

Approach to: Burn Injuries

Jason Liu¹

¹University of British Columbia, Vancouver,
British Columbia, Canada

Correspondence

Jason Liu
Email: jliu128@student.ubc.ca

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ABSTRACT

Burn injuries are trauma cases with potentially complex pathophysiology and multi-organ considerations, especially in severe cases. Serious sequelae such as compartment syndrome and inhalational injuries must be considered in victims of severe burns. Burn severity is assessed via a combination of burn area and burn depth, using methods such as the rule of nines or the Lund-Browder charts for area and clinical examination to determine depth. Mild burns can be managed on an outpatient basis by family physicians, while major burns should be referred to the local burn center for management. Non-surgical treatment of burns includes dressings, cooling, pain relief, and monitoring for infection, while surgical treatment focuses on the debridement of non-viable tissue and wound closure.

 KEYWORDS

Burns, TBSA, Flame, Parkland

1 | QUESTION

A 30 year old male presents to the emergency department for a burn injury. He was pouring accelerant on a small bonfire in his backyard in a semi-enclosed alcove when he slipped and fell into the flames onto his hands and face. He struggled to extract himself for approximately 5-7 seconds and immediately jumped into his pool afterwards to cool down. There was no loss of consciousness. His family called for an ambulance and he

was brought immediately to the nearby hospital. The paramedics could not establish an IV access and no fluids were given en route. In the ER, he complains of a mildly sore throat but his main concern is regarding pain control.

On exam, he is alert, oriented and able to speak in full sentences. His blood pressure is 140/90, respiratory rate is 28 per minute, heart rate is 100 beats per minute, and his temperature is 37.0 degrees. On inspection he has singed facial hair, facial burns and soot in his oropharynx.

Abbreviations: TLOC, transient loss of consciousness.

ynx. His burns are circumferential around his arms with weak but palpable pulses distally. The burns on his torso are bright red with sloughed skin and blisters. He describes extreme pain from the burns on his face and torso, but comments that the burns on his arms “doesn't feel as bad”. He has a notable inspiratory stridor but auscultation reveals equal air entry bilaterally. He denies any other past medical history.

A primary survey otherwise reveals no other injuries. What is the most important next step for management of this patient?

- A. Establish intravenous access and start Ringer's Lactate to replenish fluids.
- B. Assess for inhalational injury via laryngoscopy, with consideration for rapid sequence intubation.
- C. Admit to ward to observe burn progression and provide pain control.
- D. Perform a bedside escharotomy for the upper extremities.
- E. Take a detailed and complete history and calculate the Total Body Surface Area (TBSA) percentage.

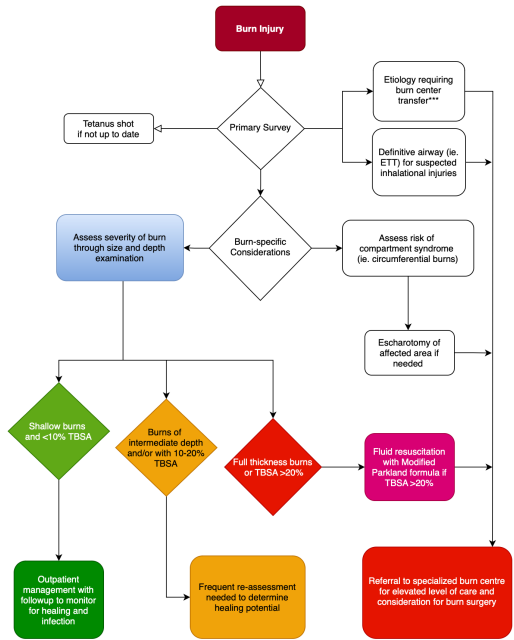
2 | ANSWER

B. Assess for inhalational injury via laryngoscopy, with consideration for rapid sequence intubation.

It is crucial to recognize the signs of a potential inhalational injury based on history and exam findings. Concerning signs can include stridor, voice changes, hemodynamic instability, respiratory distress, and soot/burns in the oropharynx. While the other options presented are valid concerns, it is most important to protect the airway if there are concerns for compromise. Once the airway is secured, further assessment of the burn injury can proceed (i.e., TBSA Calculations, fluid resuscitation, evaluation for compartment syndrome, etc.)

3 | INITIAL APPROACH

Burn injuries should be first and foremost treated as cases of trauma, with the initial attention given to the



FLOWCHART 1 An approach to a patient with burn injuries.

***ABA criteria for etiologies that would benefit from burn center referral includes electrical burns, chemical burns, pediatric cases where the current facility is unsuited for the level of care the patient requires, significant medical comorbidities, or concomitant traumatic injuries. (1)

primary survey to stabilize the patient and reveal other injuries that the medical team need to co-manage. Key components of the trauma survey per the updated 2025 ATLS guidelines include assessment of “xABCDE”: eXsanguinating hemorrhage, airway, breathing, circulation, disability, and exposure. (4,6)

Throughout the primary survey, it is important to keep consideration for burn-specific injuries. For the airway assessment, patients should be evaluated for inhalational burns first and foremost to rule out impending airway collapse and need for intubation. Studies have shown that inhalational injuries alongside cutaneous burns are associated with significant mortality. (7) Elements of the history/physical exam such as oropharyngeal soot, singed nasal hairs, prolonged exposure to smoke, and being burned in an enclosed space are all risk

factors for developing airway burns. In 2011, the American Burn Association (ABA) published a set of clinical criteria for intubation in the setting of suspected inhalational injury, including full-thickness facial burns, respiratory distress, stridor, upper airway trauma, swelling on laryngoscopy, altered mentation, hypoxia/hypercarbia, and hemodynamic instability.(8) The airway assessment should also include consideration for cyanide toxicity and/or carbon monoxide (CO) poisoning. CO poisoning secondary to smoke inhalation is of particular concern as standard pulse oximetry cannot differentiate carboxyhemoglobin from oxyhemoglobin.

In addition to inhalational injuries, there are other specific burn etiologies that should prompt consideration for immediate transfer to the local burn center. An example of this includes burns that are electrical or chemical in nature, which can cause complex internal injury requiring specialized care. Cases with concomitant trauma, burns in sensitive locations (i.e., genitalia), pediatric patients in a setting without pediatric-specific care, and patients with significant medical comorbidities are also recommended for transfer. (9)

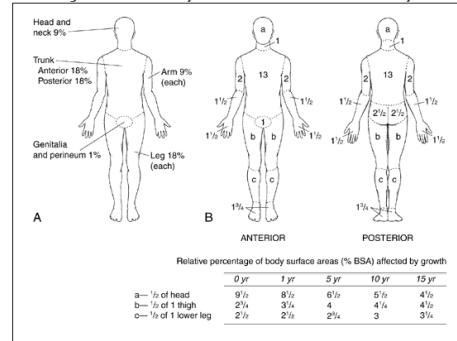
Lastly, as part of the initial management all burn patients should be offered tetanus prophylaxis if not up to date (within 5 years). Cases of tetanus post-burn injury can be found in the literature spanning more than 100 years, (10) and studies of tetanus immunoglobulin administration have shown good efficacy against the disease. (11)

Once the trauma survey is complete, a more detailed burn-specific assessment can occur. The severity of burns is assessed in two ways: the size/area of the burn and the depth of the burn. Burn depth is divided into superficial epidermal (or first-degree) burns, partial-thickness (second-degree burns), and full-thickness (third-degree) burns. Partial-thickness burns can be further described as superficial and deep-dermal burns (see Table 1). The burn depth is assessed based on appearance and sensation in the area, and is used to predict if the burn requires surgical treatment. In addition to the above classification, the term "fourth-degree burns" is also used to describe devastating burn injuries

that extend to structures underneath the dermis such as fascia, muscle, and bone. (12)

Burn area is calculated via "percentage of Total Body Surface Area" (or "% TBSA"). There are multiple ways to estimate burn area, with some common methods such as Lund-Browder charts or the Rule of Nines (see Figure 1). To prevent confusion when communicating burn severity, it is of special note that the TBSA does not include superficial epidermal burns.

Estimating Percent Total Body Surface Area in Children Affected by Burns



(A) Rule of "nines"

(B) Lund-Browder diagram for estimating extent of burns

FIGURE 2 An example of using the rule-of-nines or Lund-Browder charts to estimate TBSA. From the U.S. Department of Health and Human Services, Public domain, via Wikimedia Commons.

A special burn-specific consideration occurs when the patient presents with deep circumferential burns around their limbs or torso, as the resulting non-compliant eschar may lead to compartment syndrome. Classically, the "6 Ps" can be used for assessment of the area: pain, pallor, pulselessness, paresthesias, paralysis, and poikilothermia. If the risk for compartment syndrome is high, escharotomy of the affected area by trained surgical staff should be considered. (14) If the clinical picture is ambiguous, there are tools that can assist the diagnosis of compartment syndrome, including the use of pulse oximetry to assess distal oxygenation, Doppler ultrasound for blood flow, and the direct measurement of compartment pressures using a catheter. (15)

	Superficial (First degree)	Epidermal	Superficial dermal (Partial-thickness)	Deep-dermal (Partial-thickness)	Full-thickness (Third degree)
Appearance	Dry and red (often described "like sunburn")		Blisters, red, moist and/or weeping	Blisters, red/white in colour, can be "waxy"	Waxy/leathery white or charred/blackened
Blanchable	Yes		Yes	Sluggish	No
Sensation	Intact, painful to temperature/air/touch		Intact, painful to temperature/air/touch	Painful to touch only	Sensations to deep pressure only
Healing Potential	Will heal over days-week		Will heal with conservative therapy over 2-3 weeks	Usually need 3+ weeks to heal, would likely benefit from surgery	Rarely heals without surgical treatment

TABLE 1 Common attributes of various burn depths. Information in table adapted from Lanham et al. (2), Jeshcke et al. (3), and ABA ABLS course manual (9).

Taking into consideration the size of burn, depth of burn, and the aforementioned risk factors (such as inhalation injuries) will allow categorization of burns into burns that can be conservatively managed as “minor burns” in an outpatient setting, or “major burns” that require assessment by a burn specialist in a specialized treatment facility.

For minor burns, common components of conservative management include pain control, cooling of the area, burn dressings for partial-thickness burns, and frequent follow-up to monitor for healing/infection. (2) Analgesia can often be achieved with oral medication for uncomplicated superficial burns. Cooling the burn with tap water can decrease the tissue damage, decrease pain, and improve healing. Burn dressings allow for an environment that promotes healing with many options including silver-impregnated dressings, honey, and gauze with antibacterial ointments. Blisters may also be kept intact or deroofed to remove a potential nidus for infection depending on area of injury, patient factors, and degree of general clinical concern. Antibiotic prophylaxis is not recommended – a Cochrane review of the subject in 2013 was not able to show a benefit and suggests that it may actually contribute to antibiotic resistance. (16)

For burns of moderate concern that may or may not heal conservatively, frequent follow-up is required to determine healing potential, monitor for developing infections, and prevent heavy scarring/poor cosmesis. The full extent of burns often develop over the course of

48-72 hours, and should be re-assessed at that time to determine a final TBSA and burn depth. (17)

3.1 | Beyond the Initial Approach

For major burns, the large amount of tissue damage causes not only deleterious effects locally at the site of the burn, but also systemically throughout the body. The pathophysiology of large burns includes metabolic derangement, immune dysregulation, as well as large fluid shifts. (3) Large burns have been shown to cause drastic proinflammatory and hypermetabolic states due to dysregulated cytokine and chemokine release. (18) A sustained sympathetic drive can also develop due to the abnormal stress response involving catecholamines and cortisol, while the resulting inflammatory cascade can result in widespread redistribution of fluids, potentially leading to distributive shock and organ failure. (19) This means that patients with large/deep burns often need to be closely monitored in an intensive setting to receive adequate care. This can involve specialist care from intensivists, infectious disease specialists, and anesthesiologists in addition to the burn surgeon. For these cases, scoring systems like the modified Baux score can help prognosticate patients with severe burns, assisting in clinical decision-making. (3)

Due to the loss of the epidermal/dermal layers, there are large amounts of fluid loss through insensible routes that need to be replenished. For patients with a calcu-

lated TBSA of >20%, fluid resuscitation is indicated to combat systemic effects of the burn that lead to large fluid shifts out of the vasculature. There are several different equations to estimate fluid needs post-burn. For example, the modified Parkland formula can be used to estimate the total fluid volume needs in the first 24 hours and is as follows:

$$(2-4 \text{ mL/kg of Ringer's Lactate}) \times \\ (\text{TBSA percentage}) \times (\text{patient weight in kg})$$

This total volume is divided into 2, with one half of the amount given in the first 8 hours, and the second half given in the next 16 hours. (13) The modified Parkland formula serves as a good starting point to estimate fluid needs, but every patient should be evaluated independently for volume status. Notably, the formula is prone to over-estimation and over-fluid resuscitation which carries the risk for fluid creep and volume overload in an already ill patient. The formula should be applied cautiously in conjunction with frequent clinical assessment of volume status (i.e., PoCUS) to prevent fluid overload. A common titration point for adequate fluid resuscitation is a urine output of 30-50cc per hour. (6,12)

In addition to sequelae such as fluid loss, the absence of the skin barrier predisposes patients to infections that can delay wound healing and worsen outcomes. Careful monitoring of the burn sites is required to catch and treat any brewing infectious disease.

Deeper burns often require surgery. The excision of unviable tissue removes breeding grounds for potential pathogens and hastens healing of underlying structures, contributing to decreased morbidity and mortality. (20) Tools like laser doppler imaging, enable the burn surgeon to predict areas that will heal and areas that will not, which can assist in surgical planning for excision and grafting. Once the burned area has been adequately excised, the area can then be closed and allowed to heal. The options for grafting are numerous and are often based on burn severity, patient factors, surgeon preferences, as well as resource constraints. Common graft-

ing options include autografts, allografts (i.e., cadaveric sources), as well as synthetic biomaterials. (3,5) Care for these patients often involves a multidisciplinary team of surgeons, intensivists, internists, specialty nursing, as well as allied health professionals.

3.2 | Conclusion

Burn injuries are traumatic cases that range from extremely simple injuries to complex cases with multi-organ involvement. Burn severity is assessed via a combination of burn area and burn depth. Minor cases can be managed on an outpatient basis by family physicians, while cases of concern should be referred to the local burn center.

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