modify their decisionmaking or use of resources to allow the "greatest good for the greatest number" to be accomplished. This article reviews key concepts from the disaster literature, providing the emergency physician with a framework of ethical and operational principles on which medical interventions provided may be adjusted according to demand and the resources available. Incidents may require a range of responses from an institution and providers, from conventional (maximal use of usual space, staff, and supplies) to contingency (use of other patient care areas and resources to provide functionally equivalent care) and crisis (adjusting care provided to the resources available when usual care cannot be provided). This continuum is defined and may be helpful when determining the scope of response and assistance necessary in an incident. A range of strategies is reviewed that can be implemented when there is a resource shortfall. The resource and staff requirements of specific incident types (trauma, burn incidents) are briefly considered, providing additional preparedness and decisionmaking tactics to the emergency provider. It is difficult to think about delivering medical care under austere conditions. Preparation and understanding of the decisions required and the objectives, strategies, and tactics available can result in better-informed decisions during an event. In turn, adherence to such a response framework can yield thoughtful stewardship of resources and improved outcomes for a larger number of patients. [Ann Emerg Med. 2012;59:177-187.]

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INTRODUCTION

Emergency physicians, as "first receivers"[1] of the injured and ill, are often called on to make triage decisions and manage limited resources. Many of these decisions, which usually involve the prioritization of services (such as priority of patients to be treated in the emergency department [ED] or the order in which several trauma patients are scheduled for computed tomography scanning), are made daily. These frequent decisions are often made without much thought to the ethical and allocation considerations underlying them, given that we are experienced at making these types of decisions and that we are usually deciding about *priority for*, rather than *access to*, services or interventions.

In disaster situations, the consequences of such decisions are magnified. Which patient should you treat next, the moderately injured patient with severe bleeding or the one with an unprotected airway? Will you continue to administer blood to an actively hemorrhaging patient despite limited supplies available? Which of the many victims should be taken to the operating suite first, if at all? Who will receive a ventilator?

Unless these types of decisions are anticipated, physicians are aware of the resources available to them, and some key strategies for coping are understood, individuals encountering crisis situations are likely to try to use daily practices to address the problem. In most incidents, such an approach can be appropriate. However, during a crisis, when resources are inadequate to meet demand, the emergency physician must shift to a more utilitarian view and may have to significantly change practices to accomplish the "greatest good for the greatest number."

As demonstrated after Hurricane Katrina, the Haiti earthquake, and during the H1N1 epidemic,[2-5] the medical community has faced and undoubtedly will face choices of how we can best steward the resources available to us. The context and setting differed greatly for each of these 3 events, but in all 3 cases available resources were inadequate to meet the demands of the incident, and each required a thoughtful approach to ensure that key medical resources such as medications, N95 masks, or evacuation capacity were allocated fairly.

Incident demand / resource imbalance increases →
Risk of morbidity / mortality to patient increases ← Recovery

	Conventional	Contingency	Crisis
Space	Usual patient care space fully utilized	Patient care areas re-purposed (PACU, monitored units for ICU - level care)	Facility damaged / unsafe or non-patient care areas (classrooms, etc) used for patient care
Staff	Usual staff called in and utilized	Staff extension (brief deferrals of non-emergent service, supervision of broader group of patients, change in responsibilities, documentation, etc)	Trained staff unavailable or unable to adequately care for volume of patients even with extension techniques
Supplies	Cached and usual supplies used	Conservation, adaptation, and substitution of supplies with occasional re-use of select supplies	Critical supplies lacking, possible re-allocation of life-sustaining resources
Standard of care	Usual care	Functionally equivalent care	Crisis standards of care

Normal operating conditions — Extreme operating conditions

Figure 1. Continnum of incident care and implications for standards of care. Adapted from Institute of Medicine – Guidance for Establishing Crisis Standards of Care in Disaster Situations.[7]

In a worst-case scenario, emergency physicians may have to ration the delivery of care in the face of extreme demand, limited resource availability, or both. We should not approach these crisis situations without forethought about how our priorities and approach differ from those in our daily practices. In this article, we define crisis medical care on the continuum of mass casualty care and review strategies that emergency physicians and other providers confronting a scarce resource situation may use. We review the basic foundations of triage for cases in which those strategies require resource triage. Finally, we discuss specific tactics for select crisis situations to aid responder decisionmaking. Though the discussion is centered around ED care, the principles can be applied to other practice settings as well.

CONTINUUM OF MEDICAL CARE

Medical care that is rendered during a mass casualty event occurs across 3 phases on a continuum (Figure 1)[6-7]:

- Conventional care: *usual* resources and level of care provided. The maximal use of the facilities' usual beds, staff, and resources is ensured.
- Contingency care: provision of *functionally equivalent* care—care provided is adapted from usual practices; for example, boarding critical care patients in postanesthesia care areas.
- Crisis care: inadequate resources are available to provide equivalent care—care is provided to the level possible, given the resource gap. Increased risk of morbidity and mortality because of a lack of resources defines the care provided in this phase; this risk can be minimized by implementing resource use strategies.

The objective of mass casualty response is to remain in the conventional and contingency phases of response or to return to them as quickly as possible by effective management of resources.

Preparedness activities (planning, caching of supplies) increase the capacity of the system to provide conventional and contingency care, increasing the volume of patients who can be accommodated before shifting to crisis care, a shift that may compromise patient outcomes. Thus, preparedness activities allow us to increase our capacity to respond so that it requires larger and larger incidents to cross the threshold from "incident" (when resources are adequate to meet demand) to "disaster" (when resources are inadequate to meet demand).

Four resource categories are the key to successful hospital surge capacity implementation. Emergency physicians should understand the resources available in these areas and how additional resources or assistance may be obtained[8-11]:

- Space: adequate physical space to care for patients. This may include categories of space such as critical care, medical/surgical, and pediatrics but also includes availability of adequate outpatient space. Emergency providers should understand the expansion/surge plans for their department and region, including triaging of patients to other locations or the opening of other clinical areas for emergency care.
- Staff: sufficient, appropriately trained staff, including subspecialty staff. This includes the ability to call in qualified staff and extend the capacity of current staff (by changing expectations during the event for charting, etc).
- Supplies: sufficient pharmaceuticals and medical supplies and equipment to provide care for the arriving patients. Availability of supplies varies greatly, depending on the size of the facility, its preparedness planning, and its role in the community (children's hospital, trauma center, Veterans Administration facility, etc).
- Special: considerations for specific events or populations outside of the usual clinical resources (availability of airborne infection isolation rooms or decontamination, burn, or pediatric services).

These categories are interdependent. Despite well-trained staff and adequate space, without beds or cardiac monitors, capacity to expand critical care is limited. With a growing emphasis on just-in-time inventory, cost containment, and other inventory and workflow streamlining processes,[12] efforts to preserve inventories of beds, monitors, and clinical supplies for surge capacity may be stymied. Stockpiling of supplies is difficult because expenses for preparedness are a low priority in times of financial instability and are not considered reimbursable expenses by most health insurers (including Centers for Medicare & Medicaid Services).

Supplies for contingencies should be cached according to the hospital's hazard analysis (including the potential for catastrophic incidents and the risk of its isolation from usual supply chains, etc) and its agreements with other hospitals in the area. An example of contingency supplies maintained at a burn center as part of a metropolitan area burn plan is provided in Table 1.[13] These supplies can generally be cached at nominal expense, but unless an ongoing commitment is present to have these amounts of product on hand and to rotate the stock as needed, no storeroom will maintain this level of inventory. Rotation of products may be the critical planning factor for supplies such as pharmaceuticals with a short shelf life, whereas space may be the problem with more durable supplies such as beds. Receiving commitments to purchase and maintain surplus

Table 1. Contingency supplies for 50 burn casualties—first 24 hours (50% body surface area burn).

Supply	Amount per Patient	×50 Patients
Bacitracin	8 oz/day	25 lb
Petrolatum-impregnated dressing 8×18	15 sheets/day	750 sheets
Kerlix 4.5-in	10 rolls	500 rolls
Morphine	10 mg/h=240 mg/day	12 g
Lorazepam	5 mg/h=120 mg/day	6 g
Tetanus booster	0.5/patient (assume 50% need)	25
Lactated Ringer's	4 mL/kg×70 kg×50%=14 L	700 L
Central line kit	1	50

supplies can be daunting but is necessary to provide reasonable levels of care during a mass casualty incident or epidemic.

There may be a significant lack of qualified staff because of a large number of patients requiring specialized care (eg, intensive care, burn care), an overwhelming number of patients in relation to facility staff, inability of the staff to access the facility (eg, because of road closures), personal injury, family commitments (eg, childcare), or fear of being exposed to potential harm.[14] Incident type contributes significantly to health care worker decisions; a study of Hawaiian providers by Lanzilotti et al[15] found that only 49% of nurses would report for a disaster if they knew the incident involved radiation. Accordingly, supplemental staff may have to be sought, and staff assignments may have to be prioritized so that specialized staff can devote their time to areas of their expertise (eg, burn nurses may be responsible only for dressing changes and wound assessments rather than overall nursing care). Just-in-time training may be used for tasks that can be safely performed by other providers, and staff with lower levels of training may be assigned to provide workforce extension (serving meals, etc).

RESOURCE UTILIZATION STRATEGIES

When anticipating or faced with a resource shortfall, providers may use 6 key strategies[6,7,16]:

- Prepare: Optimally, planning can identify and mitigate resource shortfalls by stockpiling commonly needed (and often inexpensive) items such as morphine and intubation equipment.[17] Preparation also includes methods to maintain the equipment and supplies; for example, adherence to preventative maintenance, stock rotation, and restocking schedules.
- Conserve: Restrictions are placed on the use of certain therapies or interventions to maintain supply (for example, N95 masks, oxygen).
- Substitute: A functionally equivalent medication or device is used (for example, using benzodiazepines instead of propofol for sedation of a tracheally intubated patient).
- Adapt: Use of a device for purposes for which it was not intended (for example, using an anesthesia machine or Bi-level positive airway pressure machine as temporary ventilator or using an oxygen saturation monitor with high/low rate alarms instead of cardiac monitor to detect tachy or bradydysrhythmias).
- Reuse: After appropriate cleaning, disinfection, or sterilization, the majority of material resources can be reused.
- Reallocate: Certain critical resources (ventilators, extracorporeal membrane oxygenation) may have to be allocated to those patients most likely to benefit, in extreme situations this may involve removal from one patient to give substantially better chance of a good outcome. This, clearly, is a last resort and should be done only when no other options exist and no relief is possible.

Successful implementation of surge capacity strategies and use of these techniques require that clinicians have administrative support in carrying out their duties. Additionally, if triage decisions are being made proactively, specific legal backing and liability protections through local or state emergency declarations may be invoked. Protections for providers making these types of proactive decisions vary, and emergency physicians are encouraged to understand what protections (and limitations) exist at the state level for their facility-based ED practice. Providers with out-of-hospital, interstate, or federal responsibilities will need to be familiar with the protections offered for that practice situation as well.[7,18]

Incident management must be used within the facility and across the affected area to gain situational awareness, maximize available resources, maintain consistency of approach with other regional facilities, and request needed resources from suppliers, partner hospitals, and emergency management.[19,20] Support services and functioning infrastructure must be available (potable water, ventilation/temperature control, food services, etc). The hospital command center should ensure the best possible infrastructure to support emergency care and help coordinate expansion of inpatient space and acquisition of resources. The institution should have written plans and policies in place to respond to crisis situations that require resource triage, including an ethical framework and a concept of operations that allows proactive clinical decisions to be made, documented, and reviewed. Several articles have addressed these proactive approaches and provide templates, including the detailed Institute of Medicine *Guidance for Establishing Crisis Standards of Care for Use in Disaster Situations*,[7] which provides a concept of operations for health care facility decisionmaking.[21,22]

Unfortunately, the ED, especially in the early hours of an event, will not have the benefit of these systems or the situational awareness to understand when peak demand will occur or predict what resources will be available in what period. Thus, ED staff may have to make some of the most difficult triage decisions during the event, with the least information available to them.

Because catastrophic situations are rare, it is important that emergency physicians have the opportunity to practice triage

Table 2. Differences between reactive and proactive triage situations.*

	Reactive	Proactive
Incident type	Early in event period. Often no-notice event (often static or short timeline) (eg, earthquake, bombing)	Later in no-notice event or anticipated, often dynamic event (eg, pandemic influenza)
Incident management implemented fully?	No (full implementation is transition point to proactive)	Yes
Situational awareness	Poor	Good
Resource availability	Extremely dynamic (during hours)	Relatively static
Resource shortfall(s)	Stabilization care through definitive	Definitive care, select medications or therapies
Dominant triage	Primary, secondary	Tertiary
Most likely resource triaged	Operative care (may not be able to provide any operative care if massive event), diagnostic imaging, fluid resuscitation	Mechanical ventilation/critical care (improvised nuclear device is an exception because of delayed radiation illness)
Triage decisionmaker	Triage officer(s) on initial assessment at bedside	Triage team not involved with patient's care
Triage decision basis	Clinical assessment	Clinical plus diagnostics (decision tool)
Decisionmaking	Unstructured, ad hoc	Structured
Regional and state guidance and legal protections/emergency declarations needed	No	Yes

*Modified from Table 7, Institute of Medicine, used with permission.[7]

decisionmaking. Opportunities to do so may be offered in simulation environments (both physical and Web based), tabletop exercises, courses (such as the triage discussion module in advanced trauma life support), or functional disaster exercises.[23]

TRIAGE STRATEGIES

Primary triage is the first level of evaluation and prioritization and occurs before initial medical interventions: in the out-of-hospital setting, on the ambulance dock, or in the hospital lobby, for example. Out-of-hospital transport criteria may be in place to ensure that the most critically injured are directed to trauma centers during a disaster after initial triage.

Physicians may be of value to assist triage at incident scenes in which the number of victims exceeds transport resources or prolonged rescues are occurring. These physicians should have proper training and protective equipment to allow them to operate safely and integrate with the out-of-hospital providers.

Certain situations can lend themselves to overtriage (assignment of patients to a "red," or highest-priority, category who are actually not at immediate risk of death without treatment). For example, after blast events there is a tendency to categorize patients with major soft tissue injuries as higher priority, regardless of underlying hemodynamic and critical injury status. This practice can potentially lead to resource bottlenecks as too many highest-priority patients compete for the limited resources available.[24] The emergency physician must assess carefully for life threats (in particular, subtle penetrating truncal wounds) and early evidence of shock or airway compromise that would warrant immediate intervention.[25] Experienced providers are likely to be the best triage officers.[26] It is rare in US civilian practice to have to triage patients as "expectant" ("black-tag" in most field triage systems)[27-31] or not destined to receive definitive care,[3] but in a crisis setting this may become necessary. In such circumstances, it is important to recognize that care is continued, albeit with the objective being palliation, comfort, and support and not necessarily survival. Patients should be reassessed and retriaged as their condition and the resources available change.

Ambulatory patients with minor injuries ("walking wounded," or "green" patients) should be directed to a different care area during events that are likely to overwhelm the ED capacity (predesignated clinics, urgent care, lobby, or other open area of the facility).

Secondary triage occurs after additional assessment and initial interventions are conducted (for example, intravenous fluids or airway management). These decisions are usually performed by emergency medicine or surgical staff to establish priority for diagnostic studies or treatment.

Tertiary triage involves assessment of the value of ongoing resource commitment during delivery of definitive care (for example, deciding about continued ventilator support or whether to continue surgery after initial findings at laparotomy).[25] Emergency physicians are less likely to perform tertiary triage but may be involved with the process at the hospital level (eg, during a pandemic if decisions about who shall receive the available ventilators are being made).

As opposed to tertiary triage, which generally occurs in more proactive fashion, primary and secondary triage is usually reactive, that is, occurring before availability of reliable situational awareness and usually performed before diagnostic testing (Table 2).[7]

An ethical framework must ground all disaster triage decisions. Several authors have provided detailed analysis[7,32-35] of these issues; a brief synopsis is provided here. Core components of ethical decisionmaking are the following:

- Fairness: The process is inherently just to all individuals, and the process itself treats all individuals equally who have equal needs.
- Duty to care: Physicians have a duty to care as best they can for all victims of the incident.
- Duty to steward resources: Physicians have a duty to attempt to obtain the best outcome for the greatest number of patients with the resources available (this does not specifically translate to "save the most lives" because a comfortable death may be a good outcome and thus appropriate to receive resources).[36]
- Transparency: Though difficult in reactive triage decisions, the process and criteria should be as transparent as possible.
- Consistency: The process should be applied in the same way to all presenting for care.
- Proportionality: The degree of resource restriction should be proportional to the demands.
- Accountability: Triage officers and others should be able to defend their decisions and be answerable for them. This may involve documentation and potential review of decisions by the institution and possibly outside agencies.

There is an ethical imperative that we plan for triage decisionmaking situations before an event occurs. The larger the consequences of our triage decisions, the more important it is that we account for these components to avoid introduction of provider bias and value judgments into our decisionmaking.

As an example, after Hurricane Katrina a decision was made at Memorial Hospital that patients with do-not-resuscitate orders would receive a lower priority for resources.[37] Though this is an attractive strategy because of its ease of application, the expression of advance directives does not correlate with prognosis. Many patients without do-not-resuscitate orders have a much worse medical prognosis than those who have chosen to express these wishes. Thus, what might seem a reasonable means of triage actually does not pass our ethical analysis of fairness and consistency.

An accepted basis for allocation decisionmaking was originally developed by the American Medical Association in response to the shortage of available organs for donation[38] (Table 3). In emergency situations, the "urgency" portion of the American Medical Association framework is moot because all patients in the EDs are likely to have an "urgent" resource requirement (as opposed to a broader range of urgency of transplantation in organ failure patients). Determining likely resource consumption may be an evolving process. In certain situations minimum qualifications for survival may have to be defined, beyond which further resource commitments to that patient are unlikely to result in a good outcome and will consume disproportionate shares of a scarce resource.[15,39] For example, a limitation on the number of units of packed RBCs that can be allocated to an individual trauma victim may be reasonable when they are in short supply at the institution (in one military series of 50 mass casualty patients from 3 events, an average of 3.5 units of packed RBCs were used per patient, but 4 of the 24 patients receiving blood consumed 43% of the product).[40] In crisis situations, transfusion might also be limited to a specified number of units of packed RBCs, determined in part by the likelihood of survival from the injury sustained. Also, access to packed RBCs could be limited to specific indications most likely to benefit, with reevaluation of these restrictions as supply changes.

Table 3. Factors influencing resource allocation.[38]

May Consider	Should Not Consider
Likelihood of benefit	Sex
Change in quality of life	Race
Duration of benefit	Ability to pay
Urgency of need	Social worth
Amount of resources required	Perceived obstacles to treatment
	Patient contribution to illness
	Past resource use

In addition to considering the amount of resources required, it is reasonable to consider the duration of use of a resource (for example, a trauma patient is likely to need a ventilator for a much shorter period than a patient with respiratory failure from viral pneumonia). Likelihood of benefit often relates to injury or disease-specific prognosis, along with any severely life-limiting medical conditions (end-stage heart or liver disease, for example).[21,22] Again, the emergency provider will not have access to results of many tests or medical history when making decisions in a mass casualty situation.

Age is a distinguishing variable that is not specifically addressed in the American Medical Association document or many other related guidance (aside from its relative relationship to the issue of duration of benefit). Some authors believe that advanced age should reduce priority for resources because such patients have experienced a "full life" already and the resources should be given to younger patients (the "fair innings" argument).[41-43] The authors believe that age (except in extreme cases) is not a medical distinguisher in many situations (such as pneumonia) and that the assessment of a full life is also subjective. Age *does* have prognostic implications in both trauma[44] and burn[45] morbidity and mortality, and thus the emergency physician may need to consider age in these settings. In most cases, however, inclusion of extremes of age in triage criteria offers limited utility (for example, only 1.5% of the US population is older than 85 years; thus, age-based criteria at this threshold would provide marginal effect [however, 85 years was the median age at which critical care providers were comfortable invoking age as a decision factor in withholding care]).[46,47]

If we are to incorporate age or other nonprognostic factors in triage, we must agree how and when to do this. In public

Table 4. Scarce resource situations: oxygen.*

Intervention	Category	Conventional	Contingency	Crisis
Ensure plans for external supply of oxygen in case of system failure	Prepare	X	X	X
Use oxygen concentrators in shortage situations to supply low-flow oxygen	Substitute	X	X	X
Restrict use of oxygen-driven nebulized medications (substitute metered-dose inhalers, air-driven nebulizations)	Conserve	X	X	X
Use reservoir cannulas to conserve flow rates	Conserve	X	X	X
Restrict flow rates on partial/nonrebreather masks to 10 L/min	Conserve	X	X	X
Eliminate reference bleed on air/oxygen blenders and disconnect when not in use	Conserve	X	X	X
Restrict use of high flow cannula and mask devices and oxygen-powered suction devices	Conserve		X	X
Revise clinical targets:	Conserve		X	X
Provide oxygen only for documented hypoxia				
Revise targets for oxygen saturations downward according to shortages (eg, reduce target to 90% saturations for otherwise healthy adult/child)				
Reuse oxygen equipment and delivery devices after appropriate disinfection or sterilization. Bleach concentrations of 1:10, high-level chemical disinfection, or irradiation may be suitable. Ethylene oxide gas sterilization is optimal but requires a 12-h aeration cycle to prevent ethylene chlorohydrin formation with polyvinyl chloride plastics.	Reuse		X	X
Reallocate limited oxygen supply to patients most in need or likely to benefit	Reallocation			X

*Modified from Minnesota Department of Health,[53] with permission.

forums in Minnesota and King County, WA, there was general agreement that large age differences between those needing the same resource should be considered, but there was an inability to provide specifics around that agreement (J.L.H.). The engagement of society in these discussions is the subject of a current Institute of Medicine effort to define both the structure and the outcomes of public engagement so that cultural and societal preferences can be incorporated to the degree possible when medical factors do not establish priority between patients (otherwise, a first-come, first-served or random allocation strategy would be used).[48]

TREATMENT STRATEGIES

The next step after triage is to provide medical interventions that offer the greatest benefit with the least use of resources. This section will summarize some of the key areas in which resource shortfalls may be anticipated and general strategies for providing interventions.

Guidance for specific surge capacity strategies has been published by others[8-11,49-51]; this section assumes that through activation of emergency operations plans and implementation of these strategies, maximal access to space, staff, and supplies is attained and that coordination with other available resources is in progress. In general, clinical resource shortages can be anticipated to occur in the following areas:

- oxygen
- medications
- hemodynamic support (including intravenous fluids)
- ventilators and other life-sustaining technologies such as extracorporeal membrane oxygenation
- staff (medical and nursing in particular)
- blood products (unlikely to be in national shortage, aside from platelets in the weeks after a nuclear detonation, but institutional and regional shortfalls may exist for brief periods).[52]

A card set has been published that provides recommendations within each of these areas according to the degree of resource shortfall.[53] This material will not be detailed here, though a sample for oxygen is shown in Table 4. Institutions should identify key vulnerabilities and coping strategies within these areas. The 6 basic strategies outlined above should be applied to the resource(s) in short supply to attempt to mitigate the situation. In certain situations, it may not be possible or advisable to offer certain treatments (for example, though extracorporeal membrane oxygenation was used successfully as salvage therapy during the H1N1 pandemic, the degree of resource commitment required would be inadvisable when those resources are needed to care for a broader group of patients).

Because the emergency physician may need to rely on more ad hoc decisionmaking in the reactive phase of an event, a few key interrelated principles of triage in mass casualty situations should be kept in mind:

1. The larger the number of casualties, the less time intensive the interventions that should be performed. As casualty numbers increase, consider how much time and resources

In order of general priority for salvageable patients; note temporizing surgery rather than definitive:

- hemorrhage control—temporizing use of tourniquets and bandaging
- needle decompression of tension pneumothorax
- emergency airway interventions (for isolated respiratory tract injury)
- tube thoracostomy
- cranial burr holes for rapidly decreasing level of consciousness and lateralizing examination (eg, blown pupil, unilateral paresis)
- laparotomy—penetrating injury, hemodynamically unstable
- laparotomy—blunt isolated injury, hemodynamically unstable
- laparotomy—blunt or penetrating with peritoneal signs or intra-abdominal fluid
- laparotomy—multisystem trauma with any of above
- limb salvage procedures—vascular or orthopedic
- thoracotomy for hemodynamic instability or continued thoracic hemorrhage not responsive to tube thoracostomy

Figure 2. Sample prioritization of procedures.

an individual patient will require. The military has looked at this from the perspective of "time," "task," and "treater"; that is, how much time, expertise, and material resources does the patient require? The most critical intervention in a mass casualty setting, hemorrhage control, requires little time, expertise, or materials. Basic airway interventions (such as use of a nasal airway to prevent obstruction) and needle decompression of a tension pneumothorax are included in basic military casualty care because they require very little time, training, or equipment in return for a large potential benefit[54,55] (Figure 2).

2. Adapt your triage to the scope of the incident. Assume that you have some out-of-hospital information coming in and that for every 100 injured, you know that 15 is the usual number of critical patients[56] (though terrorism/blast-related injuries, particularly in a confined space, tend to be more severe and may alter this percentage somewhat[57]). Consider the 2 patients discussed in Table 5. If a bomb went off on a bus in an urban area and there were 5 critical patients who presented to your Level I trauma center, both patients would be taken to the operating suite. If the blast destroyed a school and there were 50 critical casualties, the patient with the multisystem trauma, critical head injuries, and intra-abdominal hemorrhage (patient B) would be a lower priority. In the setting of a catastrophe (nuclear device detonation, etc), when the facility is overwhelmed by casualties, *neither* patient is likely to receive operative intervention because the resources needed to staff the operating suite and provide care could be better used for acute hemorrhage control and other targeted stabilizing measures for a larger group of patients.
3. The larger the event, the greater the focus on treatment of the moderately injured. In a true crisis situation, the focus should be on those victims who can benefit from brief, targeted interventions, as outlined above. Treatment of the moderately (as opposed to critically) injured is much more likely to result in a functional recovery with minimal interventions.[25,54]

Diagnostic testing should be minimized and targeted toward lifesaving procedures. Laboratory and radiology personnel should be prepared to prioritize basic testing (chest radiographs, abdominal radiographs for foreign body localization,[24] blood gases, hemoglobin, etc). The use of bedside ultrasonography can facilitate rapid assessment and operative triage in mass casualty/scarce resource situations.[58-60] In addition, other technology-based solutions such as telemedicine may offer advantages, especially to hospitals without access to extensive subspecialty care or field-based disaster medical facilities.

TACTICS FOR SPECIFIC SITUATIONS

The 15 national planning scenarios detail multiple threats that would pose a challenge to any medical system.[61] Because our focus is on the reactive phase of events, the specific considerations of burn, blast, chemical, and radiation (improvised nuclear device) are overviewed in Table 6. Infectious disease emergencies tend to lend themselves to more proactive strategies and decision tools that are addressed by other sources.[7,16,21,22] A key part of planning for any of these scenarios is the regional exercising of response plans and resources. It is critical to connect facility response and resources to the larger regional health care response and resources. Improved information flow and patient load balancing are most likely to succeed when such integration exists.[62-64]

Preparedness should also account for special populations and situations not normally seen by the facility. For example, in a mass casualty situation, because of the need to keep families together and the potential that dedicated pediatric hospitals may be overwhelmed, there is a need for all facilities to be prepared to treat pediatric patients (and for pediatric facilities to be able to at least initiate treatment for adult patients; though emergency medical services may transport only families with adult minor injuries, critically injured adults may self-present to a children's hospital). A starting point is to ensure that appropriately sized airway and venous access equipment is easily available for all body types and sizes. Even basic pediatric equipment may not routinely be present in many EDs.[65,66]

Palliative care is often regarded as hospice care, but it is not. Palliative care is treatment that focuses on patient comfort and should thus be received by all patients. In some situations, palliative care may be all that is offered when the patient is certain to die or when resource requirements far exceed what can be offered. Too often, little effort is directed in health care emergency planning toward adequate pain and anxiety relief.

Table 5. Sample trauma patients presenting to the ED.

	Patient A	Patient B
Age, y	32	35
Blood pressure, mm Hg	80/60	80/60
Glasgow Coma Scale score	15	4 (since time of injury)
Injuries	Isolated shrapnel injury to left upper quadrant, free fluid in Morison's pouch on ED ultrasonography	Pneumothorax, free fluid in Morison's pouch on ED ultrasonography, oxygen saturations 85% on room air, open scalp wound
Interventions	Intravenous access, intravenous normal saline solution; still hypotensive	Tube thoracostomy; slight improvement in oxygenation status, still hypotensive
Probable triage category; 5 critical patients	Operating room (red)	Operating room (red)
Probable triage category; 50 critical patients	Operating room (red)	Expectant (black)
Probable triage category; 500 critical patients	Expectant (black)	Expectant (black)

Table 6. Specific considerations for crisis care.

	Prepare	Triage	Treat
Chemical	Stock additional airway management supplies and at minimum, bulk or other supplies of atropine.[69]	Acid-gas exposure: upper airway obstruction=high priority (those in cardiac arrest likely unsalvageable as primary respiratory process). Those with mild symptoms usually will not progress (exception: phosgene and similar). Cardiac arrest from cholinergic/other; may have good outcomes, provide interventions if resources available.	Antidotal treatment as indicated. Emphasis on atropine for cholinergic syndrome treatment. Airway management for airway irritants; usually temporary requirement for mechanical ventilation.
Burn	Stock analgesia, sedation, intravenous fluids, burn dressing alternatives (Table 1).	Burn triage category heavily influenced by body surface area and age. Consider use of burn triage table,[45] which may be used in conjunction with overall clinical assessment	Early airway management if possible. Early and aggressive analgesia. Escharotomy as required. Consider sterile sheet wraps rather than dressings initially. Further wound care as circumstances permit.
Blast	Stock analgesia, intravenous fluids, sodium bicarbonate, broad-spectrum antibiotics, surgical trays, tetanus immunizations.	Open head injury with coma nearly universally fatal.[31,70,71] Multiple amputations or extremity mutilation, coma, persistent hypotension predict high mortality.[71] External hemorrhage control and internal isolated hemorrhage because of shrapnel most likely to survive with time-limited interventions.[31]	Tourniquets and compression bandages for hemorrhage control. Airway management. Intravenous fluids. Splinting of unstable limbs. Watch for evolving chest/abdominal pathology in patients with significant injuries, especially in confined space blast injury or with evidence of other barotrauma.
Radiation/nuclear device*	Analgesia, antiemetics, antidiarrheals, cytokines[†]	Do not use vomiting as early triage indicator; nonspecific.[72] Usual trauma triage principles apply until radiation exposure can be defined. Combined injury (radiation plus trauma or radiation plus thermal burns) dramatically increases mortality (animal model of 2-Gy radiation and 10% BSA burn=90% mortality).[75]	See published resources[73,74] for clinical guidance. Cytokines (eg, G-CSF) should be administered as early as possible, with use restricted as necessary to patients most likely to survive.

*This does not apply to radiologic dispersion devices, which release a fraction of the radiologic material and are unlikely to cause significant numbers of patients with acute radiation sickness.[74]

[†]National stockpile of cytokines exists; some regions have elected to maintain additional stocks. Extremely expensive; relatively short shelf life limits stockpiling. Benefits unclear but presumed in setting of pancytopenia related to acute radiation sickness.

Supplies of medications for analgesia and anxiolysis and personnel to provide basic psychological support are inexpensive but provide great patient benefit. All resources need not be directed at definitive care, and in fact, some resources should always be directed at relief of suffering regardless of what other patient interventions are planned.[36,67]

Emergency physicians have clinical and administrative skills that make them adaptable to unique situations. They will be looked to in the early hours after a disaster for clinical leadership within their department and institution. If crisis care scenarios have not been considered in advance and the emergency physician is not prepared to direct the shift from usual care to crisis care, it will be impossible to respond optimally. Most mass casualty events do not require us to rethink our approaches to triage and provision of medical care. Those that do require consideration in advance about how we would manage and make decisions under such circumstances because thinking of new ideas under duress is difficult.[68] As Louis Pasteur said, "Chance favors the prepared mind." Emergency physicians should practice and be prepared to face these situations so that they are able to manage resources and make ethical clinical decisions when the unthinkable happens.

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