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TACTICAL COMBAT CASUALTY CARE: TRANSITIONING BATTLEFIELD LESSONS LEARNED TO OTHER AUSTERE ENVIRONMENTS

The Care of Thermally Injured Patients in Operational, Austere, and Mass Casualty Situations

Booker T. King, MD; Wylan C. Peterson, MD

From the US Army Institute of Surgical Research, San Antonio, TX.

Burn injury affects a half million people in the United States annually. The severe thermal injury can have long-term debilitating effects. The management of burn patients in austere and operational environments is more complex. Mass casualty incidents can result in a large number of patients with multiple traumatic injuries, which often include burn injury. Appropriate triage of casualties is essential. Severely burned patients should be evacuated to a burn center if possible. Airway management and fluid resuscitation of burn patients present unique challenges. Supplies, resources, and expertise to maintain a definitive airway may not be readily available. Airway adjuncts can be helpful but judicious use of resources is warranted in the austere setting. Traditional resuscitation of severe thermal injury is not practical in the austere environment. Oral resuscitation and in rare cases rectal hydration may be utilized until the patient can be transported to a medical facility. Much has been learned about the management of burn and polytraumatized patients after mass casualty incidents such as the September 11, 2001 terror attacks and the Pope Air Force Base disaster. A well-coordinated emergency preparedness plan is essential. The care of burn patients in austere, operational, and mass casualty situations can tax resources and manpower. The care of these patients will require creativity and ingenuity. Burn patients can be difficult to manage under normal circumstances but the care of these patients under the above situations complicates the management severalfold.

Keywords: burns, austere environment, mass casualty

Introduction

Severe thermal injury can be lethal or result in long-term debilitating effects. According to the Centers for Disease Control (CDC) almost a half million patients sustained thermal injury requiring some sort of medical treatment annually. Of these patients, 40,000 require hospitalization for their injuries (three-fourths of which were admitted to a burn center).[1] In the United States in 2016, 3275 patients died as a result of thermal and/or inhalation injury. There were 123 burn centers in the United States as of 2011. Sixty-five burn centers are verified by the American Burn Association (ABA) according to 2015 data.[2] However, many communities are located at great distances from any burn center and several states have no burn center within it. Globally the lack of burn treatment facilities and expertise in burn care is even more pronounced.

Burn care is immensely more complex in austere and operational environments. Severe burn injury (defined as total burn surface area [%TBSA] greater than 20%) is incredibly difficult to manage in these environments. It is imperative that patients with severe thermal injury are evacuated to a higher level of care as soon as possible. Medical evacuation may be delayed and in some cases simply not possible. Alternatives must be devised for airway stabilization, burn resuscitation, and burn wound care. Burn patients who sustain their injuries during mass casualty incidents are much more likely to have concomitant polytraumatic injuries that further complicate their management.

Corresponding author: Booker T. King, MD, US Army Institute of Surgical Research, JBSA-Fort Sam Houston, TX; e-mail: booker.t.king.mil@mail.mil.

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In a mass casualty event, 20–30% of casualties can have thermal injury.[3] Obviously, this proportion increases if incendiary explosives devices are involved. Natural and man-made disasters often result in significant casualties with complex assortment of injuries, which include burn injuries in many cases. Managing casualties in austere, operational, and mass casualty situations have several similarities: resources are usually limited, medical expertise may not be ready available, difficulties in evacuating casualties to an appropriate medical facility, and the need to care for these casualties in suboptimal situations for a prolonged period of time.

Triage and severity of burn injury

The first step in the management of thermally injured patients is to assess the severity of the injury. The amount of body surface area burned, the depth of the injury, presence of inhalation injury, and presence of associated injuries are all factors that determine the severity of burn injury. Patients with burn surface area involvement in excess of 20% may require resuscitation for treatment of their burn injury. The depth of burn and presence of inhalation injury also influence the amount of resuscitation. Both of these factors tend to increase the amount of fluid resuscitation required.[4]

Larger burns (more than 20% TBSA area) are extremely difficult to care for in austere and operational environments. As mentioned above, these patients will require burn resuscitation in many cases. Inadequate fluid management will result in profound hypovolemia, acute kidney injury, and in some cases cardiovascular collapse and eventual death. The risk of burn wound infection is also increased with prolonged exposure of wounds to the environment. Specifically, the inability to cleanse wounds and treat with topical antimicrobial dressings will increase infection risks. Patients with large thermal injures are also susceptible to hypothermia and must be kept warm and protected from the elements.[4,5]

Patients with large burns must be evacuated expeditiously, preferably to a burn center. This, of course, is difficult when injuries occur in austere and operational environments. Medical evacuation may require transport across harsh terrain or require rotary or fixed wing transport to traverse great distances. The ability to communicate with the surrounding medical facilities and their ability to rapidly respond and dispatch trained medical teams is important. Even highly trained medical evacuation teams may lack the expertise to care for patients with large burns without specific burn training.

Airway management

Airway management “in the field” can be difficult but even more so in patients with severe thermal injuries. Inhalation injury should always be suspected when a patient is exposed to noxious smoke in a closed space. The patient can present with facial burns, oral/ nasal soot, and carbonaceous sputum and in late stages dyspnea and stridor. The effects of inhalation injury are due to chemical pneumonitis caused by a host of inhaled toxins including carbon monoxide, cyanide, aldehydes, and other poisons. Patient may present with normal respiratory status initially then progress to respiratory failure in 12–48 hours.[6] It is imperative to obtain airway stabilization before symptoms occur as the patient can decompensate rapidly.

Patients with large burns who do not have inhalation injury are at risk as well. As the burn surface area exceeds 20% the inflammatory response becomes more systemic. This inflammatory response is more pronounced with increasing burn surface area. Burn surface areas that exceed 50% will almost always require stabilization of the airway. Systemic inflammation leads to diffuse swelling and eventual loss of the airway. Airway stabilization is extremely arduous and in some cases near impossible to obtain in large burns after several hours when swelling is maximal. Aggressive resuscitation can accelerate this swelling therefore necessitating earlier airway stabilization.[7]

There are several options for airway stabilization. Most airway adjuncts provide temporary airway support but definitive airway is usually obtained with endotracheal intubation or surgical airway. Definitive airway can be difficult to obtain in the field. Placement of definitive airway will require advanced medical skill and can be resource intensive. These factors must be considered before decision is made to place a definitive airway in a burn patient when in austere conditions.

Burn resuscitation

Burn resuscitation may be required when total burn surface area exceeds 20%. Traditional resuscitation formulas utilize balance salt solutions given intravenously. The most commonly used formulas are derived from the product of percent burn surface area, weight in kilograms, and resuscitation factor (4 mL/kg/%TBSA – Parkland formula; 2 mL/kg/%TBSA – Modified Brooke formula). These formulas require that the total fluid rate be halved at 8 hours and again at 16 hours.[8] This may be difficult during complex burn resuscitation. The USAISR Burn Center developed a simplified formula that determines the initial fluid rate from the product of the percent burn surface area and a resuscitation factor of 10 (Rule of Tens) (see Figure 1).[9] All these formulas