Evaluation and Management of Thermal Burns

Editor:
Susan B. Promes, MD, FACEP
Associate Professor, Division of Emergency Medicine, Department of Surgery, Director, Emergency Medicine Residency Program, Duke University School of Medicine, Durham, NC

Contributors:
John J. Villani, MD, PhD
Assistant Professor, Division of Emergency Medicine, Duke University School of Medicine, Durham, NC

Justin Zanone, MD
Resident, Division of Emergency Medicine, Duke University School of Medicine, Durham, NC

Table of Contents

Introduction .................................................... 2
Burn Severity and Physiology ............................... 2
Management of Life-Threatening Burns ................. 3
Management of Less Severe Burns ....................... 8
Conclusion ..................................................... 10
Suggested Reading ........................................... 10
References ..................................................... 10

Copyright 2007, Turner White Communications, Inc., Strafford Avenue, Suite 220, Wayne, PA 19087-3391, www.turner-white.com. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, mechanical, electronic, photocopying, recording, or otherwise, without the prior written permission of Turner White Communications. The preparation and distribution of this publication are supported by sponsorship subject to written agreements that stipulate and ensure the editorial independence of Turner White Communications. The authors are solely responsible for substantive content. Statements expressed reflect the views of the authors and not necessarily the opinions or policies of Turner White Communications. Turner White Communications accepts no responsibility for statements made by authors and will not be liable for any errors of omission or inaccuracies. Information contained within this publication should not be used as a substitute for clinical judgment.

www.turner-white.com  Emergency Medicine Volume 9, Part 4  2
Evaluation and Management of
Thermal Burns

John J. Villani, MD, PhD, and Justin Zanone, MD

INTRODUCTION

Thermal burns are a frequent presenting complaint in US emergency departments (EDs). The National Center for Injury Prevention and Control (NCIPC) estimated that there were 467,929 ED visits for burns in 2003.1 Of these patients, 441,655 were treated and released and 19,899 were admitted or transferred. The NCIPC also estimated that there were 3875 burn deaths in the United States in 2003. Approximately 55% of those who presented to the ED due to burns were males, and 68% of the burns requiring hospital admission or transfer were suffered by males. The incidence of burns prompting ED visits is bimodal, with a peak at ages 1 to 4 years and a second peak at ages 25 to 34 years.1

Most burns are caused by fire/flame (46.0%), scalds (32.5%), or contact with hot objects (8.1%). Scalds are the primary cause of burns in the very young, accounting for 65.5% of burns requiring burn center referral in the neonate to 4.9 years age-group. Fire/flame burns are the primary cause of burns for all other age-groups.2

Burn severity seen in the ED ranges from widespread full-thickness burns that lead to life-threatening airway compromise and hemodynamic collapse to small-area superficial burns that require only reassurance and discharge. Complex decisions must be made by the ED physician, including when and how to invasively manage a burn patient’s airway; when to transfer a burn patient to a regional burn center; how to begin optimal fluid rehydration and manage electrolytes; how to minimize compartment syndrome and infection; and how to dress burn wounds to minimize pain, fluid loss, and subsequent scarring or infection. Optimal ED management of severe burns takes into consideration the dynamic nature of skin and systemic burn physiology and anticipates life-threatening complications before they occur. This article reviews the approach to emergency care of thermal burns, with an emphasis on burn management issues.

BURN SEVERITY AND PHYSIOLOGY

PHYSICAL PROPERTIES AFFECTING BURN SEVERITY

Burns are caused by heat transfer to the skin. In general, the physical properties of the substance causing the burn will determine its severity. Although temperature and duration of contact time with heat sources are important factors in determining the severity of the resulting burns, physical parameters such as heat capacitance and heat conductance are also critical. For example, the burn caused by superheated steam at a given temperature is typically much worse than a burn caused by superheated air at the same temperature because the heat capacitance of water is much greater than that of air. Likewise, contact with a rapid and efficient conductor of heat (eg, metal) will cause a relatively more severe burn in a shorter period of time than a poor conductor of heat.

BURN ZONES

Tissue damage from a thermal burn decreases as the distance (in both depth and surface distance) from the core of the burn increases, with necrotic tissue in the superficial and central portions of the burn giving way to progressively less damaged tissue with a higher likelihood of tissue survival. Although the relationship between distance and burn severity is continuous, severe burns are often divided conceptually into 3 “zones” based on long-term tissue viability. The zone of coagulation shows the greatest tissue damage and contains only dead tissue. The zone of stasis is adjacent to the dead tissue and is an area of potential injury. In this zone, cells are damaged and show increased permeability leading to edema as well as decreased perfusion and reversible ischemia. The tissues in the zone of stasis can survive if appropriate and timely treatment is initiated. The zone of hyperemia is the outermost burn zone. Tissue in this zone receives adequate blood flow and will survive unless there is secondary insult, such as infection or profound systemic shock.3
BURN SEVERITY CLASSIFICATION

Burns are classified as first, second, or third degree, depending on the depth of tissue damage. Recently, the more descriptive terms “superficial burns,” “partial thickness burns,” and “full thickness burns” have come into favor and are often used instead of first-, second-, and third-degree classification, respectively. In almost all cases of severe burns, the burned patient will have a combination of full thickness and partial thickness burns, typically with more severe full thickness burns surrounded by areas of progressively less severe partial thickness burns.

Superficial burns are limited to the epidermis and result in no significant tissue damage. These burns are typically bright red and can be quite painful. Although superficial burns typically heal quickly and have no long-term sequelae, the pain associated with widespread superficial burns can be exquisite, and pain control may be a significant short-term challenge.

Partial thickness burns (often called dermal or second-degree burns) extend into the dermis without complete destruction of the dermis. Partial thickness burns are often further characterized as “superficial” or “deep” (Table 1). This distinction is important when educating patients about their injuries because the length of the healing process and severity of scarring increase with the depth of the partial thickness burn. As dermal burns increase in depth, more of the cells that allow the skin to reepithelialize and heal are destroyed. Superficial partial thickness burns should heal within 21 days and leave a minimal scar, whereas deep partial thickness burns take longer than 21 days to heal and often lead to substantial scarring.

Full thickness (third-degree) burns are defined by destruction of the entire epidermis and dermis, including skin accessory components such as hair follicles and sweat glands. Full thickness burns may appear black and charred or may be dull and dusky in appearance with a firm, leathery texture. The skin does not blanch with pressure, and the patient feels no sensation in areas with full thickness burn. Because the dermis is completely destroyed, the skin’s ability to regenerate is lost. Thus, full thickness burns require skin grafting or other operative management to heal.

PHYSIOLOGIC EFFECTS OF SEVERE BURNS

The physiologic effects of both full thickness and more severe partial thickness burns are not limited to local tissue damage. Burned cells release a multitude of inflammatory mediators that can lead to a systemic inflammatory response. The larger the burned area, the more mediators are released, thus increasing the chance for a systemic inflammatory response. In severe cases, this leads to profound shock and the systemic inflammatory response syndrome. As will be discussed below, a primary role of the ED physician is to recognize and appropriately treat burn shock.

MANAGEMENT OF LIFE-THREATENING BURNS

When managing major burns, the ED physician should generally follow initial trauma management guidelines specified by the American College of Surgeons Advanced Trauma Life Support principles. Due to the unique local and systemic pathophysiology of major burns, there are additional clinical presentations and management considerations that every ED physician must know. ED physicians must understand burn airway management, fluid resuscitation, pulmonary injury, smoke/toxic inhalation, and initial burn wound care. In addition, ED physicians must be prepared to treat any traumatic injury that the patient may have suffered in addition to his/her burn injuries. For example, if the patient is unable to provide a history and there is a possibility that the burn patient fell, then the patient should be placed in a cervical collar and be treated as a potentially injured trauma patient as well. Lastly, ED physicians must be vigilant about assessing the cause of all burns regardless of their severity, especially in young children. If abuse by caregivers is suspected, the physician has the responsibility to alert appropriate government protective services agencies and not discharge a patient whose burns are possibly the result of nonaccidental trauma. Burns that are suspicious for...
nonaccidental trauma include the following: (1) burns with obvious patterns from cigarettes, lighters, irons, or other common hot objects; (2) scald burns to the soles, palms, genitalia, buttocks, or perineum; (3) symmetric scald burns of uniform depth; (4) burns with associated upper limb restraint injuries; and (5) burns with other signs of nonaccidental trauma.⁵

AIRWAY

Physiology

As with every trauma patient evaluated in the ED, initial assessment and management should begin with the airway. This step is especially challenging in burn victims because the degree of potential airway compromise may not be obviously related to the extent of observable skin damage from the burn. Airway obstruction results from direct thermal damage (ie, the burn) and hot gas inhalation as well as subsequent severe airway inflammation/edema. In the early stages of burn injury, airway edema is dynamic. Hence, a burn patient initially presenting with a patent airway may still be at significant risk of airway compromise during the hours following the initial insult. As such, the ED physician needs to have a high level of suspicion for potential airway compromise and a low threshold for initiating invasive airway management of burn patients before airway compromise develops. Attempting endotracheal intubation after airway edema has progressed may lead to an immediately life-threatening situation in which the burn patient can neither be intubated nor ventilated, thus requiring an emergent surgical airway. Airway edema, however, is not the only etiology of airway compromise in the severely burned patient. Deep circumferential neck burns may cause external compression on the patient’s airway either through edema or reduced skin compliance. In this situation, neck escharotomy in which an incision is made through the burned tissues, performed in the ED may be indicated.⁶

Assessment

Direct assessment of the burn patient’s airway can be very difficult. Although physical examination findings (eg, hoarseness, stridor, cyanosis, respiratory distress) are easily assessed and should prompt immediate intubation, they only occur when airway edema has progressed significantly. Thus, waiting for these findings to appear before securing the burn patient’s airway puts that patient at risk. A review of the literature on burn airway management performed by Cancio⁷ did not reveal any well-validated guidelines for deciding when a burn patient should be intubated. However, expert consensus dictates that patients with stridor, respiratory compromise, cyanosis, deep and extensive burns to the face or neck, or carbonaceous sputum production should be intubated immediately.⁸ In patients with suspected airway compromise, some experts recommend that the ED physician examine the airway for edema or other worrisome signs with rapid direct laryngoscopy using a topical anesthetic, with intubation indicated for any signs of airway burn, inflammation, or edema.⁹ Also, patients exposed to heat in an enclosed space (eg, a house fire) should be treated with a high level of suspicion regardless of the severity of skin burns, as trapped, superheated air in enclosed areas often injures the upper airway with little or no evidence of direct burn injury to the skin.

Paralytic Agents

The choice of paralytic agents for rapid sequence intubation of burn victims is somewhat controversial. Succinylcholine is a depolarizing muscle relaxant frequently used in the ED, typically for procedures such as intubation, due to its fast onset and short duration of action. Administration of succinylcholine causes serum potassium levels to rise, which can lead to hyperkalemia and ultimately cardiac arrest in some patients. Succinylcholine achieves muscle paralysis by mimicking the effects of nicotinic acetylcholine receptors at the neuromuscular junction, specifically by depolarizing the muscle membrane. As with all deep tissue traumas, severe burns result in increased synthesis of acetylcholine receptors. In trauma patients, the acetylcholine receptors are not confined to the portion of the muscle cell membrane composing the motor end plate as usual but are spread across the entire muscle cell membrane. When succinylcholine is administered, excessive quantities of intracellular potassium may be released into the vascular space, thereby leading to hyperkalemia in some patients. However, this hyperkalemic response depends on the proliferation of acetylcholine receptors, which can take days or weeks to occur. Thus, succinylcholine is viewed as safe as a rapid sequence intubation paralytic in the acute burn setting. However, succinylcholine should be used with increasing caution 24 hours after the initial burn; the use of a short-acting nondepolarizing paralytic agent is recommended after this point.¹⁰

BREATHING

Airway compromise is an early, life-threatening presentation of major burns. However, airway compromise is an uncommon cause of fire-related deaths. The vast majority (~80%) of fire-related deaths are due to smoke/toxin inhalation.¹¹ The ED physician must be prepared to recognize and intervene on breathing
complications of major burns, including direct thermal and chemical damage to small airways and alveoli, systemic implications of specific toxic inhalations, and direct mechanical breathing difficulties associated with circumferential torso burns.

**Thermal and Chemical Damage**

Direct thermal damage to the lungs and lower airway is rare. Air does not hold heat well and the tissues of the oropharynx dissipate heat effectively. Thermal injury to airways has been reported in cases of superheated steam or hot particle inhalation, as these substances have high heat capacitance. \(^\text{12}\) Direct chemical damage to airways and alveoli is much more common and results in both immediate and delayed effects. Immediate effects include direct damage to airway epithelium, followed by the development of edema and protein exudates that can trigger bronchospasm. Delayed effects include the development of tough fibrin casts that may completely occlude both large and small air passages. \(^\text{12}\) This dynamic sequence of change occurs over the first 24 hours after the burn, well within the time period when the ED physician may be the first physician available to treat the patient. The ED physician can do little to prevent these problems, but a high level of suspicion when the burn history is consistent with this type of injury will help avoid a potentially catastrophic result. Arterial blood gas analysis can be helpful in assessing deficiencies in ventilation and oxygen exchange. \(^\text{12,13}\) However, clinical suspicion is of paramount importance. As with airway management, early intubation of high-risk burns is critical.

**Inhalations of Toxins with Systemic Effects**

**Carbon monoxide.** Combustion of hydrocarbon-containing materials inevitably results in the formation of carbon monoxide. When inhaled, carbon monoxide binds strongly with hemoglobin, thus preventing hemoglobin from binding with oxygen. Any patient with prolonged exposure to fire in an enclosed area, regardless of the extent of skin burns, should be presumed to have carbon monoxide toxicity until proven otherwise. Patients with carbon monoxide toxicity may present to the ED with headache, altered mental status, psychosis, or coma. In the field, all burn patients should be placed on 100% oxygen by face mask, as the half-life of the carbon monoxide–hemoglobin bond is 40 to 60 minutes if the patient is breathing 100% oxygen versus a half-life 250 minutes on room air. On arrival in the ED, an arterial blood gas analysis with co-oximetry should be obtained to determine carbon monoxide levels. Carbon monoxide levels greater than 25% or any elevated carbon monoxide level accompanied by moderate to severe symptoms should prompt consultation with a hyperbaric center. \(^\text{12,14}\)

**Other toxic inhalants with systemic effect.** Of the toxins besides carbon monoxide that have specific systemic pathophysiologic effects and specific antidotes, hydrogen cyanide is the most important. It is formed through the combustion of nitrogen-containing polymers found in some plastics. Inhalation of hydrogen cyanide can cause cyanide toxicity. Although this is an inhalation, its effect is noticed most as resistant lactic acidosis and persistent tachycardia with hypotension despite adequate fluid resuscitation and, thus, is discussed in the section on circulation. Finally, many gases that would not ordinarily be considered toxins (eg, carbon dioxide, methane, nitrogen) can lead to simple asphyxiation and hypoxic injury if inhaled in large concentrations in enclosed spaces. The treatment for inhalations of simple asphyxiants is supportive oxygen by face mask or mechanical ventilation, but any tissue damage is likely to be irreversible. \(^\text{12}\)

**Circumferential Torso Burns**

Circumferential torso burns are a third major cause of breathing difficulties in the severely burned patient. Full thickness burns cause tissue to shrink and significantly decrease skin compliance. Circumferential full thickness burns on any part of the body can lead to morbidity and mortality: they can cause compartment syndrome and distal vascular insufficiency on extremities or they can cause airway obstruction on the neck. If such burns occur on the torso, they can significantly decrease chest wall compliance, leading to respiratory compromise due to external constriction from the patient’s burned skin. In such cases, endotracheal intubation and positive-pressure ventilation are indicated, but these interventions may not be sufficient. In cases where positive-pressure ventilation is failing, emergent torso escharotomy is indicated. \(^\text{6}\) Escharotomy can release the constriction resulting from circumferential burns. Although escharotomy is typically performed by a surgeon, an ED physician may need to perform this procedure in life- or limb-threatening cases of circumferential burn. A torso escharotomy is performed using a scalpel or electrocautery to cut 3 long incisions through the tough eschar but not deep into the subcutaneous tissues. One incision should be made in each of the mid axillary lines and a third should connect the first 2 incisions along the costal margin (Figure 1). \(^\text{6}\)

**CIRCULATION**

Fluid loss, profound hypovolemic shock, life-threatening electrolyte abnormalities, and other
manifestations of massive systemic inflammatory mediator release are the hallmarks of major burns. The ED physician plays an important role in the early management of major burn patients, as initiating early and aggressive fluid resuscitation is critical to the survival of these patients.

A major burn triggers both local and systemic inflammatory responses. In the area of the burn, direct damage to tissues produces an immediate inflammatory response, with loss of cell membrane integrity leading to gross local edema that is further enhanced by inflammatory mediators released by the burned tissue. Initially, the effects of these inflammatory mediators are local, but, a systemic inflammatory response may occur as these vasoactive chemicals are released into the circulation, leading to altered vascular endothelial permeability and massive third spacing of fluid. One estimate suggests that when deep burn injury is greater than 25% of total body surface area (TBSA), the systemic inflammatory response is strong enough to cause generalized edema of uninjured tissues. An untreated burn greater than 33% of TBSA invariably leads to “burn shock,” the end result of which is decreased intravascular volume, increased systemic vascular resistance, decreased cardiac output, end-organ ischemia, and metabolic acidosis.15

Although much of the current burn research is focused on targeted therapies to dampen the effects of these inflammatory pathways, very aggressive fluid resuscitation is the only therapy accepted to prevent or blunt the development of burn shock.16 The ED physician typically treats burn patients during the initial 24- to 48-hour period after the burn, which is the period of maximum effective hypovolemia and consequently the period of critical fluid management. Administering insufficient quantities of fluids or administering fluids too slowly leads to progressive cell death. However, excessive quantities of fluid or fluid administered too rapidly will worsen edema and its consequences.

There are several fluid replacement formulas for burn victims that should be familiar to most ED physicians. These include the Parkland formula, which specifies 4 mL/kg of fluid per percentage of TBSA burned over the first 24 hours after the burn, with half of this total given over the first 8 hours following the burn. The modified Brooke formula recommends administering 2 mL/kg of fluid per percentage of TBSA in adults and 3 mL/kg of fluid per percentage of TBSA in children during the first 24 hours.17 Significant inhalation injury may double this fluid requirement, as fluid loss from damaged lung tissue may be massive.7

Although these formulas are useful as guides, all burns are unique and thus an outcome-based fluid resuscitation technique is also recommended, with urine output carefully monitored and maintained between 0.5 to 1.0 mL/kg per percentage of TBSA in adults and 1.0 to 1.5 mL/kg per percentage of TBSA in children.17 Most experts recommend lactated Ringer’s solution as the crystalloid of choice for the first 24 hours. Other more complicated fluid regiments have been tested but have not proven to be significantly better than lactated Ringer’s solution.16

As noted earlier, hydrogen cyanide effects the circulatory system in the form of profound, refractory shock. The pathophysiology of cyanide toxicity is well-known to ED physicians, with inhibition of cellular aerobic metabolism through inhibition of cytochrome oxidase, leading to tissue death and profound lactic acidosis and eventual cardiovascular collapse. In a major burn patient, an initial arterial blood gas level that shows severe lactic acidosis along with initial vital signs that show tachycardia and hypotension are most likely due to severe hypovolemic shock. If these parameters show no improvement despite very aggressive fluid resuscitation, the ED physician must consider cyanide toxicity. For such a critically ill patient, there is little to lose in presumptively treating this disorder with the standard regimen of amyl nitrite and sodium thiosulfate.9 However, if concomitant carbon monoxide toxicity is also present (as is often the case), amyl nitrite is relatively

**Figure 1.** Common escharotomy sites. (Reprinted from Davis JH. Clinical Surgery, St. Louis: CV Mosby’s; 1987. Copyright ©1987, with permission from Elsevier.)
contraindicated because its mechanism of action involves the formation of methemoglobin, which may further reduce the oxygen carrying capacity of the blood.\(^7\)

**DISABILITY**

After the burn patient’s airway and breathing issues have been addressed, appropriate vascular access with 2 large-bore intravenous (IV) lines has been obtained, and aggressive fluid resuscitation has begun, the ED physician should turn to an evaluation of the patient’s burns and any other traumatic injuries, if present. Burn evaluation in the ED is primarily descriptive, requiring a relatively rapid assessment of the percentage of TBSA covered by full thickness, partial thickness, and, to a lesser extent, superficial burns. Accurate evaluation is important, given that the extent and severity of burns dictate fluid resuscitation in the first 24 hours and whether the patient meets criteria for transfer to a burn center.

**Burn Severity Assessment**

The ED physician should examine the completely undressed patient, taking careful note of the location, degree, and extent of burned skin. Assessment of TBSA burned can be done rapidly and with reasonable accuracy using the “rule of nines.” For adults, each arm and the head and neck constitute approximately 9% TBSA; the front of the torso, the back of the torso, and each leg are approximately 18% TBSA. The remaining 1% is reserved for the neck in some references or the perineum in others.\(^8\) The ED physician considers each of these body areas separately and estimates the fraction of that body area burned, taking note of partial thickness and full thickness burns. Another useful rule of thumb is that the size of a patient’s hand is approximately 1% of that patient’s TBSA. Modifications to any of these rules of thumb must be made for assessment of burns in small children given their body part proportions, with head surface area a greater fraction of TBSA and leg surface area a smaller fraction of TBSA the younger the child.\(^9\) Some EDs have a chart such as the one in Figure 2 that can help the ED physician make a more accurate assessment of TBSA burned.

Categorizing burns as either partial thickness or full thickness is not always easy, as burn severity is a continuum. Although dusky, non-blanching leathery skin is clearly full thickness and blistered, weeping, bright red blanching burns are clearly partial thickness, many burns lie between these. Burn specialists have developed many techniques for assessing burn severity, generally focused on assessing whether perfusion to the burned area is intact. From an emergency medicine perspective, however, the fine distinction between severe partial thickness burns and mild full thickness burns is not particularly important, as burns of either type are indications for referral to a regional burn center for intensive specialist management. Burns in vital areas, such as the face, neck, and perineum, should be evaluated and documented with particular care. Any patient with a face burn should have an eye examination that includes fluorescein staining and ultraviolet light examination to detect corneal burns.\(^10\)

After the burn location, extent, and severity are assessed, the ED physician should determine whether any of the deep partial thickness or full thickness burns are circumferential, that is, whether the burn encircles an extremity, digit, neck, chest, or the abdomen. Circumferential burns, either through edema or through reduced skin compliance, can increase the pressure on vital structures within the tissues. As described above, mechanical constriction of breathing can occur when the torso is circumferentially burned. If the abdomen is circumferentially burned, an abdominal compartment

---

**Figure 2.** Lund and Browder chart for estimating total body surface area (TBSA) of burned skin.
syndrome may result. If the neck is circumferentially burned, airway compromise may result. If digits or limbs are circumferentially burned, a compartment syndrome may occur with distal limb or digit ischemia. All severe circumferential burns should be noted. Pulses should be checked by Doppler ultrasonography distal to any limb circumferential burns. If there is concern for compartment syndrome due to circumferential burn, escharotomy should be performed, by the ED physician if necessary (Figure 1).6,20

FURTHER EMERGENCY DEPARTMENT MANAGEMENT

After the ABCDs of trauma are completed as described above and after any potentially life- or limb-saving escharotomies are performed, the burn wounds should be dressed first with a clean, dry sheet. This procedure helps with pain control and protects the exposed burn. Laboratory studies should be reviewed to assess degree of shock, address possible electrolyte abnormalities, and monitor for signs of cyanide toxicity. Jewelry should be removed. Pain management should be a priority at this point and narcotics are typically used to achieve pain control. A Foley catheter and a nasogastric tube (if indicated) should be placed. Tetanus boosters should be updated if indicated. Prophylactic systemic antibiotics are generally not recommended. Fluid resuscitation decisions can be refined. The patient should be carefully monitored at all times until final disposition.16

DISPOSITION OF SEVERE BURNS

In the United States and Canada, the resources required for appropriate long-term treatment of major burns are concentrated into approximately 150 regional burn centers. These burn centers are subject to stringent accreditation requirements, including appropriate staffing, equipment, and other resources. They are centers both for clinical care and for burn management research. The ED physician needs to be familiar with the local burn centers as well as their procedures for inpatient transfer and referral for follow-up care. Of course, not all patients with burns require care at a burn center, and the ED physician should understand the established criteria for burn center referral.

Once the patient has been stabilized, transfer to a regional burn center is almost always indicated for severe burns. Most partial thickness thermal burns covering less than 10% of TBSA can be treated by the ED physician and discharged to home with follow-up by the patient’s primary physician, or, in the case of patients without a primary physician, in the ED or urgent care setting for follow-up in 3 to 4 days.21,22 Conversely, the most severe burns and burns that lead to respiratory or circulatory compromise obviously require transfer to a specialty care burn center. Of course, many severe burns lie in between these extremes and the decision whether to transfer or refer patients to a regional burn center can be complex. The American College of Surgeons provides guidelines for transferring patients to a regional burn center (Table 2).21 All burn centers will have an on-call physician who can be consulted to discuss transfer and referral issues.

MANAGEMENT OF LESS SEVERE BURNS

Although all ED physicians must understand how to manage life-threatening burns, most thermal burns are not life threatening and patients can be treated and safely discharged from the ED. The main issues confronting ED physicians in the management of less severe burns are (1) how to manage skin damage associated with partial thickness burns, (2) how to dress wounds to minimize pain and the likelihood of infection, and (3) when to transfer or refer patients to a regional burn center.

AIRWAY AND BREATHING COMPLICATIONS

Airway compromise may still be a feature of less severe burns. Extensive partial thickness burns to the face and neck, while not life-threatening, may signal inhalation of hot gases and resulting airway edema or lung damage. Likewise, fires in enclosed areas may result in only mild burns, but toxic inhalation still may have occurred and might be missed by a less than vigilant ED physician. If there is concern for these complications, further work-up and a period of ED observation are warranted.

WOUND MANAGEMENT

Débridement

Partial thickness burns often present with large areas of blistering and denuded skin, which can serve as a portal of entry for bacteria. Therefore, the patient’s tetanus status should be ascertained and updated if necessary. Regardless of whether the patient is slated for admission, transfer, or discharge, the ED physician must make decisions about débridement and wound dressing. There have not been extensive randomized controlled trials of varying techniques of partial thickness burn management. Common practice suggests that the loose skin partially covering ruptured blisters should be débrided in the ED. However, the management of intact blisters is more controversial. In general, most experts recommend that very thin-roofed and
In addition, burns to key body areas such as the face, systemic physiologic effects if they cover a large TBSA. However, these burns may still lead to threatening; however, these burns may still lead to systemic absorption by bacteria and lead to infection.

Wound Dressing
Exposed epidermis and dermis causes severe pain in patients with partial thickness burns, and these areas are at significant risk of infection. Topical treatment of these burns is designed to minimize both pain and the likelihood of infection. The deeper the partial thickness burn is, the greater the likelihood of infection, thus increasing the importance of ED wound care accompanied by detailed discharge instructions and arranged follow-up. Generally, for both pain control and prevention of wound infection, débrided partial thickness burns should be gently washed with soap and water at least daily. These burns should be coated with a topical antibiotic, such as 1% silver sulfadiazine or one of the common over-the-counter antibiotic ointments. It should be noted that 1% silver sulfadiazine is not recommended for facial burns, which should instead be treated with a petroleum-based triple antibiotic ointment. Burns treated in this way should then be loosely covered with a nonadherent gauze dressing. Dressings should be changed every 12 to 24 hours.

Pain Management
Oral analgesics including nonsteroidal anti-inflammatory agents and oral narcotic pain medicines are critical for the management of all but the least severe burns. The use of topical pain control is controversial and not well studied. Topical prilocaine-lidocaine cream provided no significant pain relief in 1 small study, while 5% topical lidocaine at a dose of 1 mg/cm² provided pain relief in another study. However, the treating physician must be very careful when using topical lidocaine for burns covering a relatively large surface area because the threshold for lidocaine toxicity may be reached quickly, especially given that skin damaged by burns has heightened systemic absorption of topical treatments.

BURN DISPOSITION
Partial thickness burns are not typically life-threatening; however, these burns may still lead to systemic physiologic effects if they cover a large TBSA. In addition, burns to key body areas such as the face, hands, or perineum may require expert ongoing treatment to minimize disfigurement. By definition, full thickness burns always lead to significant tissue loss, whereas superficial burns never lead to tissue loss. However, the severity and outcome of partial thickness burns are significantly more variable. Partial thickness burns may extend only down through several layers of epidermis, in which case the burn generally heals without significant scarring and typically does not require specialty care. However, deeper partial thickness burns extending into the dermis can damage the regenerative cells that replenish the skin (the “epidermal appendages”). In these cases, even partial thickness burns can lead to poor healing, infection, and permanent disfigurement. Specialty care in these cases can improve outcomes.

As noted earlier, the American College of Surgeons’ guidelines recommend that any patient with partial thickness burns covering 10% or greater of TBSA or any patient with partial thickness burns to the face, hands, feet, genitalia, perineum, or major joints be referred to a burn center (Table 2).

<table>
<thead>
<tr>
<th>Table 2. American College of Surgeons Guidelines for Patient Transfer to a Regional Burn Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial thickness (2 degree) burns &gt; 10% TBSA</td>
</tr>
<tr>
<td>Full thickness (3 degree) burns in any age-group</td>
</tr>
<tr>
<td>Burns to the face, hands, feet, genitalia or major joints</td>
</tr>
<tr>
<td>Electrical, chemical, or inhalation burns</td>
</tr>
<tr>
<td>Patients with preexisting medical disorders compromising outcome</td>
</tr>
<tr>
<td>Patients with burns and concomitant trauma in which the burn injury poses the greatest risk to the patient</td>
</tr>
<tr>
<td>Patients requiring extensive social, emotional or long-term rehabilitation support</td>
</tr>
<tr>
<td>Pediatric patients with burns at a facility without qualified personnel or equipment</td>
</tr>
</tbody>
</table>

TBSA = total body surface area.
Adapted with permission from the American College of Surgeons. Guidelines for the operations of burn centers. In: Resources for optimal care of the injured patient. Chicago: The College; 2006.79–86.
with superficial burns. As the skin is unbroken in these burns, infection prophylaxis and a tetanus booster are typically not indicated. The primary role of the ED physician is to provide pain control. The pain associated with superficial burns can be severe, especially when the burn involves a significant area of the patient’s skin. Topical treatments (eg, prilocaine-lidocaine) can greatly ease the pain of superficial burns. Oral pain medicine should also play a role, including narcotics for more severe pain. A short hospital inpatient stay is sometimes indicated for patients with large areas of superficial burn, as pain may be so intense that intravenous narcotic pain medicines are required, especially in the pediatric population. In general, inpatient care for pain control is not provided by a regional burn center, and patients with only superficial burns do not need to be referred to a burn center for outpatient follow-up. The only caveat to this recommendation is that burns taking more than 2 weeks to heal may be more serious partial thickness burns in disguise. If the ED physician encounters a slow-healing burn, that patient may require outpatient referral to a regional burn center.

CONCLUSION

Thermal burns are a frequent and challenging presenting complaint of ED patients. ED physicians need to be vigilant in assessing and managing multiple issues, such as the delayed and often hidden problems of airway compromise, the subtle presentations of inhalation injury, the hemodynamic and electrolyte instability of burn shock, the threat of vascular compromise due to circumferential burns, the severe pain associated with many burns, and the complexities of disposition. Although burn evaluation and treatment is complex, the early actions of the ED physician can be life- and limb-saving. The ED physician is often the first and only physician the burn patient sees during the acute phase of the burn injury. Thus, a thorough understanding of burn evaluation and management should be the goal for every ED physician.

SUGGESTED READING


REFERENCES


