Burns management in the military and humanitarian setting

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Received 3 October 2020
Revised 25 October 2020
Accepted 27 October 2020
Published Online First 24 December 2020

To cite: Sandhu A, Herron JBT, Martin NA. *BMJ Mil Health* 2022;**168**:467–472.

ABSTRACT

Burns are an unpredictable element of the modern battlespace and humanitarian operations. Most military burns are small and may not be a significant challenge for deployed healthcare assets but usually render the individual combat ineffective until healed. However, larger burns represent a more significant challenge because of the demand for fluid resuscitation therapy, early surgical intervention and regular wound management that can rapidly deplete surgical capabilities. Beyond the initial injury, longer-term consequences, such as psychological morbidity and loss of functional independence, are rarely considered as part of an ongoing care plan. Globally, most of the morbidity and mortality associated with burns are seen in less economically developed countries and are frequently associated with conflicts and natural disasters, but with simple interventions and resources, outcomes in these environments can be markedly improved. Prehospital providers should be confident to manage the initial assessment of a burn, including triaging for evacuation and packaging for safe transfer. This article provides an overview for prehospital providers on the management of thermal burns in military and humanitarian settings, with additional considerations for the management of chemical and electrical injuries.

Key messages

- ⇒ Scene safety is important when arriving at an incident involving burns and should take priority before triaging and treating patients.
- ⇒ Appropriate and timely first aid is a fundamental part of burn care.
- ⇒ Larger or complex burns, such as electrical and chemical injuries, need early specialist management and should always be evacuated to higher levels of care.

INTRODUCTION

While burns are not the most common injury seen in military or humanitarian settings, they are generally accepted to be one of the most complex forms of trauma. Burn injuries are associated with high levels of physical and psychological morbidity and are resource intensive to treat, yet most deployed healthcare teams have little or no burn care experience.

A recent review of epidemiological trends for burns revealed their global incidence and severity are decreasingly linked to the establishment of hierarchical specialist services and advances in critical care.[1] However, there are little epidemiological data from low-income to middle-income countries, which account for the majority of the 180 000 deaths from burns worldwide, and where burns remain one of the leading causes of disability.[1] This article provides an overview for prehospital providers on the management of thermal burns in military and humanitarian settings with additional considerations for the management of chemical and electrical injuries.

In the first quarter of 2014, Médecins Sans Frontièrs performed around 5000 burns-related procedures in nine of their centres across seven countries.[2] A retrospective review over a 6-year period between 2006 and 2014 revealed that 44.9% of operative procedures carried out were secondary to trauma. Of these procedures, change of burns dressings was the most common planned reoperation.[3] During the same period, data collected by Stewart *et al* from 27 different centres in 16 countries identified that in non-specialised operating theatres, burns-related procedures accounted for 6% of the operative workload during natural disasters and 11% in conflict zones.[4]

Burns are a ubiquitous part of human conflict. During Operation HERRICK, the 12-year UK military campaign in Afghanistan, there were 134 casualties repatriated to the UK with burns injuries between 2001 and 2007.[5] These were often related to accidents with hazardous elements and poor adherence to safety protocols. The most common mechanism of injury for combat burns was close proximity detonation of improvised explosive devices (IEDs).[5] Only four patients had inhalation injuries in this group. Between 2008 and 2013, 65 casualties were repatriated, nearly three-quarters of which were for non-combat burns mostly attributed to the misuse of fuels. Most combat burns remained due to IEDs.[6] In both studies, flash and flame burns predominated, while the total burn size was relatively small and generally <5% of total body surface area (TBSA).[5 6] The overall decrease in burn incidence was due to the introduction of new protective equipment, stricter adherence to safety protocols and a global education programme. A review of burns patients admitted to a US role 3 hospital revealed that factors associated with a higher rate of mortality in burns patients include a higher % TBSA, inhalation injury, increasing age and a higher percentage of full-thickness burns.[7]

The International Society for Burn Injury has published Practice Guidelines for Burn Care that define the best standards for diagnosis, treatment and management in resource-limited environments (RLEs).[8] They cover the entire patient journey and are a valuable resource for prolonged field care with extended evacuation timelines and enduring humanitarian missions. RLEs challenge the usual paradigms of care; the use of oral resuscitation and staged excision are examples of 'doing the best with what is available', especially in the context of mass casualty incidents. The Emergency Management of Severe Burns course, used by British Forces, also provides a good foundation to manage severe burns.[9]

Interburns is a charity whose focus is '*transforming the way burn care is delivered in low and middle income countries*'.[10] Their concepts of care are achievable in low-resource settings, and training programmes are available for multiprofessional teams.

BURNS MANAGEMENT

Approaching the scene and scene management

The burn incident scene is frequently chaotic and fraught with hazards, especially if multiple casualties are present. An accurate description of the scene, including mechanism of injury and residual hazards, will assist planning and anticipation of the resources needed prior to arrival.

Once on the ground, always ensure that it is safe to approach the scene and casualty. First responders must maintain scene awareness as potential risks may still be present, such as explosives or toxic smoke from burning sources. Following an industrial electrical injury, always ensure that nearby power sources are turned off before approaching to prevent arc injuries. Personal protective equipment (PPE) should be worn at all times but especially when dealing with grossly contaminated chemical burns.

The burn scene can be very confusing and it is easy to be distracted by the burn. First responders must identify and treat life-threatening injuries before dealing with the burn. All patients should be managed following the <C>ABCDE algorithm to ensure life-threatening injuries are identified and treated in a timely manner.

Inhalation injury

Inhaled hot gases can cause rapid oedema formation and airway compromise. A detailed history and examination should look for signs and symptoms of airway burns and inhalation injury. Inhalation injury has three distinct components that can occur in isolation but more often occur together.[8] Direct thermal injury leads to upper airway oedema and progressive obstruction, while inhalation of smoke and the toxic products of combustion cause lower direct airway damage and indirect systemic metabolic poisoning.[8]

Prehospital practitioners should have a high index of suspicion for inhalation injury.[11] Burns sustained in an enclosed space, facial burns, singed nasal hair or eyebrows, wheezing or stridor, and carbonaceous sputum are all suggestive of inhalation injury. If suspected, the patient must be closely monitored and urgently evacuated because intubation may be necessary. In general, airway compromise from a burn takes at least 8 hours to develop.[8] However, deterioration should be anticipated and an emergency airway kit must be available. Patients should be transported in an upright position wherever possible. The airway must be secured if there is any suggestion of airway compromise.[12]

Carbon monoxide is an odourless and colourless gas released during incomplete combustion. When inhaled, it is rapidly absorbed and forms carboxyhaemoglobin, which reduces oxygen-carrying capacity to the tissues. Patients with carboxyhaemoglobin levels of 10%–20% may complain of headache and nausea; at 20%–30%, they may develop muscle weakness and impaired cognition; and at 30%–50%, they may develop cardiac ischaemia or become unconscious.[11] All patients should be given high-flow oxygen[13–15] for a minimum of 6 hours.[8] Prehospital practitioners should always consider factors that may produce similar symptoms of reduced consciousness, such as drugs or alcohol.[8] The prehospital practitioner should be aware that carboxyhaemoglobin gives falsely high oxygen saturations with pulse oximetry and should give high-flow oxygen until blood gas analysis can be performed.

Assessment and management of burns

Once evaluated and treated for life-threatening injuries during the primary survey, a detailed history and secondary survey should be performed. They should be examined carefully, sequentially removing clothing to maintain dignity and to prevent hypothermia. Burned clothing should be removed but not if adherent as this may cause unnecessary tissue damage and pain. Jewellery and any other potentially constrictive adornments should be removed before swelling develops. A history should include a clear description of the fire event as well as first aid given, and to establish any risk of inhalation injury or exposure to chemical or other noxious agents.

Burn size and depth must be determined. Burn size is calculated using the percentage of TBSA burned. Assessment of burn depth is difficult for inexperienced providers and can be difficult to determine accurately in the prehospital environment. The use of telemedicine to support assessment of burn size and depth may be useful.[16] If available, it should be used early as both a triage tool and to assist decision making.

Burn depth is best classified anatomically as epidermal (superficial or first degree), dermal (partial thickness or second degree) or subdermal (full thickness or third/fourth degree). It progresses over the first 3–5 days and should be evaluated regularly. In RLEs, depth is assessed by clinical examination[16]:

- Epidermal burns are a simple erythema and do not blister. These burns are hyperaemic and painful but heal within a few days without scarring. They must not be included in the burn size.
- Superficial dermal burns involve the papillary dermis and form blisters. They are hyperaemic and very painful but generally heal within 7–10 days. Deep dermal burns involve the reticular dermis, do not blanch easily and are less painful but can heal without surgery in about 21 days. Mid-dermal burns are a heterogenous mix of both.
- Subdermal burns are full-thickness injuries and do not blister. They are often 'leathery' with a variable appearance and are not typically painful.

Calculating the TBSA burned

A number of methods have been described, but the modified Lund and Browder chart and Mersey Burns App are recommended. Once calculated, key decisions can be made regarding fluid resuscitation therapy and evacuation strategies.

Cooling the burn

Cool running water should be applied over the area for 20 min.[15] This reduces the inflammatory response and mitigates the severity and volume of tissue damage. Hypothermia must be prevented during this time. Remember to cool the burn but warm the patient.[13–15] During a mass casualty events, cooling can be performed by bystanders or those with minor injuries after appropriate education.[17] However, if this occurs, prehospital

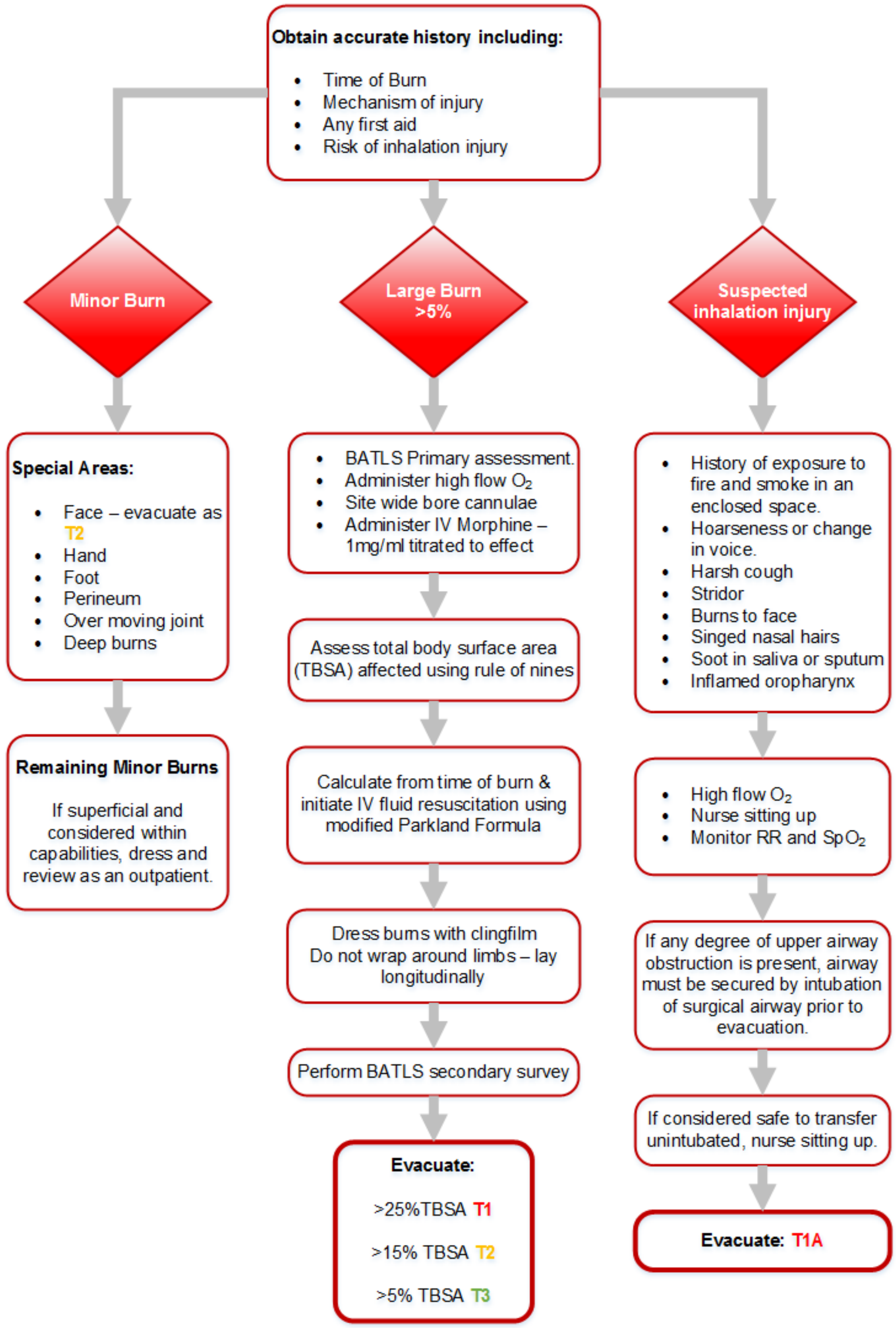

Figure 1 Thermal burns flowchart from UK Clinical Guidelines for Operations.[12]

practitioners must remain vigilant for evolving hypothermia and deterioration of their patients.

Dressing the burn

Cling film, or similar, should be used to dress the burn.[13 14] Circumferential wrapping must be avoided because it can become constrictive. Loosely applied strips of cling film protected with a dressing prevent heat and fluid loss as well as improving pain control.[17]

Fluid management

The Parkland Formula guides fluid management in burns. The formula estimates the fluid requirement for the first 24-hour period after a burn (4×%TBSA×weight (kg)). Half of the total fluid should be given in the first 8 hours from the time of injury with the remaining volume given over the next 16 hours. Wherever possible, patients should receive warmed fluids.[14 15] The modified Brooke formula (2 mL×%TBSA×weight (kg)) requires less fluid and may be more appropriate in RLEs. Over-resuscitation can cause significant morbidity due to oedema accumulation and increases the risk of compartment syndrome, including abdominal compartment syndrome.[16] Although fluid resuscitation therapy is essential for burns of >20% TBSA, cannulation at the scene should not delay timely evacuation to definitive care unless expected transfer timelines are extended. If it is necessary to hold patients at the scene, it is recommended

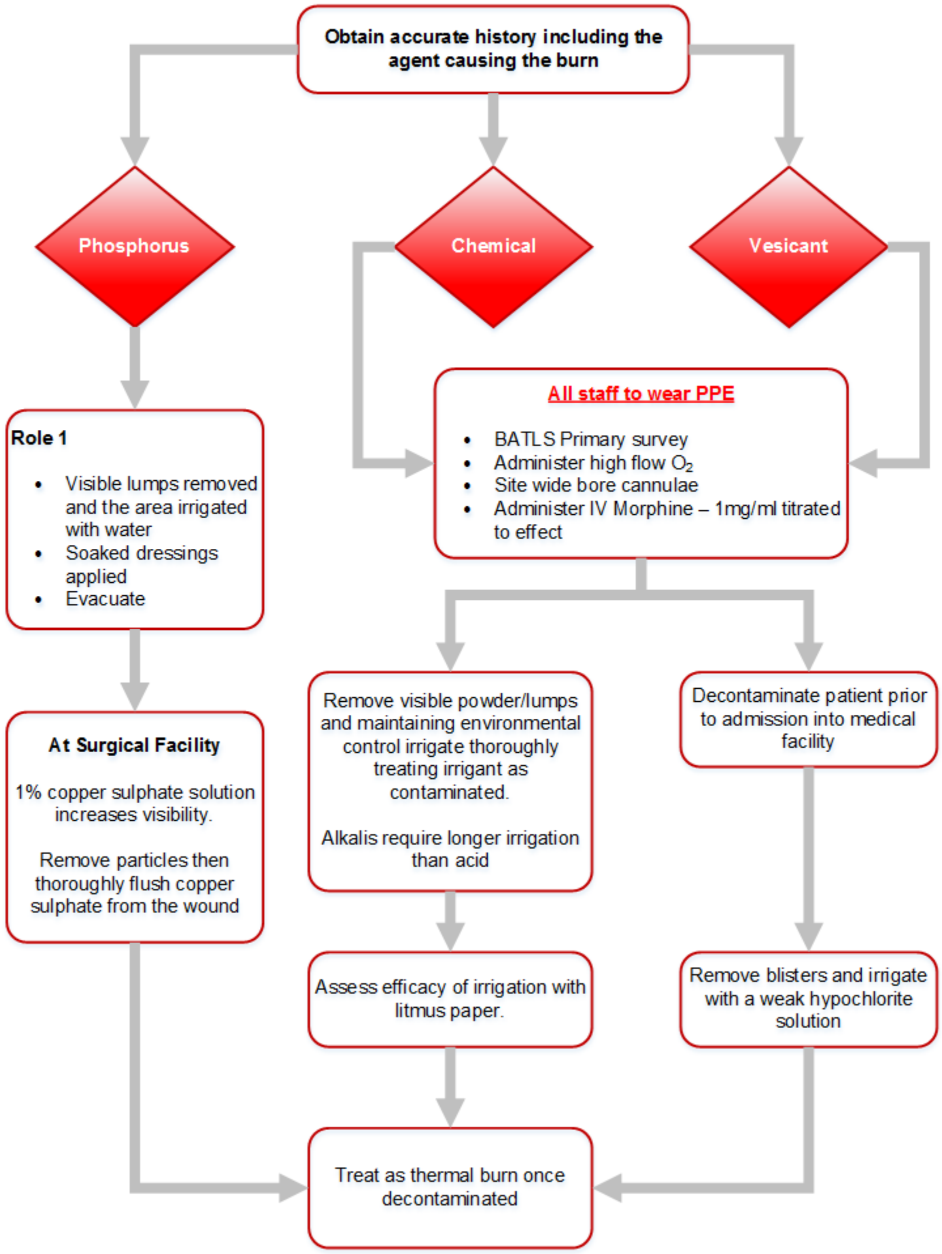

Figure 2 CGO chemical burns treatment algorithm.[20] PPE, personal protective equipment.

to contact the receiving centre to discuss fluid strategies. In many cases, oral fluid resuscitation therapy may be appropriate.

Analgesia

Burns are very painful and frequently require opioid medications. Intravenous morphine should be given in aliquots of 1 mg/mL titrated to response. This can be augmented with regular paracetamol. Non-pharmacological interventions, such as cooling, distraction and comfortable dressings can also provide analgesic effect.

Transport

Clinical Guidelines for Operations (CGOs) provide a summary of those patients who will require transport to hospital following a burns injury (Figure 1). This is not a definitive list and the individual patient, their injury and the circumstances around the injury should be considered when deciding who needs to be transported to a higher level of care. During humanitarian operations and natural disasters, prehospital practitioners may be treating patients from a wide demographic which may affect treatment and transport decisions. If there are any concerns, senior colleagues should be consulted for advice and support.

The period of time a patient is transported is another point at which they are at an increased risk of hypothermia. Simple steps can prevent hypothermia during transportation, including turning the heating up as high as possible in the vehicle, using layered blankets and opening windows and doors for the shortest time possible.[17] Core temperature should be monitored closely.

SPECIAL CIRCUMSTANCES

The detailed management of chemical or electrical burns is beyond the scope of this article. An overview is provided as follows, but the reader is encouraged to consult other references for further information.

Electrical burns

The incidence of electrical burns is low, but they are associated with considerable morbidity, especially if compartment syndrome or neurological injury is unrecognised. Electrical injury is often classified into low voltage (<1000 V) and high voltage (>1000 V), and whether they involve alternating current or direct current. This is useful information to gather but does not influence outcome.

Electrical burns may have entry and exit wounds. The greater the distance between entry and exit points, the greater the number of organ systems are likely to have been affected by the passage of the current and the amount of electrical energy transferred to the tissues. Skin can often appear normal, but extensive damage may have occurred to organs and tissues beneath. Evacuation to a higher level of care is essential.

Patients with electrical injuries must have their neurological status fully assessed for neurological deficits, including Glasgow Coma Scale and pupil response.[18] Cardiac monitoring is not needed in the presence of a normal ECG but is necessary if there is evidence of cardiac instability and may be appropriate for reassurance during transport. Fluid resuscitation should be guided by urine output (1 mL/kg/hour) as true estimation of the extent of injury is challenging in these patients.[16] Wherever possible, any delays in transporting these patients to higher levels of care should be avoided.

Chemical burns

Chemical injuries from fuel spillage is a common cause of non-combat burns.[5] As with any burn, prevention is a key step in management. Prehospital practitioners should ensure those responsible for training include education on the safe handling of any chemical that service personnel may interact with on deployment. Rapid confirmation of the chemical involved is essential and should be discussed with higher levels of care as soon as possible to initiate appropriate treatment and to prevent progression of the burn. In industrial areas, chemical data sheets may be available to assist with immediate management.

Chemical burns need to be decontaminated by continuous irrigation with water until the burning sensation subsides or for as long as practical.[15] Prehospital practitioners must not attempt to neutralise corrosive substances as this may cause further damage by generating heat during the chemical reaction. Chemical injuries to the eyes should be treated as an emergency and must be evacuated as a priority. Hydrofluoric acid presents a unique challenge as the acid sequesters calcium and magnesium, releasing potassium in addition to liquification of the tissues. This can result in fatal arrythmias; thus, calcium gluconate should be administered to the patient.[19]

In military settings, phosphorus burns are a significant threat. White phosphorus reacts with air and releases a toxic smoke as it burns.[16] PPE is necessary while treating patients. Visible lumps should be removed and placed in oil to prevent ignition, and the affected area should be thoroughly irrigated. Wet dressings should be applied and the patient urgently evacuated.[20] CGOs for chemical burns are useful references for the interested reader (Figure 2).[20]

UK MILITARY BURN CARE ON HUMANITARIAN MISSIONS IN THE FUTURE

Wren *et al* have described a consensus framework for the humanitarian surgical response to armed conflict.[21] One of the key themes is the creation of a trauma system from point of injury to definitive care that mirrors the trauma pathway established by coalition forces during the most recent campaigns in Iraq and Afghanistan. They propose that lay people should be trained to deliver basic, but effective, care at the scene of injury to facilitate the overall response. This should include burns training, which could be delivered by UK military medical personnel as part of humanitarian assistance in a conflict or disaster setting. It was recognised by the expert panel that burns are common in both low-income and conflict settings and that burn care and rehabilitation are key elements required to improve outcomes. The framework also recommends those procedures that should, and should not, be performed in RLEs. Early burns reconstruction and release of established scar contractures are recommended as minimal but highly effective surgical interventions.

CONCLUSIONS

Burns represent a significant challenge for prehospital practitioners. Fire scenes and burn events can be chaotic and hazardous, and injuries are likely to be distressing to both the patient and first responders. A structured approach to the management of burns patients is essential, and prehospital practitioners must exclude life-threatening injuries without being distracted by the burn. Understanding when to evacuate burns patients is key to the successful management of this complex group of trauma patients.

Contributors AS, JBTH and NAM contributed to conception and intellectual content. AS led the initial drafting with input from JBTH and NAM. Critical appraisal and manuscript revisions were made by AS, JBTH and NAM. The final manuscript was approved by all authors.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Commissioned; externally peer reviewed.

Data availability statement No data are available. N/A.

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