Burn Care in Disaster and Other Austere Settings

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INTRODUCTION

Most readers of this article will need to care for patients with burn injuries in an austere environment without the advantage of consulting references, so the recommendations provided here center on those actions that can be taken with a dearth of resources and can translate into saving life and limb in a highly leveraged fashion.

KEYWORDS

- Disasters • Mass-casualty planning • Triage • Low-income countries

KEY POINTS

- Each burn center needs both an external and internal plan for mass-casualty disaster preparedness; these plans should outline standard operating procedures for airway management, resuscitation, and wound care, including pain management strategies.
- Collaborating with local, state, regional, and national stakeholders is essential to devise successful disaster plans, which should involve a regional strategy for patient transport.
- Improvised recipes for fluid resuscitation of burns greater than 40% total body surface area can be lifesaving when customary supplies for burn shock resuscitation are unavailable.
- Beyond the urgency of securing the airway and initiating treatment of circulatory collapse from burn shock, the risk of limb loss requires careful vetting before performing escharotomy and/or fasciotomy.
- Combined burn-trauma injuries are exponentially dangerous and, faced with this dilemma, trauma management must precede burn management.
- Focusing on preventing the progression of burn depth from partial to full thickness is likely to save the maximal number of lives.
- Ideal disaster preparation is repeated training that drills to fail, pushing care teams out of their comfort zones and past their present capacities.
- Although clean water and other sterile supplies and equipment may be absent or limited, strive to effect sterile, antiseptic technique and to do the most good for the most people.

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http://dx.doi.org/10.1016/j.suc.2014.05.011 surgical.theclinics.com

0039-6109/14/ – see front matter © 2014 Elsevier Inc. All rights reserved.
The term austere conditions, as it is used here, refers to impoverished communities, care on the battlefield, and the landscape in the aftermath of a mass-casualty situation. These three very different scenarios are the basis for the recommendations that follow.

AIRWAY AND BREATHING

The single most proximal cause of death for a burn victim, including during austere conditions, is loss of the airway. The most sensible approach to airway preservation varies widely, with the root cause likely to be limiting medical resources. In modern warfare there are often extensive medical resources available within 6, 12, or 24 hours, and endotracheal intubation or securing an airway surgically makes the best sense. Preventable airway deaths seem to be uncommon in this setting, although in lower-intensity conflicts this may not be true.\(^1\)

Practitioners in the environment of low-income countries are the best judges of what airway and ventilator management is available. When these professionals deem that no management is possible, their wisdom cannot be second-guessed by clinicians not facing the same limitations. These clinical decisions determine which patients are in either the potentially survivable group or those to receive expectant care only. Clinical decisions in these environments also shape every aspect of burn care to effectively minimize those occasions when the only option is mechanical ventilation. Mass burn casualties with 200, 2000, or 20,000 living injured quickly consume the available number of endotracheal tubes and ventilators. The limited supply of medical-grade oxygen also becomes a rate-limiting step for care. Triage and burn resuscitation guidelines must, as always, be strategically optimized to minimize the number of patients requiring airway and breathing resources.\(^2\)

In addition, if the burn injury has occurred in a closed space with a likelihood of carbon monoxide inhalation, 100% oxygen, if available, for several hours might be lifesaving; it hastens the elution of carbon monoxide and frees hemoglobin for its intended role of oxygen transport to cells.

BURN SHOCK RESUSCITATION

Under austere conditions, intravenous cannulation and sterile intravenous salt solutions, which are the foundation of modern burn shock resuscitation, become luxuries. The following recipes for fluid resuscitation in the aftermath of burns (orally, and less commonly by enema) are the primary message of this article. Burns of 20% total body surface area (TBSA) can be successfully resuscitated in this manner. Burns of up to 40% TBSA can most likely be resuscitated.\(^3-5\) In austere conditions without access to intravenous therapy, fluid resuscitation for burns larger than 40% TBSA must suffice by using the techniques described later. The current published global experience is not large, and the magnitude of burn injuries that successfully respond to World Health Organization oral rehydration solution (ORS) when put to the challenge is surprising:

- **ORS** can be made with 1 L of clean water, 1 teaspoon of table salt (3 g), and 3 tablespoons of sugar (18 g or 9 sugar cubes); it can also be purchased as packets.
  - Clean water can be obtained by boiling the water, or by adding potassium alum, chlorine drops, or iodine tablets.
  - As an alternative to table salt, sodium bicarbonate (baking soda) can be used as a source of sodium.
A worldwide list of commercial manufacturers and distributors of ORS products can be found at http://rehydrate.org/resources/suppliers.htm

If the quantity of added salt cannot be measured, the solution should have the taste of tears.

Molasses and other forms of raw sugar can be substituted for white table sugar (note that both brown sugar and molasses add additional potassium.)

If necessary, boil the water before adding ingredients, and add salt and sugar while still warm; do not boil the solution once the sugar has been added or it will decompose.

Patients should take sips every 5 minutes, and wait 10 minutes after an episode of vomiting. Overall instruction to the patient is to try to drink at least 4 cups (1 L) per hour.

Keep the solution cool if possible; discard after 24 hours and make a new batch.

Other local solutions for oral rehydration therapy (ORT) include the following:

- Rice water (congee) with salt
- Fresh lime water with salt and sugar
- Vegetable or chicken soup with salt
- Lassi (yogurt drink with salt and sugar)
- Sugarcane juice with lemon, black pepper, and salt
- Sports drink (eg, Gatorade or Powerade) with one-quarter teaspoon salt and one-quarter teaspoon baking soda for each quart
- Carrot soup
- Gruel (cooked cereal diluted with water)

Drinks to be avoided include:

- Soft drinks
- Fruit drinks with high sugar content
- Sweet tea or coffee
- Herbal teas that contain diuretics

Procedure for performing proctoclysis:

- Boil water to reduce risk of infection or allergic reaction
- Warm water to body temperature
- Create balanced rehydration solution by the addition of salt and bicarbonate as described earlier
- Insert urethral catheter into rectum
- Attach reservoir (such as 50-mL syringe with plunger removed) to catheter
- Infuse fluids at a rate comfortable to the patient and consistent with clinical signs

Common formulas for intravenous resuscitation of burn shock include the following:

- Brooke: lactated Ringer (LR) 1.5 mL/kg/% burn plus colloid 0.5 mL/kg/% burn plus 2 L dextrose 5% in water (D₅W)
- Modified Brooke: LR 2 mL/kg/% burn
- Parkland: LR 4 mL/kg/% burn (can modify from 2–4 mL/kg/% burn)

**THREATENED LIMBS AND LIMB SALVAGE**

Beyond securing the airway to provide adequate gas exchange, and initiating treatment of circulatory collapse from burn shock, the next most pressing concern is the
risk of limb loss as a consequence of delay in necessary escharotomy or fasciotomy. Included in this topic is the parallel pathophysiology of constricted ventilatory excursion secondary to circumferential full-thickness burns of the chest and/or abdomen.

The pathophysiology is basic to all medical professionals: if burns are full thickness and circumferential a severe tourniquet effect occurs caused by the linear shrinkage of the injured skin envelope. Compartment syndrome results when limb pressures exceed venous outflow pressures (but not arterial pressures), leading to ischemic tissue necrosis. Warm ischemia time is typically thought to be 4 to 6 hours, and therefore the need to effect remedies is foremost.

The burn care provider under austere conditions must weigh the ability to make escharotomy and/or fasciotomy incisions and have the wherewithal to control resultant bleeding from the cut edges, because fatal hemorrhage from uncontrolled bleeding can result. This dilemma requires careful vetting.7

**COMBINED BURN-TRAUMA INJURIES**

Mass-casualty situations of the last decade show that between 10% and 20% of all trauma victims also have significant burn injuries. Beyond advanced age and smoke inhalation, the next most deleterious factor in burn injury survival is the presence of major concurrent trauma; combined burn-trauma injuries are exponentially dangerous.6

When faced with this daunting combination, trauma management precedes burn management. As the care of these patients begins to extend beyond the first several hours, start to incorporate management of burn shock resuscitation and threatened limbs, and then consider initiating burn wound management. Initial wound management need not be more detailed than covering the patient with clean linens to prevent hypothermia and minimizing further wound contamination.

**MONITORING ADEQUACY OF BURN SHOCK RESUSCITATION**

Perhaps the most effective management of burns under austere conditions centers on prevention of what are initially partial-thickness burns that progress to full-thickness burns. Without this focus, the maximal number of lives will not be saved.

Even experienced burn care providers may be quick to deem deep burns full thickness/third degree. It is self-evident that the greater the thickness of a burn wound, the greater the mortality. This trend is exacerbated under austere conditions in which resource-intensive excision/autografting may not be possible. Furthermore, solid evidence supports the tendency of burn depth to progress unless appropriate wound care and cardiovascular support is provided.8

In a resource-poor state, the only readily available tool might be burn shock resuscitation. In the First World, this monitoring can be taken to high and exacting standards, as exemplified by cardiac filling pressures, cardiac output, and resolution of metabolic acidosis, none of which are available in the scenario of interest.

An enduring end point of burn shock resuscitation (urine output 30–50 mL/h, adult) focuses on adequate renal perfusion as a proxy for euvoemia. British military burn victims aboard the hospital ship SS Uganda during the Falklands conflict did not have access to urinary catheters, and their burn shock resuscitations had to be monitored by the degree of hemoconcentration on finger-stick blood spun capillary tubes.9

Thus, inventiveness under austere conditions demands that any and all available proxies for adequate perfusion (mentation, interactivity, skin turgor, sunken eyes, and so forth) be relied on to guide optimal fluid management.
BURN WOUND CARE OPTIONS

Burn wound management is central to the care of every burn patient. Under austere conditions, a great deal of creativity and willingness to improvise, with care protocols, materials, and personnel, is required. This creativity and improvisation must be fostered through local health care workers, who are the best resources for gauging what is possible and what is not.10

Burn care is difficult to render without the ability to bathe patients with clean water; hypothermia is also a risk. Regardless of prevailing conditions, seek to provide this treatment. If possible, once-daily dressing changes reduce the risk of burn wound sepsis, which is a central goal of therapy. Wound care is painful, and the ability to provide pain and anxiety relief may be a rate-limiting step for wound management. Ketamine is a particularly useful single agent that, if available, can widen the scope of wound care that can be provided at the bedside. In addition, although it may seem impossible, under even the most limited of situations, strive to effect sterile, antiseptic technique.

Diluted solutions of sodium hypochlorite (laundry bleach, Clorox 5.25% solution) are usually used topically at 0.5% on burn wounds, and are bactericidal to a wide spectrum of organisms. This material is widely available around the world and should be easy to acquire and use in practically any setting. Several reports have been issued on the effectiveness of using Dakin solution during wartime burn care. Honey is another agent that is found around the world, and it is a highly effective antibacterial when applied to burn wounds once a day. If silver nitrate is available in large quantities for use as a chemical reagent, an effective topical solution can be made for burn wounds.

Under different circumstances, silver-impregnated dressings are being championed as the burn dressing of choice for wartime burns or living burn casualties in the aftermath of a massive terrorist attack. In their most deployable form, rolls of silver-impregnated mesh, which can be applied like Ace-bandage wraps, can be applied as buddy care by nonmedical personnel. Hence, this material has been recommended to the US Federal Government for stockpiling. Another positive attribute of this mesh material is its ability to stay in place effectively for 5 days or more, thus reducing the need for skilled medical personnel to perform wound dressing changes.

Topical antibacterial agents used daily in burn facilities are typically either mafenide acetate 11% cream (Sulfamylon) or silver sulfadiazine (Silvadene) cream. If available, they can be used to good effect, but stockpiling them is difficult because of shelf-life and lability. For a massive number of casualties, the amount, expense, and manpower required to use these agents is rapidly eclipsed by the more primitive methods described earlier. If significant quantities of powdered mafenide acetate are available, a 5% or 10% aqueous solution can be used topically and economically. This method has been shown to be highly effective under austere wartime conditions.

In addition, silver sulfadiazine mixed with and augmented by cerium nitrate warrants mention. This compound produces a leatherlike eschar that effectively prevents burn wound sepsis, thus permitting delayed excision and grafting. Licensed in Europe as Flammacerium, it is not approved by the US Food and Drug Administration but has the potential to change the strategy by providing the luxury of time when burn care resources in a large event are overwhelmed.

BURN SURGERY IN AN AUSTERE ENVIRONMENT

Contrary to popular opinion, burn surgery in even the most resource-rich environment is an operation that presents the highest order of risk and physiologic stress, akin to
open-heart procedures. For those not appropriately respectful of the task at hand, on-
table death is a probable outcome. When the task of burn surgery arises in the austere
environment, the options can quickly become untenable.\textsuperscript{11}

In general, excision and grafting of burn wounds, although they are the gold stan-
dard, cannot be performed without adequate and sophisticated anesthesia, the pro-
vision of critical care, and blood-banking infrastructure. Therefore, in impoverished
settings, the primary goal of care should be preserving and facilitating the healing of
partial-thickness burns. There are situations in which excision and autografting of
large burns must be undertaken in low-income and developing nations; imperative
to these situations is thoughtful self-assessment by the medical team regarding
whether or not they can meet infrastructure requirements. In addition, reconstructive
surgery may be performed in these settings because healing of deep second-degree
burns leaves disfiguring scar bands across joints and presents risks for other dangers
such as ectropion and downstream ocular problems. Thus, surgeons in this setting are
often experts at plastic surgical procedures that can correct scarring and cicatrix.

Plans for operative management of mass burn casualty incidents are often quickly
abandoned when the number of living casualties exceeds a region’s specialty burn
bed capability. In this overflow situation, sensible considerations and public health
strategies can resemble scenarios in the developing world in which saving the largest
fraction of burn survivors depends on nonoperative care strategies.

In a wartime environment, burn surgery should be reserved for the far-rear echelon
hospital setting, in which there are personnel and resources to provide specialized
and definitive care alone. This care does not include limb-salvaging procedures performed
in the aftermath of circumferential or fourth-degree burns.

THE DIFFICULTY OF UNCUSTOMARY TRIAGE DECISIONS

The following concept is probably foreign to most surgical practitioners: people who
would routinely be saved in a clinician’s everyday practice are going to die under
austere conditions. The more austere and the more compressed the situation, the
more degraded the ability to save lives.

Every austere scenario that the clinician faces casts a different degree of despera-
tion. Only the people at the scene (and especially local health care providers, irrespec-
tive of training level) are able to arrive at the appropriate triage set points. The medical
team can only speculate, and if a continuous effort is made to vary triage set points as
situational awareness improves, no one can be faulted in hindsight for having acted
according to their best estimates.

The American Burn Association’s National Burn Repository (NBR), the largest main-
tained resource for all burn injury databases, includes regularly updated mortality ta-
bles that can assist with triage of US disaster events. The latest proposed versions of
these tables, which are based on an outcomes study of NBR data, are shown in
Tables 1–3.\textsuperscript{12} Although not intended to be viewed as immutable, these figures can
serve as guidelines for conducting triage under austere conditions in the aftermath
of a mass-casualty event. Age, TBSA, and the presence/absence of smoke inhalation
are the dominant free variables. These tables were created to reflect the mantra that all
clinicians would do well to recite under austere conditions: do the most good for the
most people respectful of limited available resources.\textsuperscript{12}

PAIN MANAGEMENT UNDER AUSTERE CONDITIONS

The topic of triage of burn victims in austere conditions prompts a discomfiting discus-
sion: the ability to intervene is limited by multiple factors. Just as unsatisfactory are
discussions regarding pain management. Although seemingly cold-hearted, perhaps the statement that pain does not kill must be kept in mind when the number of burn victims greatly exceeds the total stock of narcotic and nonnarcotic pain medications.

A general rule to follow in these circumstances is that a major burn (20%–30% or more TBSA) requires approximately a 100-mg morphine equivalent per day to meet current practice patterns in the First World (ie, patient pain perception maintained at 2–3 on a scale of 10).

Under austere conditions the existence of adequate resource stockpiles is highly unlikely. A wise approach embraces the objective of delivering equal treatment of patients and the graceful degradation of therapeutic goals. The decision may have to be made to reserve medications for pain associated with treatments such that no effort can be made to address baseline or breakthrough pain. An alternative might be to establish the set point to maintain patient pain perception at 6 to 8 out of 10.

Desperation demands that any and all analgesic compounds (both narcotic and nonnarcotic, traditional and nontraditional) be used. Routes of administration may be unusual. Cannabis and chewing opium may be all that is available to a local population. Management of pain cannot be business as usual.13–18

PALLIATIVE CARE

Only recently has the important topic of palliative care received its due recognition both in everyday health care and in postdisaster management. Although some recognized philosophic guidelines have been published to govern best practices in these circumstances, there is little in print about palliative care in resource-restricted environments.

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<th>Table 1</th>
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<td>Triage table based on all patients</td>
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<td><strong>Burn Size Group, % TBSA</strong></td>
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<td><strong>Age</strong></td>
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<tr>
<td>0–1.99 Very High</td>
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<td>2–4.99 Outpatient</td>
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<td>5–19.99 Outpatient</td>
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<td>Triage table, noninhalation injury</td>
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<td><strong>Burn Size Group, % TBSA</strong></td>
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Basic guiding tenets are concerned with equal treatment, preservation of personal dignity, sensitivity to and involvement of personal spiritual practices, and the presence of loved ones.

The strong likelihood of inadequate medication supplies germane to end-of-life management was discussed earlier, and improvisation is again required to provide for the most people (living and dying) with a finite and limited set of resources. The balance struck must be decided by the health care team, and should be reached while adhering to the highest moral and caring standards.12,19–23

PEDIATRIC CONSIDERATIONS UNDER AUSTERE CONDITIONS

Some special considerations for the pediatric burn population in austere conditions is worthy of mention. This group of burn victims is disproportionately negatively affected when resources become scarce and chaos reigns. As a result, the pediatric mortality increases greatly during wartime, in impoverished environments, and after mass-casualty events.

Remember the following basics for treating children under austere conditions: children are much more susceptible to hypothermia and low body temperatures; the insult of burn wounds creates a life-threatening combination. Every effort should be made to connect injured children with pediatric-trained health care providers. The presence of parents and/or responsible adults is crucially important in pediatric outcomes; families should be kept together if at all possible. Nutrition demands concerted attention in children because their reserves are less than those of adults; children in these scenarios often have preexisting malnutrition and are exceptionally ill-equipped to sustain the traumatic insults. In the aftermath of these injuries, children are far more susceptible to dysentery and other infectious entities, with a corresponding high mortality. It is important to document the circumstances in which the children were recovered so as to improve the chances of repatriation with family in the aftermath of the chaos, so do not allow this information to be lost. Children often show incredible biologic resilience, and triage officers must be flexible in their use of expectant labeling. In addition, if burn surgery on adults is strongly ill-advised in austere environments, that admonishment is triple for the pediatric population.24,25

INTEGRATING AUSTERE BURN WOUND CARE WITH REALISTIC DOWNRANGE RESOURCES

Consideration of what will occur after the austere scenario is imperative. Clinicians’ realistic assessment of the weeks to months ahead for any patient may promote better triage, better stewardship of limited medications and dressing supplies, and a higher overall salvage rate.
Those working in impoverished settings with no realistic expectation for increasing availability of resources will read the recommendations given earlier from a different perspective than those working on the battlefield with first-class medical assets in the rear echelon. The aftermath of a mass-casualty event is somewhere in between these scenarios because situational awareness is difficult to assess, and the ability to predict the timeline and magnitude of downfield reinforcements is speculative at best.

Regardless of the nature of the austere condition being faced, practitioners are best equipped with their intelligence and devotion to duty; in addition, attention to this article’s content and reflection on its implications will give the people under your care the best chance for an optimal outcome.

**AID FOR BURN MASS-CASUALTY DISASTER PLANNING AND EMERGENCY PREPAREDNESS**

A guide for developing a sound plan for a burn mass-casualty disaster is presented here.

**Basic Assumptions and Key Background Facts**

Burn injuries are common in mass disasters and terrorist acts. In general, in mass-casualty events, 25% to 30% of injured patients require burn treatment. In New York City on 9/11/2001, approximately one-third of injured patients sustained severe burn injuries; likewise the Pentagon attack on the same day led to the injuries of 11 patients with burns.26,27

Burn center care is the most efficient and cost-effective care for burn injuries. Unlike most blunt and penetrating trauma, and even in patients with complex multitrauma, burn injuries often require lengthy treatment with a day of hospitalization for every 1% of body surface area burned. In a mass casualty, the average reported hospitalized burn injury is typically greater than 50% TBSA, suggesting that a patient involved in a burn mass-casualty disaster may require in-hospital care for approximately 2 months.

Burn centers are not the same as trauma centers. Although hundreds of designated trauma centers operate in the United States, only 132 burn centers exist across the country, many of which are concentrated in geographic centers, leaving vast areas of the country without a local burn center.28 In 2013, of the 132 self-designated burn centers, only 65 had been verified through a rigorous joint review program of the American Burn Association (ABA) and the American College of Surgeons (ACS). This verification process ensures that the center has the necessary infrastructure, processes, and outcomes to provide optimal care to patients with burns. As such, the burn center’s director and/or other interested personnel should be actively involved in regional burn mass-casualty disaster planning.

Burn mass-casualty disaster management should be regional and/or national. Successful burn mass-casualty disaster planning requires collaboration and communication among all stakeholders, which requires participation by multiple representatives from burn center personnel. These representatives include non–burn-trauma surgeons, emergency department providers, and hospital administrators from the burn center hospital and other local and regional hospitals. Given the small size of the burn care community and the limited number of available beds for patients with burns at any given time, a mass-casualty disaster requires coordination with state and regional hospitals that do not have a burn center or any expertise with managing burn injuries; however, they may have general surgeons or plastic surgeons who, with guidance, can facilitate early management and triage of injured patients.
Planning with local, state, regional, and national stakeholders is therefore essential to a successful disaster plan. Coordination of plan development can be facilitated through committees and working groups of national organizations such as the ABA, the ACS Committee on Trauma, or the American Association of the Surgery of Trauma. Regional grassroots efforts such as those in the US southern region\textsuperscript{29,30} or the New York region\textsuperscript{31,32} have spearheaded the designation of best practices for disaster planning. Planning for a burn mass-casualty disaster requires consideration of the appropriate organization and patient triage before the patients’ arrival at the burn center. This consideration is commonly known as an external mass-casualty plan, but planning also entails organization within the burn center hospital, or the internal disaster plan.

**External Regional Mass-casualty Burn Disaster Plan**

An external disaster plan provides the structure and organization for patient management before the patients reach the burn center hospital. This plan requires the utmost in collaboration among local, state, regional, and national authorities, and other hospitals. The burn disaster plan should fit within the overall regional incident command system. As such, the external plan should include a mechanism for appointing incident commanders at the disaster site. These commanders are responsible for communicating with someone who has burn expertise and who is positioned at a central command center with access to regional live-time bed availability but without the distraction of the responsibility for caring for patients at the burn center itself. An incident commander should be an individual with sufficient burn expertise to also consult with care providers at other facilities who may need advice regarding appropriate treatment for the first 24 to 72 hours after an incident.

The external plan should include clear guidelines that the on-site triage officer can use to safely triage patients to regional facilities based on severity of injury (discussed earlier). Sending the first 20 patients who present at the first aid station to the nearest regional burn center may not maximize resource use. Burn center personnel should instead educate the regional authorities and develop triage guidelines to direct those patients who will be best served by the expertise of the burn center staff. For instance, sending patients to the burn center who are not expected to live or who have minor burns that can easily be treated with outpatient care would misuse the limited available burn center staff and burn beds. In general, these levels of injury can be categorized as acute triage and nonacute triage. One useful tool in such a scenario is the expectancy grid developed by Saffle and colleagues,\textsuperscript{33} and subsequently revised\textsuperscript{12} based on NBR data. Although it is neither necessary nor desirable to apply such care restrictions on a daily basis, triage decisions during a mass-casualty disaster may require more difficult choices.

Mutual hospital coordination demands a regional strategy for patient transport, sometimes internally from an intensive care unit (ICU) to an acute care ward or from an acute care ward to home. More importantly, hospitals need plans for possible transfer of patients between hospitals if necessary. For example, during a burn mass-casualty disaster, a hospital without a burn center may easily be able to manage additional medical ICU patients or general surgery patients, thereby opening burn beds at the hospital with burn expertise. Planning for such an event requires establishment of hospital transfer agreements, complex medical legal documents that can take months of review by hospital lawyers.

For a burn mass-casualty disaster, a regional burn coordinating center should coordinate with the regional medical coordinating center to manage the flow of patients with burns. This management requires that the incident command structure for the
event include someone with burn expertise who is embedded in the Emergency Operations Center. Communication for such a command center should include the capability of telemedicine.

Because past experiences with disaster management indicate that transportation options may be delayed by weather, impassable roads, and limited air transportation, regional plans should include contingencies for non-burn center hospitals to care for patients with burns. Hence, comprehensive regional burn disaster plans should include dissemination of 24-hour and/or 72-hour care plans. These plans should outline standard operating procedures for airway management, resuscitation, and wound care, including pain management strategies. With current advances in wound care products, consideration should involve use of long-acting antimicrobial dressings that do not require daily dressing changes. Breakdown of the plans according to burn size greater or less than 20% TBSA may facilitate better care by nonburn personnel at local hospitals. Consultation with the burn specialist located at the Emergency Operations Center should be available for enhancing surgical decision making, including decisions regarding the need for escharotomies or early burn debridement or excision.

The ACS Disaster Management and Emergency Preparedness course proposes 3 levels (stages) of burn disaster, defined as follows:

Stage I burn disaster: an incident that requires establishment of an incident command center and implementation of previously developed burn management protocols but does not overwhelm the local burn center resources.

Stage II burn disaster: as stage 1, but involves a network of regional burn centers to accommodate the burn victims.

Stage III burn disaster: a catastrophic event that requires a federal response, including possible activation of the National Disaster Medical System and the Department of Health and Human Services. The proposed role of this response is to assist with ongoing triage needs at the disaster site and/or assistance with secondary triage.

**The Internal Burn Center Disaster Plan**

Each burn center should also have an internal plan that outlines the flow of patients after they reach the hospital emergency department. The plan should consider all contingencies regarding bed availability, staff coverage, and access to supplies and equipment. An important mistake to avoid is mobilization of all available resources during the first hours after an event without consideration of later needs; this advanced planning is especially essential for coordinating personnel who are eager to help but may better serve by providing relief as time passes.

The internal plan should anticipate the possibility that the burn director or an alternate experienced designee may be required at the Emergency Operating Center and be unavailable for patient care. Mobilization of nonburn surgeons and physicians to execute emergency care under the supervision or guidance of a burn surgeon may be necessary to deliver timely critical care to multiple patients simultaneously. Likewise, in such a scenario, nurses and therapists and other ancillary staff with burn expertise may be most useful if they are assigned to oversee several staff members, who may be less familiar with the care of patients with burns, rather than sequestered in a room with a single patient. An important part of the ABA disaster plan is the recommendation for secondary triage. Just as the external disaster plan requires hospital transfer agreements, an internal disaster plan should address the triage of critically injured patients when the number of patients exceeds the burn center surge capacity (maximal number of patients for whom the burn center can safely provide...
The principle behind this concept is that, even in a disaster, the burn community should try to provide optimal care of the burn patient, which is not possible in a center that is overwhelmed by a large number of patients who may stay for a long time. In order to avoid exhausting local resources, secondary transfer of patients with burns to other regional, or even national, verified burn centers can distribute patient volume across centers that are less stressed. Although the original ABA plan recommended that the surge capacity approach 50% more than the regular bed capacity of the burn unit, more recent and elaborate predictions of surge capacity have been described using computer modulations.37 Such distribution of patients did not happen after the events of 9/11/2001,26,27,38 but, with lessons learned, did occur after the fire in The Station nightclub in Rhode Island in 2003.39,40 To facilitate such patient transfers between burn centers, memoranda of understanding should be exchanged among regional burn center directors.

Triage

Triage of patients with burns in a mass-casualty disaster is based on 2 factors: the stage of disaster and the severity of injury as assessed by a triage officer at the scene. Five levels of triage severity are (1) immediate medical needs for life-threatening survivable injuries, (2) minimal first aid needs, (3) delayed care needs, (4) expectant care needs for nonsurvivable injuries, and (5) dead. Because a mass-casualty burn disaster may involve other trauma or exposure, those immediate life-threatening injuries should also be considered because the burns themselves may not demand emergency wound care.

Secondary triage involves the transfer of patients with burns to other burn centers (preferably those verified by ABA and ACS) when the closest burn center has exceeded its ability to care for patients based on resource limitations.

Training

Preparation for a disaster requires continual planning and training.41 Regardless of how many times a committee reviews a comprehensive written plan, that plan is still unlikely to reveal the dysfunctional events that could disrupt an otherwise well-constructed response plan. Review of past disasters has identified several potential weak points, including lack of command and coordination, substandard initial care delivered by bystanders as opposed to search and rescue teams, and lack of triage of most patients who arrive at the closest hospital by private transport or ambulation. In all of these examined disasters, between 40% and 90% of patients went to the hospital nearest the scene. Courses such as the Advanced Burn Life Support course (http://www.ameriburn.org/ABLS/ABLSCourseDescriptions.htm) or the ACS Disaster Management Emergency Preparedness Course (http://www.facs.org/trauma/disaster/) provide valuable insights into disaster management and the immediate care of patients with burns. Regional efforts to educate nonburn personnel can also increase awareness about local resources.42

The best preparation is repeated training (either tabletop exercises or hospital disaster drills) to identify potential pitfalls and areas needing improvement. However, it is essential that these maneuvers drill to fail. That is, they should be designed to test the system beyond its capacity. An exercise that goes smoothly and leaves the team in its comfort zone feeling at ease may lead to complacency and stymie growth. The ideal learning experience pushes the response team to its limits by sequentially exhausting resources and demanding more disaster-team ingenuity. Scenarios should include accommodating for pitfalls that might involve communication
breakdown, hazmat issues, chemical and radiation exposures, triage failures, supply chain breakdown, and civic infrastructure collapse.

ACKNOWLEDGMENTS

The messages and recommendations in this article are consistent with the American Burn Association Disaster plan and the American College of Surgeons Disaster Management and Emergency Preparedness Course Book. The authors recognize the editorial skills of Andrea Sattinger.

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