Abstract

Burns in patients aged < 14 years are consistently among the top causes of injury-induced mortality in pediatric patients. Pediatric burn victims with large body surface area involvement have a multi-system physiologic response that differs from that of adult patients. The spectrum of management is vast and relies heavily on both the classification of the burn and the anatomy involved. Immediate goals for emergency clinicians include resuscitation and stabilization, fluid management, and pain control. Additional goals include decreasing the risk of infection along with improving healing and cosmetic outcomes. Discharge care and appropriate follow-up instructions need to be carefully constructed in order to avoid long-standing complications. This article reviews methods for accurate classification and management of the full range of burns seen in pediatric patients.

CME Objectives

Upon completion of this article, you should be able to:
1. Clinically examine and categorize burns.
2. Manage pain and fluid resuscitation in the burn patient.
3. Appropriately disposition burn patients based on guidelines and follow-up criteria for transfer to a burn center.
4. Recognize patterns of injury consistent with nonaccidental trauma.

Prior to beginning this activity, see “Physician CME Information” on the back page. This article is eligible for 4 Trauma CME credits.
Case Presentations

A 3-month-old girl is brought to the ED by her mother with a linear burn to the right buttock. The burn occurred the day before and was caused by a hot curling iron. On examination, you see a 6-inch linear burn with the epidermis opened and draining serous fluid. What other historical data should you obtain in this burn patient? What other services should you call for the disposition of this infant?

A 6-year-old boy is brought to the ED because he had touched an area of exposed metal on the cord when he was plugging in holiday lights. On presentation, it had been approximately 1 hour after the injury, and he had a 2-cm nonpainful white annular wound with blackened edges on the distal aspect of the right thumb. You wonder if this patient meets the criteria to be discharged to home for outpatient follow-up.

Just then, a 10-year-old girl is brought in via ambulance from a local house fire. She presents with deep partial-thickness burns to her entire back, the posterior portion of her right leg, and her entire right arm. There are some superficial burns on her posterior neck and left upper arm. As you consider your management options, you consider whether this patient meets criteria for transfer to an accredited burn center...

Introduction, Epidemiology, And Etiology

With nearly 110,000 annual United States emergency department (ED) visits by pediatric patients, thermal burns in pediatric patients are a frequent injury seen in the practice of the emergency clinician. Burns in patients aged < 14 years are consistently among the top causes of injury-induced mortality. Approximately 1% of all annual United States ED visits are due to burns. Burns rank third in pediatric accidental mortality in children aged 5 to 9 years after motor vehicle collisions and accidental drowning, eighth in children aged < 1 year, and fifth in children aged 1 to 4 years. When compared to adult burns, pediatric burns carry a disproportionately higher morbidity. The vast majority of burns occur in children aged < 5 years, with a peak incidence at 1 year of age.

Most pediatric burns occur as a result of accidents in the home. Low socioeconomic status and low education level of the mother are independent risk factors for pediatric burns. The majority of pediatric burns are due to scald injuries, a burn caused by hot liquids spilling onto the skin. Scalds and contact burns from sources such as stoves and hot irons together account for 85% of burns seen by emergency clinicians. Current public health prevention strategies have decreased the incidence of scald injuries by educating the public to decrease the maximum hot water temperature in households, but additional prevention efforts are necessary. Burn depth from scalds is a derivative of the liquid’s temperature in combination with the length of time the liquid is in contact with the skin. Just 1 second exposure at 154°F and 5 minutes at 118°F both have resulted in full-thickness burns. Inpatient burn care is costly, and prevention is key to decreasing overall national healthcare costs.

There are 6 types of thermal burns: scald, flame, contact, electrical, sun, and friction burns. Flames are more often the source of burns in the adult population. Electrical burns can lead to devastating outcomes in children. Seemingly small entrance sites can potentially mask substantial injuries and bleeding. In electrical injuries, the extent of involvement is inversely proportional to the resistance of the tissues; bone has a high resistance and is, thus, more protected from injury than nerves and vasculature. The vast majority of burns are minor, and > 90% of burns can be safely managed in the outpatient setting. For the minority of patients with serious injury, appropriate disposition, care environment, resuscitation, and wound care impact morbidity and mortality greatly.

Approximately 5% of pediatric patients with burns benefit from admission to a burn center. Improvements in care and infection control have decreased burn mortality in patients treated in burn specialty centers to 3%. Much like sepsis care, burn mortality is divided into early and late death, in order to best address variables unique to each phase. Although the majority of pediatric burns are due to scalds, pediatric burn mortality is most often due to fire and inhalation injury. The LD50 (the dose that is lethal to 50% of the population) of burns in the 1950s was 51% of total body surface area (TBSA). The same statistic was calculated from data collected between 1992 and 2002, and the more recent LD50 is 71% TBSA. Although the United States has seen an overall decline in burn incidence and mortality, prevention strategies deserve further attention. Decline in burn mortality has improved disproportionately in the adult population relative to that of the pediatric burn population. Despite a prevention-based decline in bathtub-related scalds, kitchen-related injuries have not seen a parallel reduction. Kitchen injury prevention should be an area of further public health intervention.

Critical Appraisal Of The Literature

A literature search was conducted using the following databases: Ovid MEDLINE®, PubMed, Cochrane Database of Systematic Reviews, and Web of Science™. Search terms included pediatric burn, pediatric burn care, burn wound care, and burn treatment. Randomized controlled trials (RCTs), systematic reviews, and professional guidelines were sought. Recent publications yielded information on changes in the use of biomarkers, updated analysis on the cost of burn care, evidence supporting immune-modulated interventions, new wound care options, and a revised classification system of burns. Additionally, the American College of Emergency Physi-
Pathophysiologic effects due to the release of inflammatory cytokines. Capillary leak, peripheral and central splanchnic vasoconstriction, and depressed myocardial function (linked to TNF-alpha) may lead to hypotension.

Cell membrane alterations lead to potassium leak and compensatory sodium and fluid shifts creating considerable burn edema. An increased metabolic rate secondary to protein catabolism after a major burn also complicates the physiologic environment, changing nutrition requirements. The capillary leak and hypermetabolic state seen in patients with burns > 40% to 60% TBSA result in myocardial depression, decreased cardiac output, and decreased tissue perfusion. An increase in cortisol, catecholamine, and glucagon levels in circulation lead to anaerobic metabolism. Concomitant glucose elevation results in lactate production.

In the pulmonary system, acute respiratory distress syndrome (ARDS) and inflammatory-mediated bronchoconstriction are seen. Finally, erythrocyte progenitors are impacted and decline approximately 1 week after a large burn occurs. This anemia is unresponsive to erythropoietin, and transfusion remains the only viable treatment option.

Prehospital Care

Immediate burn care in the home and by first responders is important and can vastly alter outcomes, and it can significantly limit burn progression and depth. The goal of prehospital care should be to cease the burning process as well as prevent future complications and secondary injuries or infection. To stop active burning, all affected clothing should be removed. Constricting jewelry should be removed to reduce the potential for ischemia, as edema may develop 24 to 36 hours after the injury. Irrigation with cool water may help cease ongoing burning and is helpful for up to 60 minutes postinjury. Ice and ice water are contraindicated, as they can worsen tissue destruction and increase burn depth. Unruptured blisters should remain intact. The patient’s wounds should be covered with a clean sheet to prevent contamination and further heat loss. Delays in transport should be minimized.

Emergency Department Evaluation

Initial Management

Upon arrival to the emergency department, the burn victim’s airway, breathing, and circulation status must first be assessed. The relatively short and narrow airway of pediatric patients makes them highly susceptible to airway loss secondary to edema. Airway edema will peak between 12 and 36 hours. Signs on physical examination such as singed nasal hair, productive cough, carbonaceous sputum, stridulous breathing, or increased work of breath-
ing all signal possible future airway compromise and warrant immediate oxygen supplementation with 1.0 fraction of inspired oxygen (FiO₂) and possible intubation. Assessment of burned areas and consideration of chest or truncal burns and their effect on respiration and circulation is paramount. Circumferential injuries may constrict both respiration and circulation and may require prophylactic treatment with escharotomy. After assessing the airway, volume resuscitation and circulation should be addressed. For burns > 15% to 20% TBSA, intravenous fluid resuscitation is indicated. Rural prehospital personnel operating with transport times > 60 minutes should begin administration of fluids during transport, when clinically indicated, based on severity of the burn. They may also use cooling bandages and hydrogels to cool the burn without causing patients to become hypothermic.

Burn History And Examination

There are important historical features of a burn injury that influence patient outcome and prognosis. Initially, a thorough description of the mechanism of injury is relevant. For instance, history of electrical voltage in excess of 1000 volts (V) may cause myoglobinuria, fracture, edema, and compartment syndrome as well as cardiac dysrhythmias. Patients presenting after a home fire are at increased risk for inhalation injuries as well as chemical exposure to carbon monoxide or cyanide. Confirmation of the cause of a cutaneous burn is also important. Chemicals such as hydrofluoric acid (used in industrial cleaning and glass etching) can cause hypocalcemia and severe pain. If there is any history of explosion or other traumatic mechanism, perform a careful examination of the eyes with fluorescein staining to rule out a conjunctival or globe injury. Conjunctival injuries are common and need to be diagnosed early in a patient’s course before the onset of burn edema. Examine the extremities and the torso to evaluate for circumferential involvement. Circumferential injuries to the torso constrict breathing, and all circumferential burns may contribute to various compartment syndromes. The external ear is also often overlooked, and ear injuries are at risk for chondritis. Finally, emergency clinicians should maintain a high suspicion for nonaccidental trauma, especially when inconsistencies in history, delayed presentation, suspicious markings, or developmentally inappropriate findings are found.

Classification Of Burns

Burns are classified using 3 different methods: (1) by depth as established by the ABA, (2) by severity as established by the ACS, and (3) by percentage of TBSA using Lund-Browder charts. In 2009, the ABA updated its classification to describe burns based on anatomic depth and dermal involvement. Four categories were created, including superficial, superficial partial-thickness, deep partial-thickness, and full-thickness. (See Table 1.)

Classification By Depth

Calculation of the TBSA of burns does not include superficial burns, as these involve only the epidermis. They are characteristically erythematous, painful, and heal without scarring. Partial-thickness burns involve both the epidermis and the dermis. Partial-thickness burns are subdivided into superficial partial-thickness and deep partial-thickness burns. Superficial partial-thickness burns involve the entire epidermis and extend down to the papillary dermis, whereas deep partial-thickness burns involve the epidermis and papillary dermis, and extend deeper to the lower reticular dermis. A superficial partial-thickness burn is wet and weeping, often with blisters. A deep partial-thickness burn is dry and white. The ability to blanch is an easy way to differentiate between the partial-thickness burns. Full thickness burns extend through the dermis and into the underlying adipose tissue. These burns diminish elasticity, cannot heal spontaneously, require grafting, and have grossly disfiguring outcomes. Clinical visual evaluation remains the most common mode of diagnosis. (See Figures 2, 3, and 4)

Table 1. Burn Classification

<table>
<thead>
<tr>
<th>Burn Type</th>
<th>Anatomy Involved</th>
<th>Gross Appearance</th>
<th>Sensation</th>
<th>Healing Time</th>
<th>Prognosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial</td>
<td>Epidermis only</td>
<td>Erythematous, dry</td>
<td>Painful</td>
<td>5-10 days</td>
<td>Heals without scarring</td>
</tr>
<tr>
<td>Superficial partial-thickness</td>
<td>Upper dermis</td>
<td>Blister and erythematous blanching or weeping and wet blanching</td>
<td>Painful, hypersensitive</td>
<td>14-21 days</td>
<td>Local inflammation, typically nonscarring</td>
</tr>
<tr>
<td>Deep partial-thickness</td>
<td>Deep dermis</td>
<td>Yellow or white, dry, non-blanching</td>
<td>Decreased sensation, discomfort with deep pressure</td>
<td>21 days-2 months</td>
<td>Heals by contracture, may scar</td>
</tr>
<tr>
<td>Full thickness</td>
<td>Through entire dermis into subcutaneous fat</td>
<td>White to brown, firm or leather-like</td>
<td>Nonpainful</td>
<td>&gt; 2 months</td>
<td>Contracture and scarring, typically requires excision and grafting</td>
</tr>
</tbody>
</table>

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(See Figures 2, 3, and 4)
Classification By Percentage Of Total Body Surface Area Affected

The third classification of burn assessment is by percentage of TBSA. For children aged < 10 years, size-appropriate pediatric TBSA charts were created by Lund and Browder. (See Figure 5, page 6.) This system is accurate and has high interoperator reliability. Wallace’s Rule of Nines is another system of TBSA determination for children aged > 15 years, but, when examined, it has been found to overestimate TBSA calculations in younger patients. In quantifying the TBSA affected, it is essential that only partial-thickness and full-thickness burns are included. Accuracy of this calculation is critical, as the TBSA affected will be used in fluid protocols. Previous studies have demonstrated substantial inaccuracy in emergency clinician estimates. In burns that are referred to burn centers, the degree of error in calculating TBSA affected was found to be inversely proportional to the size of the burn. For small areas or irregular burns, the patient’s palm and fingers can be used to estimate 1% TBSA.

Classification By Severity

Additionally, burns may be classified by severity. The severity levels include: minor, moderate, and severe. These levels were established by the ACS and include a subclassification that accounts for age. (See Table 2.) In children, minor burns include partial-thickness burns involving < 10% TBSA or full-thickness burns involving < 2% TBSA. Moderate burns in children include those with 10% to 20% TBSA of partial-thickness but < 10% full-thickness TBSA. Severe burns involve > 20% partial-thickness and > 10% full-thickness burns. Severe burns also include any burns to specific anatomic sites: hands, feet, face, perineum; or complicating circumstances such as inhalation burns, high-voltage injuries, associated major trauma, or burns in infants.

Table 2. American College Of Surgeons Burn Severity Assessment In Children

<table>
<thead>
<tr>
<th>Severity</th>
<th>Partial-Thickness</th>
<th>Full-Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>&lt; 10% TBSA</td>
<td>&lt; 2% TBSA</td>
</tr>
<tr>
<td>Moderate</td>
<td>10%-20% TBSA</td>
<td>&lt; 10% TBSA</td>
</tr>
<tr>
<td>Severe</td>
<td>&gt; 20% TBSA or special areas</td>
<td>&gt; 10% TBSA or special areas</td>
</tr>
</tbody>
</table>

aSpecial areas include hands, feet, face, and perineum. Abbreviation: TBSA, total body surface area


Figure 2. Superficial Partial-Thickness Burn

Figure 3. Deep Partial-Thickness Burn

Figure 4. Full-Thickness Burn
Diagnostic Studies

Laboratory Studies
There are several laboratory studies indicated in the assessment of children with moderate to severe burns. While obtaining a complete blood cell count (CBC) is not routine, having an initial CBC establishes baseline white blood cell count and hemoglobin levels. Both of these are likely to change with the development of infection and anemia more common to burns affecting > 20% TBSA. Electrolytes are also highly important for future management. Glucose control throughout burn care affects clinical endpoints, and hypoglycemia has been demonstrated to increase burn mortality. Blood urea nitrogen and creatinine should be established, as fluid shifts and losses are anticipated to impact both values. Creatine kinase, urine analysis, and urine myoglobin levels are helpful in assessing the extent of rhabdomyolysis in the setting of an acute burn. For victims of fires within an enclosed space, a carboxyhemoglobin level, an arterial blood gas, and a cyanide level should be obtained to guide treatment of fire-associated carbon monoxide poisoning, hypoxia, metabolic acidosis, and cyanide toxicity secondary to burning synthetic materials. Serum lactate and its rate of clearance have been deemed as useful predictors of mortality in the pediatric burn patient, and they should be drawn at baseline and at 24 hours. Finally, there is new research currently investigating inflammatory markers that has shown promise in the use of circulating proteasome 20S activity as a biomarker for burn severity.

Diagnostic Imaging
Diagnostic imaging is minimally helpful in the early assessment of burns. If a patient has suffered multiple trauma, then the appropriate imaging should be ordered, but there are no specific radiographs to use as screening tools for the burn patient. Establishing a baseline chest radiograph may prove useful when a patient has extensive respiratory risk factors, known inhalation injuries, electrical burns, or blast-related injuries. A prospective study by Alexander et al demonstrated positive x-ray findings in < 10% of patients with known inhalation injuries. Moreover, chest radiographs had little clinical utility in the management of such patients.

Treatment
After completion of the primary survey, transfer to an ABA-verified burn center should be initiated early for patients with severe or complex burns. Goals of treatment include appropriate cooling, management of the airway, burn shock and fluid resuscitation, wound care, antibiotic administration, pain management, and discharge or placement in an appropriate inpatient care setting.

Take special care to irrigate chemical burns, as tissue damage can continue even after initial irrigation. Remove all clothing, jewelry, or other items on the skin. Chemicals and oils may impregnate clothing and continue tissue damage when left in contact with the skin. For this reason, patients may still be contaminated on arrival to the ED, and emergency clinicians should be mindful to use personal protective equipment during the initial evaluation of the burned patient.

Cooling
Cool burns with cool tap water (approximately 15°C/59°F) for up to 60 minutes after the burn occurs. This can decrease the depth and severity of the burn and has been shown to improve overall outcomes, particularly in children with moderate to severe burns. Recent research on the pathophysiological effects of burn cooling has shown positive microcirculatory and histological changes with immediate burn cooling. In patients with extensive burns, hypothermia is likely after burn cooling; however, a recent study showed no increase in mortality with prehospital hypothermia.
Airway Management
Management of the airway in a severely burned patient is critical. Research in animal laboratories has been used to better understand the mechanism of thermal airway injury. The larynx, which is very effective in heating and moisturizing the air we breathe, does not effectively cool hot air that is introduced through the oral cavity. Consequently, when heated air is introduced into the larynx, it is only cooled slightly as it travels down the bronchial tree, which may cause severe damage in the most delicate parts of the lungs, creating direct injury as well as a nidus for bacterial invasion.

All patients with suspected inhalation injury should be placed on 100% oxygen by mask and assessed for concomitant carbon monoxide or cyanide poisoning. Any patient with stridor, shortness of breath, facial burns, singed nasal hairs, cough, soot in the oral cavity, and history of being in a fire in an enclosed space should be strongly considered for early intubation. Airway edema, particularly at the level of the vocal cords, can be delayed and may make later attempts at orotracheal intubation difficult or impossible. The use of airway adjuncts, such as laryngeal mask airways and cricothyrotomies, may also be complicated or impossible due to swelling in the airway.

Emergency clinicians should consider using a reduced-size endotracheal tube if difficulty is predicted based on edema on direct visualization of the vocal cords. In the 1970s, Moylan et al described the results of fiberoptic direct visualization and bronchoscopy in patients with burn injuries. They noted that 33% of the patients admitted to the burn unit had some element of laryngeal, tracheal, and/or bronchial injury. These patients had a higher mortality rate and a 73% rate of pulmonary complication. Because of this increased mortality, emergency clinicians should strongly consider early intubation for inhalation injury in all severe burn patients.

Multiple retrospective reviews have noted that inhalation injury is associated with increased mortality. Overall, children with inhalation injuries have better outcomes than adults. There is a much higher rate of pneumonia in patients with inhalation injury. Both inhalation injury and pneumonia are separate and additive risk factors for increased mortality.

In the pediatric burn literature, it has been postulated that a grading scale for inhalation injury would have high utility, especially considering the large impact on morbidity and mortality. Recently, Ikonomidis et al created a scale based on mucosal injury in the larynx, trachea, and main bronchial tree, more commonly assessed by pulmonologists. It is a simple and quick scale with high interoperator correlation, but it does require direct visualization of the upper airways and likely falls outside of the normal scope of practice of the emergency clinician.

Fluid Resuscitation
For ACS-classified minor burns or burns < 20% TBSA, oral rehydration is usually sufficient. For burns > 20% TBSA, intravenous fluid resuscitation is indicated. As our understanding of the relationship between burn area involvement and the volume of resuscitation fluids was established in the 1940s, formulas for fluid estimates were created. The most common methods for estimating fluid requirements in pediatric burn patients include the Galveston and Parkland formulas.

Galveston Formula
\[(5000 \text{ mL/m}^2 \times \%\text{TBSA}) + 2000 \text{ mL/m}^2 \text{ daily maintenance}\]

Parkland Formula
\[(4 \text{ L/kg} \times \%\text{TBSA}) + \text{normal 24-hour maintenance fluids}\]

Some research has supported the Galveston formula as being more accurate, citing improved outcomes in children weighing < 10 kg when compared to the more widely used Parkland formula. However, no randomized controlled trials have been completed comparing the 2 formulas.

Regardless of which fluid formula is used, it is imperative that an accurate affected TBSA is obtained. Incorrect body surface calculations have been shown to account for large errors in the volume of fluid resuscitation in the first 24-hour period. The Lund-Browder chart provides guidance for proper estimation of affected TBSA. (See Figure 5, page 6.)

Both formulas have the same distribution of timing; the first half of calculated fluids are given over the first 8 hours, and the second half are given over the remaining 16 hours. Timing for total fluids given in the first 8 hours should begin from the time of injury rather than the time of arrival. For children aged < 5 years, maintenance fluids are added to each of the formulas. The goal should be to avoid both hypovolemia and fluid overloading. A single retrospective study challenged the timing of the Parkland and Galveston models. Puffinbarger et al looked at reducing the usual initial 8-hour half of fluids down to 4 hours. Studying endpoint outcomes of blood gas changes, urine output, vital signs, ventilator time, and mortality in both 4-hour and an 8-hour groups, the more-rapidly infused group achieved better endpoints.

Establishing Vascular Access
Vascular access should be secured early in the management of the moderately to severely burned patient. Accessing the vasculature through areas of burned skin has been studied, and results have shown varying rates of infection. A 2014 systematic review by Ciofi et al showed a statistically signifi-
Clinical Pathway For Management Of Burns In Pediatric Patients

Patient presents with burn injury
- Conduct primary survey of airway and breathing
- Remove constricting accessories and clothing
- Begin cooling measures

Compromise noted or presence of obvious burns or soot on face, mouth, or nares?
- NO
  - Continue primary survey assessment of circulation
  - Signs of massive hemorrhage?
  - Signs of hypotension and shock?
- YES
  - Assess for alertness (GCS score or AVPU scale)
  - Is mental status depressed?
  - Is gag reflex depressed or absent?
- NO
  - Are any other life-threatening traumatic injuries present?
  - Are there any constricting circumferential injuries?
- YES
  - Begin secondary survey with head-to-toe physical examination
  - Estimate TBSA using Lund-Browder charts (Class II)
  - Are any of the following present?
    - > 10% partial-thickness burn
    - > 5% full-thickness burn
    - > 20% TBSA affected
    - Burns to hands, feet, face, perineum, genitals, or overlying joints
    - Electrical, chemical, or inhalational injury
    - Underlying disease
    - Psychosocial complexities
  - NO
  - Continue to next page

Begin airway support
- Supplement FiO₂ at 100% (Class II)
- Consider tracheal wall ultrasound
- Secure airway in advance of ensuing edema (Class II)
- Obtain arterial blood gas levels
- Send carboxyhemoglobin and cyanide levels
- Obtain chest X-ray

Manage shock with:
- 20-60 cc/kg of normal saline (Class II)
- In the setting of massive hemorrhage, begin blood product transfusion of 1:1:1 ratio of packed red blood cells, fresh-frozen plasma, and platelets. (Class II)
- Evaluate need for vasopressor support

Manage mental status changes
- Intubate for airway protection, if not already done (Class II)
- Consider CT of head to exclude TBI (Class II)
- Send carboxyhemoglobin, cyanide, and arterial blood gas levels (if not already sent) if patient was in a fire in an enclosed space (Class II)
- Protect cervical spine

Diagnose and manage acute life-threatening injuries
- Control any areas of acute bleeding (Class II)
- Obtain additional imaging if needed (CT/X-ray)
- Perform escharotomy as indicated (Class II)
- Contact verified burn center for possible transfer
- Continue cooling burn up to 60 min (Class II)
- Treat pain and consider opioids (Class II)
- Calculate fluid requirements using:
  - Parkland: (4 mL/kg x %TBSA) + normal 24-h maintenance fluids (Class II)
  - Galveston: (5000 mL/m² x %TBSA) + 2000 mL/m² daily maintenance (Class II)
- Begin fluids and add glucose if patient weighs < 20 kg (Class II)
- Arrange baseline laboratory levels, weight, and monitoring

Abbreviations: AVPU, alert, voice, pain, unresponsive; CBC, complete blood count; CT, computed tomography; GCS, Glasgow Coma Scale; TBI, traumatic brain injury; TBSA, total body surface area.
For Class of Evidence definitions, see page 9.

aLaboratory levels and monitoring include CBC (Class II), creatinine kinase, type and screen (Class II), urine myoglobin (Class II), glucose (Class II), serum lactate (Class II), electrolytes, and Foley catheter for urine output (Class I).
Clinical Pathway For Management Of Burns In Pediatric Patients (Cont.)

Partial-thickness or full-thickness burns present?

NO

Assess cause of injury:
• Is mechanism of injury developmentally inappropriate?
• Are there other injuries present?
• Are there suspicious markings?

BEGIN WOUND CARE:
• Only debride large or constricting blisters (Class II)
• Cleanse burns with soap and water or iodine (Class I)
• Apply membrane dressing; avoid silver creams on face (Class I)
• Administer tetanus and TIG vaccines as indicated (Class II)
• Provide pain control (Class I)

YES

Consider discharge home if there is:
• A partial-thickness burn of < 10% TBSA without special areas involved
• No suspicion of abuse
• No inhalation injury suspected
• Appropriate home resources

Admit the patient if there are:
• Limited social and parental support factors
• 5%-10% TBSA partial-thickness burns
• 2%-5% TBSA full-thickness burns

Consider nonaccidental trauma:
• Contact child protective services to report
• Consider admission
• Contact social worker
• Document physical and historical findings

Abbreviations: TBSA, total body surface area; TIG, tetanus immune globulin.

Class Of Evidence Definitions

Each action in the clinical pathways section of Pediatric Emergency Medicine Practice receives a score based on the following definitions.

Class I
- Always acceptable, safe
- Definitely useful
- Proven in both efficacy and effectiveness

Level of Evidence:
- One or more large prospective studies are present (with rare exceptions)
- High-quality meta-analyses
- Study results consistently positive and compelling

Class II
- Safe, acceptable
- Probably useful

Level of Evidence:
- Generally higher levels of evidence
- Nonrandomized or retrospective studies: historic, cohort, or case control studies
- Less robust randomized controlled trials
- Results consistently positive

Class III
- May be acceptable
- Possibly useful

Level of Evidence:
- Generally lower or intermediate levels of evidence
- Case series, animal studies, consensus panels
- Occasionally positive results

Indeterminate
- Continuing area of research
- No recommendations until further research

Level of Evidence:
- Evidence not available
- Higher studies in progress
- Results inconsistent, contradictory
- Results not compelling

This clinical pathway is intended to supplement, rather than substitute for, professional judgment and may be changed depending upon a patient’s individual needs. Failure to comply with this pathway does not represent a breach of the standard of care.

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cant increase in infection rate for vascular access obtained through burned tissue. Intraosseous cannulation remains a viable and rapidly accessible option for children with large burns where access points may otherwise be difficult to obtain.

**Appropriate Fluid Choice**

After establishing access, the emergency clinician must consider the amount and type of fluids to administer. In cases of massive hemorrhage, blood-product transfusion is indicated using a 1:1:1 ratio of packed red cells, fresh-frozen plasma, and platelets. The goal of the fluid resuscitation is maintenance of end-organ perfusion while simultaneously preventing overresuscitation and "fluid creep," which can lead to pulmonary edema, ARDS, and compartment syndromes.

The choice of fluid has been heavily researched for the initial phase of resuscitation, and crystalloid fluid is indicated. Although no controlled trials exist comparing lactated Ringer’s to normal saline, most burn centers prefer lactated Ringer’s for the initial resuscitation, citing the sodium content (130 mEq/L) as capable of correcting hyponatremia caused by the burn. Despite not being widely discussed in the burn literature, trauma surgery literature supports lactated Ringer’s over normal saline; however, the trauma literature encompasses hemorrhagic shock and is not specific to burn hypovolemic shock. Research has argued for colloids or hypertonic saline to maintain better intravascular volume and lower total fluid needs, yet most centers continue to recommend only crystalloid solutions during the initial resuscitation period (first 24 hours).

Recent studies have examined the use of colloid as a supplement for patients with more-severe burns in order to normalize the hourly input/output ratio. Colloid is generally not started until after the 24th hour after injury. New research has proposed a salvage use of 5% albumin for burns that are unresponsive to initial lactated Ringer’s resuscitation. A case-controlled study found no change in mortality with use of this colloid in crystalloid-unresponsive patients given 5% albumin up to the 48th hour.

Along the same physiologic reasoning for the use of colloids, the use of hypertonic saline has been studied. In 2006, Oda et al published a study addressing the role of hypertonic fluids in severely burned children. This revisited several smaller prospective studies completed in the late 1970s and the early 1980s, and concluded that decreased overall volume administration for the hypertonic saline patients led to better outcomes. Oda et al’s study found lower abdominal compartment syndrome morbidity, lower peak-inspiratory pressures, and lower total volumes in patients receiving hypertonic saline compared to patients receiving normal saline or lactated Ringer’s.

**Monitoring Fluid Resuscitation And Assessing Endpoints**

Once fluid resuscitation has begun, dynamic endpoint testing is indicated, including measurement of the base deficit, lactate levels, central venous pressure, and bladder pressure. Emergency clinicians should employ hourly urine output as a means of determining fluid needs, and the target in children is 1 to 2 mL/kg/h. A systematic review in 2014 examined the use of hourly urine output versus hemodynamic monitoring and followed outcomes of mortality, organ dysfunction, length of stay, time in the intensive care unit, time on ventilation, and complications (pulmonary edema, compartment syndromes, and infection). They found improved survival with hemodynamic-guided resuscitations versus monitoring hourly urine output. However, the review acknowledged the impact of 1 large cohort study and noted that removal of this single study resulted in loss of any statistical significance in favor of hemodynamic monitoring over hourly urine output.

Most research supports that fluid resuscitations often underestimate total requirements, especially when inhalation injuries are present. Using the Parkland or Galveston formula is merely the starting point for estimating fluid requirements. Urine output and input/output ratio, in addition to other hemodynamic indices, should ultimately guide titration of fluid resuscitation. Similar to sepsis protocols, it was presumed that central venous pressure monitoring could be used to maximize cardiac index and more tightly guide fluid resuscitation; however, prospective work by Holm et al determined that no such cardiac optimization advantage existed when controlled against an arm receiving fluids per the Parkland formula. For additional information on the management of shock and fluid resuscitation, see the April 2015 *Pediatric Emergency Medicine Practice* issue titled “Septic Shock: Recognizing And Managing This Life-Threatening Condition In Pediatric Patients,” available at: www.ebmedicine.net/septicshock.

**Wound Care**

**Superficial Burns**

If the skin is merely erythematous and is not broken or blistered, cleansing of the wound and topical care to decrease discomfort are sufficient to manage the burn. Silver sulfadiazine is readily available in most EDs, and it is commonly placed on these burns, but there is no evidence to show that it is more effective than petroleum jelly or other over-the-counter ointments.

**Partial-Thickness Burns**

The majority of burns managed in the ED are superficial to deep partial-thickness burns.
**Cleanse The Burn Wound**

Irrigation is key to wound cleansing, and vigorous scrubbing should be avoided. A recent review by the AAP supports the use of sterile normal saline and gauze to gently remove sloughing epidermis. Chlorhexidine should be avoided, as it impairs wound healing. In the past, iodine was also to be avoided due to similar concerns, but a recent systematic review by Vermeulen et al shows that iodine may be an effective antimicrobial agent that does not impair wound healing. It is important to address the patient’s pain prior to debridement and cleansing of the burn.

**Examine The Skin And Consider The Need For Aspiration Of Blisters**

Once the area is clean, examine the skin to determine if it is intact, blistered, or has an unroofed blister. There is consensus that if a blister is intact and is < 1 cm², it should be left intact. If rupture is imminent in a large blister, it may be aspirated and debrided under sterile conditions. Debride devitalized skin from blisters that rupture on their own to reduce the rate of infection and improve cosmetics.

There remains controversy regarding aspiration of intact, clear-fluid–filled blisters > 1 cm². It is difficult to evaluate the true depth of an underlying burn with an overlying blister. Also, the biologic contents of blister exudate are both beneficial and detrimental to burn healing. Some argue that these blisters should be left intact, claiming faster healing times, reduced infection risk, and decreased pain, as first noted in a single study by Gimbel et al with 14 volunteers from 1957. It has been established that de-epithelialized wounds re-epithelialize faster when kept moist.

A literature review by Murphy et al examining the question of debridement concluded that all blisters > 1 cm² should be ruptured and covered with an occlusive dressing to maintain a moist environment for the burn during healing. There is concern that, if a blister is unroofed, it will create a nidus for infection due to the loss of skin as a barrier. However, it has also been noted that damaged hair follicles can become entry points for bacteria in blistered skin. Finally, deroofing blisters increases pain for the patient in the short-term, as nerve endings are exposed, but alleviates the pressure-like pain from a tense blister. Therefore, blisters > 1 cm² can be debrided or left intact, as there is contradictory evidence on this topic.

**Choosing Topical Therapies And Wound Dressings**

Once the burn is clean, topical therapies and a bandage or an occlusive, nonadherent bandage alone may be applied. A topical antimicrobial agent (silver sulfadiazine, mupirocin, polysporin, bacitracin, or mafenide acetate) may be applied to the wound. Mafenide, a sulfa medication, works well as an antimicrobial, but it is painful when applied to a burn and can cause a patient to develop metabolic acidosis if applied to a large area of the skin. Mafenide acetate is contraindicated in patients who are pregnant or aged < 2 months. Silver sulfadiazine should not be applied to the face, due to concern for bleaching of the pigment of the skin, particularly in patients with darker skin pigmentation. An additional risk of silver-based creams is toxicity if they come into contact with mucous membranes (such as the eyes and mouth). These agents must be applied twice a day and necessitate a dressing change with each application.

Silver products have historically been used on burn patients because of their natural antibiotic properties. Silver sulfadiazine is the most common topical agent used, and it is very easy to apply, but current clinical evidence does not support its presumed antimicrobial and pro-healing effect. A recent systematic review has shown that, while silver sulfadiazine decreases in vitro bacterial load, amnion membrane and membranous dressings (eg, Biobrane®, DuoDERM®) alone perform superiorly in vivo. These dressings also do not have to be changed as often, are better at absorbing the large amount of exudate produced, promote faster healing, and improve pain relief. A recent Cochrane review by Wasiak et al concluded that there is no conclusive evidence of the superiority of any of the available dressings.

Dressings that are impregnated with silver (Acticoat® and Aquacel®) slowly release silver into the burned area, preventing growth of bacteria, such as *Pseudomonas* species and methicillin-resistant *Staphylococcus aureus*. These dressings have also been shown to be more effective than silver sulfadiazine.

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(See Table 4, page 12.)

Finally, medical-grade honey has also been reconsidered as a natural antibiotic. In ancient times, honey was often applied to wounds, and it has been found to have inherent antibiotic properties. In 2013, Vandamme et al authored a review article analyzing available studies of honey as a topical antibiotic. In general, the studies did show honey to have antimicrobial activity, but it was noted by the authors of the review that more research was needed, as many of the studies that they reviewed had concerning methodology processes.

**Full-Thickness Burns**

Full-thickness burns need to be evaluated by a surgeon early in a patient’s hospital course. Even small full-thickness burns are usually treated with excision and closure. For minor full-thickness burns,
surgery consultation may not be necessary in the ED, but these patients should receive follow-up with a surgeon for wound evaluation. There is little to be done for the full-thickness burn in the ED except for tetanus prophylaxis and appropriate pain management (parenteral medication) for the surrounding superficial area and partial-thickness burns.

**Antibiotics And Tetanus Prophylaxis**

**Antibiotics**

Topical antibiotic treatment or an occlusive dressing with impregnated silver or antibiotic material can be used for burns. Intravenous or oral antibiotics are not necessary unless there is concern for systemic infection. Burn patients are at particular risk for infections from both normal skin flora (such as *S. aureus*) and from gram-negative organisms (such as *Pseudomonas aeruginosa* and *Acinetobacter* species). The pharmacokinetics of antibiotics are altered in burn patients due to the hypermetabolic state that a patient enters into beginning 48 hours after a serious burn. This state is marked by increased cardiac output and augmented regional blood flow at the burn site, with a subsequent increase in creatinine clearance and glomerular filtration rate.

If a patient with a severe burn (> 20% TBSA) needs intravenous antibiotic therapy for an infection, it is likely that he will need higher doses than non-burn patients due to the observed increased clearance of antibiotics in burn patients. This is particularly true for vancomycin and tobramycin. Continuous intravenous infusion is another option to increase blood levels of vancomycin. This is also a helpful technique if a patient has decreased renal function.

**Tetanus Prophylaxis**

Tetanus prophylaxis is critical after burn injuries because even a minor burn involving violation of the epidermis is not considered to be a clean wound. Tetanus prophylaxis should be given if there is delayed presentation after the initial injury because the incubation period for *Clostridium tetani* can vary from 1 day to several months. See Table 5, page 13 for a summary of recommended postwound tetanus prophylaxis. Give tetanus immune globulin (TIG) to patients who have not had their first 3 doses of tetanus toxoid. For the child on the recommended immunization schedule in the United States, the first surgery consultation may not be necessary in the ED, but these patients should receive follow-up with a surgeon for wound evaluation. There is little to be done for the full-thickness burn in the ED except for tetanus prophylaxis and appropriate pain management (parenteral medication) for the surrounding superficial area and partial-thickness burns.

**Table 3. Occlusive Dressings: Advantages, Disadvantages, And Associated Costs**

<table>
<thead>
<tr>
<th>Dressing</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biobrane® (nylon-silicone laminate)</td>
<td>Single dressing, allows for exudate drainage, controls pain</td>
<td>May increase bacteria at burn site, costly</td>
<td>$220 per 5&quot; x 5&quot; sheet</td>
</tr>
<tr>
<td>DuoDERM® (hydrocolloid)</td>
<td>Comfortable; dressing change every 3-7 days</td>
<td>Does not allow for exudate drainage</td>
<td>$6 per 6&quot; x 6&quot; sheet</td>
</tr>
<tr>
<td>Acticoat® (polyethylene with polyester/rayon core)</td>
<td>Comfortable; dressing change every 3-7 days</td>
<td>Stains skin, requires intense nursing care</td>
<td>$30 per 5&quot; x 5&quot; sheet</td>
</tr>
<tr>
<td>Aquacel® (sodium carboxymethylcellulose on hydrofibers)</td>
<td>Comfortable, dressing change every 2 weeks, allows for drainage, retains antibiotic properties</td>
<td>No evidence of proven efficacy over alternative dressings</td>
<td>$30 per 4&quot; x 5&quot; sheet</td>
</tr>
<tr>
<td>Amnion membrane (biologic)</td>
<td>Decreases bacterial load, comfortable</td>
<td>Experimental, not widely available</td>
<td>Unknown</td>
</tr>
<tr>
<td>Tegaderm™/OpSite®</td>
<td>Easy to apply</td>
<td>No ability for exudate to drain, only to be used on mostly healed burns</td>
<td>$0.60 per 4&quot; x 4&quot; sheet</td>
</tr>
<tr>
<td>Mepitel® (silicone)</td>
<td>Easy to apply directly to wound, nonstick, dressing change every 7-10 days</td>
<td>No antibacterial activity</td>
<td>$7.00 per 4&quot; x 4&quot; sheet</td>
</tr>
</tbody>
</table>

**Table 4. Topical Therapies: Advantages, Disadvantages, And Associated Costs**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacitracin</td>
<td>Inexpensive, can apply anywhere on the body, painless</td>
<td>Mild antimicrobial activity</td>
<td>$6.00 per 30 g</td>
</tr>
<tr>
<td>Silver sulfadiazine</td>
<td>Inexpensive, readily available in most EDs, provides minor pain relief</td>
<td>Cannot apply to face, requires dressing changes twice daily, may impair healing, difficult/painful to remove from wound</td>
<td>$6.00 per 30 g</td>
</tr>
<tr>
<td>Mafenide acetate (carbonic anhydrase inhibitor)</td>
<td>Effective antimicrobial, good eschar absorption</td>
<td>Burns on application, can not be applied to large surface area due to risk of metabolic acidosis</td>
<td>$20 per 30 g</td>
</tr>
<tr>
<td>Honey</td>
<td>Antimicrobial, painless, inexpensive</td>
<td>Messy, difficult to keep on wound</td>
<td>$3.00 per 30 g</td>
</tr>
</tbody>
</table>

Abbreviations: bid, 2 times per day; ED, emergency department.
3 doses will be completed by the age of 6 months, since the third dose is given at 6 months of age.

**Pain Management**

Independent of depth, size, location, and etiology, most children with burns experience some level of associated pain. Pain produces counter-regulatory hormones common to stress states that, in turn, increase morbidity and mortality. Studies have indicated that EDs are undertreating burn-related pain. To facilitate patient compliance with medications and dressing changes, mitigate social and emotional effects, and prevent delays in healing, pain must be adequately managed. It is important to differentiate between baseline pain and procedural pain and to address each at appropriate times. Evidence supports that both parents and practitioners are poor assessors of pain in children; however, validated pediatric pain scales (such as Wong-Baker FACES® and Oucher™) are effective and should be used. Consideration of medication choice should be made based on ease of use, tolerability, rapidity of pain control, bioavailability, ease of titration, and side-effect profile. Agents to consider include acetaminophen, nonsteroidal anti-inflammatory drugs, opioids, and alpha-2 adrenergic antagonists.

**Topical Analgesics**

For small-area burns, topical analgesics are an option. While they do have potential for allergic reactions, toxicity, and decreased wound re-epithelialization, they have the advantage of being non-sedating and can be effective in pain management in the setting of a minor burn. Topical agents often include epinephrine and/or lidocaine, and research has demonstrated that the potential for allergic reaction is largely related to the epinephrine and not to the lidocaine. Additionally, the toxicity and decreased epithelialization has been further studied and is most common when lidocaine is applied to mucosal surfaces such as the eyes. Proponents have used it on moderately large burns (up to 30% TBSA) without toxicity. Finally, improved healing and a decrease in pain scores with smaller-sized wounds (1%-5% TBSA) have been shown.

**Opioids And Adrenergic Antagonists**

For moderate to severe burns, opioids and adrenergic antagonists should be used and up-titrated during procedures that manipulate the injured tissue. Emergency clinicians should be mindful of evidence that supports a linear relationship between the amount of opioid used and increasing resuscitation volumes that may adversely impact outcomes. Few RCTs exist comparing the effectiveness of different opioids in the treatment of burn pain. A small randomized and blinded study by Borland et al demonstrated intranasal fentanyl to be equivalent to morphine in the setting of pain associated with dressing changes. They concluded that intranasal fentanyl would be effective either alone or in combination with other agents. A systematic review by McGuinness et al examined 4 studies on ketamine in burn patients and showed that intermediate dosing (0.3 mg/kg/h) reduced primary hyperalgesia. However, they concluded that larger RCTs are needed before definitive support can be issued for its clinical use in burn patients. Methadone has been deemed safe in safe for pediatric burns. It acts on both mu and N-methyl-D-aspartate (NMDA) receptors. A retrospective case-matched comparison of methadone found that patients treated with methadone had a

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**Table 5. Recommended Tetanus Prophylaxis In Burn Wound Management**

<table>
<thead>
<tr>
<th>Previous Tetanus Toxoid Doses</th>
<th>Administer Tetanus Toxoid-Containing Vaccine</th>
<th>Administer Human Tetanus Immune Globulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3 doses or unknown</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>≥ 3 doses</td>
<td>Only if last dose given ≥ 5 years ago</td>
<td>No</td>
</tr>
</tbody>
</table>

*The preferred vaccine preparation depends upon the age of the patient and vaccination history:

- Children aged < 7 years: administer DTap.
- Underimmunized children aged ≥ 7 and < 11 years who have not received Tdap previously: Administer Tdap. Children who received Tdap between age 7 and 11 years do not require revaccination at age 11 years.
- Children aged ≥ 11 years: A single dose of Tdap is preferred to Td for all individuals in this age group who have not previously received Tdap. Pregnant women should receive Tdap during each pregnancy.
- Td is preferred to DT for patients who received Tdap previously and when Tdap is not available.

*250 units intramuscularly at a different site than tetanus toxoid; intravenous immune globulin should be administered if human tetanus immune globulin is not available.

*The vaccine series should be continued through completion as necessary.

*Booster doses given more frequently than every 5 years are not needed and can increase adverse effects.


Abbreviations: DT, diphtheria, tetanus; DTap, diphtheria, tetanus, acellular pertussis; Td, Tetanus, diphtheria; Tdap, tetanus, diphtheria, acellular pertussis.
decreased amount of time on mechanical ventilation compared to patients who did not receive methadone. Because of escalating opioid tolerance, reactive states of hyperalgesia, and the known adverse impact of opioids on fluid resuscitation, alpha-2 antagonists such as dexmedetomidine continue to gain interest. Dexmedetomidine is an alpha-2 antagonist that acts as a sedative, analgesic, and anxiolytic with considerably less respiratory depression compared to other sedatives. Though some have proposed intravenous lidocaine for neuropathic pain related to nerve damage, a Cochrane review by Wasiak et al does not support this practice.

Pruritus
Pruritus is also related to the pain and discomfort of burns. Well documented in the adult literature and less studied in pediatrics, pruritus affects > 90% of burn patients at the time of discharge. The incidence is more frequent than patient-reported pain and sleep disruption. Pruritus is found to slowly decrease in intensity over time and is unrelated to burn etiology, patient gender, patient age, and burn size. Pediatric studies support treatment with lidocaine/prilocaine cream (such as EMLA®), gabapentin, or loratadine. Although this entity is less likely to be encountered by the emergency clinician, its high incidence supports a role for anticipatory guidance and education in the ED.

Disposition
Once the emergency clinician has assessed the patient, determined surface area involvement and depth, and initiated local and systemic treatment for stabilization, the appropriate care setting must be determined. A regionalized referral system established over 50 years ago facilitates the transfer of selected burn patients to centers with the equipment and personnel capable of providing an appropriate level of care. The ABA has 54 verified burn centers nationally. Delays in transfer to a burn center have been shown to be related to increased infection rates, acute kidney injury, increased length of catheter time, hospital stay, and total rehabilitation time. The ABA has identified clear indications for transfer of pediatric burn patients to an accredited burn center. (See Table 6.)

Additionally, consideration of inpatient hospital management at a non–burn center is indicated if the patient has limited social and parental support factors in the setting of 5% to 10% TBSA partial-thickness burns, if there is concern for nonaccidental injury, or if full-thickness burns between 2% and 5% TBSA are present.

Discharge is an option for up to 90% of patients treated in the emergency setting. Discharge should be considered for partial-thickness burns affecting < 10% TBSA, burns without airway involvement, patients capable of oral rehydration, a history consistent with the presenting injury, and appropriate family resources for home management. Discharge instructions should be clear regarding timing and method of dressing changes, signs that necessitate prompt medical attention, and timing for wound re-evaluation.

Prevention And Advocacy
Emergency clinicians should be mindful of their role in the prevention of thermal injuries. Anticipatory guidance and salient counseling regarding home safety is in the realm of education that should occur prior to fully dispositioning patients and their caregivers from the ED. Kitchen safety includes adjusting water heating limits to 49ºC (120ºF), proper positioning of cooking vessels on the stove (such that handles remain in rear-facing positions), and ensuring that warmed fluids are stored on the rear burners. Oven door locks prevent contact burns and child-proof safety covers for oven dials prevent flame-related injuries.

Home prevention includes confirming functioning smoke detectors in the house with a biannual battery check. Timing smoke detector checks with daylight saving time in a campaign known as “change your clock, change your battery” was advocated by the International Association of Fire Chiefs. Additionally, within the home, outlet covers prevent electrical injuries. Fireworks should remain off limits to children. Finally, smoking cessation not only prevents house fires, but also promotes the overall health of the patient and housemates exposed to second-hand cigarette smoke.

Table 6. Indications For Transfer To A Burn Center

- Partial-thickness burns > 10% TBSA in children aged < 10 years or > 20% TBSA in any age
- Full-thickness burns > 5% TBSA
- Burns to high risk areas, such as the face, hands, feet, genitals, perineum, or major joints
- Electrical burns, including lightning strike
- Chemical burns
- Inhalation injury
- Pre-existing conditions known to impair healing and increase risk of mortality
- Burns in combination with traumatic injury (eg, fracture, traumatic brain injury) whereby the burn is the leading risk for patient mortality
- Children requiring support in social, emotional, or rehabilitative care
- Burns in a setting unequipped (personnel, equipment, or unit) to care for critically ill children

Abbreviation: TBSA, total body surface area.
**Special Circumstances**

**Circumferential Burns**
When circumferential burns are present around an extremity, the chest, or the abdomen, they pose a special concern. Initial evaluation should include monitoring the extremities for signs of distal hypoperfusion or compartment syndrome. Circumferential chest burns can quickly restrict breathing, contributing to respiratory failure. Patients’ respiratory status should be closely monitored with pulse oximetry and capnography. If a circumferential burn is noted and signs of compartment syndrome or respiratory failure are observed, an escharotomy should be performed to release the tissue pressure. This is accomplished by making an incision through the full-thickness eschar, releasing the contracting skin overlying the wound. Careful consideration must be taken to avoid underlying neurological and vascular structures. Incisions should be made laterally on extremities or the chest wall. (See Figure 6.) Anesthesia is generally not required as the nerves providing skin sensation have more than likely been destroyed in a full-thickness burn.

Abdominal circumferential burns may also lead to compartment syndrome. The intra-abdominal fluid accumulation with third spacing and the associated swelling can compress the internal organs, decreasing blood flow, and finally lead to multiorgan failure and death.111

**Chemical Injuries**
Caustic agents, both acidic and basic, can also cause burn injuries. Caustic chemicals exist in most households and businesses in the form of cleaning agents, making exposure to them a common occurrence. Caustic agents can either be acidic (pH < 7, with a strong acid having a pH < 3) or basic (pH > 7, with a strong base having a pH > 11). Damage to the patient is caused either by direct skin contact with the chemical or via ingestion.112 Acid burns break down the protein in skin and tissue, causing coagulation necrosis. An eschar forms at contact points. Alkali burns dissolve proteins and collagen in the skin and tissue and typically lead to deeper and more extensive damage than acid burns. There is a large amount of fluid loss associated with alkali burns. While painful and disfiguring, topical exposures are rarely lethal. Although rare, most pediatric deaths occur after a patient has ingested a compound. In 2012, it was noted that 2% of the overall pediatric ingestion mortality was due to ingestion of a caustic agent.113

The first step in care of a chemical burn injury is protection of the rescuer, followed by removal of the patient from the offending agent. Remove all clothing and jewelry from the patient to decrease continued exposure, and initiate extensive irrigation with water. Do not attempt neutralization of the offending agent with an opposing acid or base, as this can cause additional caustic injury. Neutralization also causes an exothermic reaction, which may lead to a compounding thermal injury. Litmus paper is often used (the pH square of a urine dipstick may also be used) to assess for adequacy of irrigation and neutrality.114 Special consideration should be taken for ingestions and any chemical injuries of the eye. Ophthalmology and gastroenterology should be consulted early, as indicated, for any exposures.

**Special Agents**

**Hydrofluoric Acid**
Hydrofluoric acid is particularly destructive, and even small exposures may have systemic effects on the patient. Hydrofluoric acid is used to etch glass, and it is now also used in many products such as rust remover, cleaning sprays, and in fertilizer production. Most hydrofluoric acid burns are small and involve the hand. Due to the binding properties of fluoride, even a small exposure (> 1% TBSA) can cause systemic hypocalcemia and hypomagnesemia within hours. Fluoride is also directly cardiotoxic. Initiate irrigation with water immediately, followed by topical application of calcium gluconate 2.5% gel. As the gel is absorbed, it helps deactivate the fluoride ion, thus aiding in relief of pain and direct tissue damage and in prevention of electrolyte imbalance. Calcium gluconate 5% can be locally infiltrated into the wound site if the gel does not adequately relieve the pain. If pain relief is not achieved with local infiltration, direct intra-arterial injection of calcium gluconate is also an option.115 Monitor the patient’s cardiac function with an electrocardiogram. Consultation with a poison control center can be helpful in guiding the extent of cardiac monitoring that should be undertaken.

**Anhydrous Ammonia**
Anhydrous ammonia is a colorless gas commonly used in fertilizer. It is usually stored at a very cold temperature where it remains in a liquid state. Patients who are exposed to anhydrous ammonia...
Electrical Injuries
While electrical injuries account for a minority of burns in children, it is prudent for the emergency clinician to understand management. Pediatric electrical injury has a bimodal prevalence, first in young children and then again in adolescence. Younger children are usually exposed to low-voltage current from wall sockets and home appliances, and adolescents are typically injured by higher voltages due to risky behavior. Voltage \(< 1000 \text{ volts}\) is considered to be low voltage and \(\geq 1000 \text{ volts}\) is considered to be high voltage. Most low-voltage injuries are rela-

Risk Management Pitfalls In Management Of Pediatric Burns
(Continued on page 17)

1. “I saw a patient who was in a house fire, and he was breathing fine when I first examined him. I don’t know why he suddenly got worse.”
Patients presenting from fires that have occurred in closed spaces are at higher risk for inhalation injury. Early normal voice and oxygen saturation levels may not adequately predict a patient’s true airway status. In fact, oxygen saturation may be spuriously high from concomitant carbon monoxide poisoning. Look for carbonaceous sputum, soot in the nares, or damage to the oropharynx. Patients with signs of inhalation injury should be considered for early intubation due to potential respiratory failure from airway edema and obstruction.

2. “I didn’t know that some topical burn treatments can’t be used on the face, and I had no idea that it could cause permanent pigment changes to the skin. I gave the patient silver sulfadiazine because the parents told me that they didn’t have insurance and couldn’t afford medications.”
Facial burns, particularly in patients with darker skin tones, should not be treated with silver sulfadiazine cream due to the bleaching effect that this compound can have on the skin. For facial burns, bacitracin or other nonsilver occlusive dressings may be applied to achieve the best cosmetic outcome. Always be attuned to patient’s financial and social concerns regarding the ability to follow up and manage burn care. Partial-thickness and full-thickness burns can require long-term care, and patients without insurance or means may need to be referred to a social worker to accommodate the cost of the care.

3. “The burn was really small, and I didn’t know that patients with genitourinary burns needed to be referred to a burn center.”
Most small, superficial, or partial-thickness burns do not necessitate burn center referral. However, wounds to select anatomical regions are at increased risk for complications, and they have been grouped as independent criteria for possible referral to a verified burn center. These areas include the hands, feet, face, genitals, and perineum, and major joints.

4. “It seemed strange that the burn was on the child’s back and a spilling mechanism of injury didn’t seem to make sense, since the child is developmentally delayed and in a wheelchair. It also seemed odd that his mother waited a day to come to the ED for treatment. Even so, the burn was minor, and the child was current on his tetanus immunization, so I performed local wound care and sent the patient home.”
This child is at high risk for nonaccidental trauma, and child protective services should be notified. The child cannot be discharged home until a safe environment can be verified. Risk factors for nonaccidental trauma include male sex, developmental delay, wound site inconsistent with the history given, and delayed presentation for care.

5. “I thought that every burn needed oral antibiotic prophylaxis, especially ones on the hands and feet, but my patient had a bad reaction to the antibiotics and now my peers say that I never should have given her antibiotics in the first place!”
In burns, prophylactic systemic antibiotics are not indicated. Topical antibiotics are useful, but oral or intravenous antibiotics are only indicated if the patient has signs of bacterial super-infection.
fibrillations, and new bundle branch blocks.\textsuperscript{117}

Head and cervical spine injuries should be considered in all patients with high-voltage injuries, as patients may be thrown large distances after being exposed to a high-voltage shock. Some patients may suffer prolonged exposure to the current if the initial shock causes them to lock on to the source. Consider both the potential current to which the patient was exposed and the total amount of time of exposure. External burns may be very minimal even if there is extensive internal organ damage. The electricity actually causes a burn in the patient due to the thermal conversion of electricity.

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### Risk Management Pitfalls in Management of Pediatric Burns

(Continued from page 16)

6. "I have a severely burned patient who is in shock, and I calculated the fluid with the Parkland formula, but he is still hypotensive. Now the intensivist is saying that the patient needed fluid much faster."

The Parkland formula is the mainstay for calculating 24-hour fluid needs in burn victims, but patients presenting in shock require trauma management, including fluid boluses up to 60 mg/mL/kg (in 20 mg/mL/kg aliquots), followed by consideration of vasopressor support for fluid-resistant shock. Using the Parkland hourly fluids calculation for a patient in shock will typically not provide adequate fluid resuscitation.

7. "I was worried about inhalation lung injury, so I got a chest x-ray when the patient was in the ED. It was normal, so I didn’t intubate her. How was I to know that she would decompensate and need intubation within 12 hours of admission?"

Immediate chest radiographs are an unreliable test to determine level of inhalation injury in patients. Studies have demonstrated that the utility of an initial chest x-ray is low, as chest radiographs can be normal in up to 90% of inhalation injury patients.\textsuperscript{38} The relatively short and narrow airway of pediatric patients makes them highly susceptible to airway loss secondary to edema. Airway edema will peak between 12 and 36 hours.

8. "The patient took 4 hours to get transferred to me, and I calculated the fluid requirement, but now the burn intensive care unit team is saying that I didn’t give the patient fluids fast enough."

When using the various calculations to determine the amount of fluid resuscitation required, a 24-hour fluid requirement is calculated. The first half of the fluids should be given in the first 8 hours from the time of injury. If there is delay in initiating fluid resuscitation, then this must be taken into account.

9. "I saw a 3-month-old patient with a burn. How was I supposed to know that the patient also needed tetanus immune globulin?"

Burns are deemed to be unclean wounds, and thereby require tetanus prophylaxis if the patient has not had a tetanus vaccine in the last 5 years. Special consideration must be given to children aged < 6 months, as these patients will not have had their 3 total tetanus toxoid-containing vaccines yet, if they are following the immunization schedule recommended by the United States Centers for Disease Control and Prevention. Any patient who has not had the base level of 3 toxoid vaccines requires acute treatment with both the vaccine and tetanus immune globulin.

10. "I have a patient who has 10% TBSA superficial burns, 7% TBSA partial-thickness burns, and 4% TBSA full-thickness burns, totaling 21% TBSA burned. I called the burn center to transfer the patient and I calculated the fluids for resuscitation. They accepted the transfer, but told me to recalculate the TBSA affected."

Superficial burns are not included in calculation of the percentage of TBSA affected by burns; only partial-thickness and full-thickness burns are included. This estimate should be calculated as accurately as possible, as it will determine fluid volume for resuscitation and will help determine a patient’s appropriate disposition for definitive care.
to heat in the tissue itself, which is why the skin may only be slightly affected, while internal tissue damage may be extensive.\textsuperscript{118}

Electrical injuries can affect multiple organ systems from the onset of the exposure. A patient may suffer cardiac arrest after the initial shock or may have multiorgan involvement and failure. If a patient presents with a history of being exposed to any voltage shock for a prolonged or unknown period of time, he should be evaluated for rhabdomyolysis by testing with urinalysis and serum blood urea nitrogen and creatinine, as it may progress to renal failure. All patients exposed to a high-voltage shock or a lightning strike should be evaluated for multisystem trauma and rhabdomyolysis. Fluid resuscitation goals are the same for patients with electrical injuries as with other burn injuries, and cardiac enzymes do not play a role in the initial evaluation of these patients.\textsuperscript{119}

For additional information on the management of electrical injuries in pediatric patients, see the September 2013 Pediatric Emergency Medicine Practice issue titled “An Evidence-Based Approach To Electrical Injuries In Children,” available at: http://www.ebmedicine.net/electricalinjuries.

**Nonaccidental Trauma**

It is estimated that there are 1.25 million cases of nonaccidental trauma each year in the United States, and that approximately 2\% to 10\% of children presenting to the ED are victims of abuse or neglect.\textsuperscript{120} The emergency clinician is in a unique position to both recognize and report child abuse. A retrospective trial conducted in 2008 using national burn data revealed that 6\% of burns in children aged < 12 years were due to physical abuse.\textsuperscript{121} Burn history and physical characteristics that are statistically related to child abuse include the following: young patient age, immersion lines, certain injury patterns resembling home appliances, young parents, inconsistent history of injury, and delays in presentation.\textsuperscript{122}

Suspicious injury patterns may be the first sign that a child has been abused. When a child touches an object or liquid that burns them, they should immediately try to withdraw from the stimulus, causing poorly demarcated burn lines. If burns lines have distinct lines of demarcation, if the burn is symmetrical or both extremities are equally burned, or if there is sparing at flexor lines with deep burns to surrounding tissue, then nonaccidental trauma should be suspected. Classic child abuse burns involve the circular, well-circumscribed cigarette burn, linear burns by curling irons and irons, and radiator or space heater marks. (See Figure 7.) If nonaccidental trauma is suspected, then it must be reported immediately, and the child should be kept in the ED or admitted to the hospital until a safe home environment can be assured.

**Controversies And Cutting Edge**

**Technology To Estimate Total Body Surface Area Of Burns**

There are multiple areas of new and trending research in the area of pediatric thermal burns. One area of active research is the use of laser and computer 3D technologies to more accurately and reliably calculate the TBSA and depth of a burn, as this is critical for fluid resuscitation calculation, burn treatment, and clinical disposition. In 2014, Sheng

**Figure 7. Comparison Of Accidental Iron Burn Versus Nonaccidental Space Heater Burn**

A. Accidental, poorly demarcated.  
B. Nonaccidental, well-demarcated, pattern burn.

et al presented a program called BurnCalc that uses portable 3D scanning to estimate the TBSA of a burn. They internally validated their tool and have reported very accurate interoperator reliability. The authors proposed that BurnCalc is superior to both the Rule of Nines and the Rule of Palms. This and other technological advances will be clinically useful in the management of burn patients.

**Decreasing The Number Of Early Intubations**

In the last year, there has been a movement to consider decreasing the number of early intubations performed on burn patients. Intubation and mechanical ventilation have their own set of associated harms, and the concern is that some patients with facial burns and singed nasal hairs do not require intubation. Without evidence of intraoral or upper airway involvement, patients may be safe to observe without intubation. Additionally, there is new evidence that there may be utility in using ultrasound to assess for airway edema in the burn patient with suspected inhalation injury. In a case study, tracheal wall thickening was reported to have been measured using readily available external ultrasound. This is an exciting new area of research for emergency clinicians and certainly requires further evaluation, as there are no side effects with the use of ultrasound.

**Ongoing Controversies In Management**

The question of intravenous colloid fluid administration remains unclear despite multiple studies performed. Initial fluid resuscitation should be performed with either lactated Ringer’s or normal saline. A recent survey completed by the ABA burned patients.

**Time- And Cost-Effective Strategies**

- Taking measures to decrease hospital stay, ventilation time, morbidity, and mortality will decrease the cost of care of the burn patient. Financial analysis has concluded that operative costs, length of stay, dressings, and staff were the largest contributors to the total cost. Further research is needed on the most effective ways to reach these goals.
- A study by Bharat found that focusing on cost reductions in dressings and antibiotics impacted roughly half of the overall cost. Moving to exposure dressings and avoiding prophylactic and nonindicated antibiotics stands to significantly impact cost.
- Burn prevention will always be more cost-effective than burn management. With the average cost for burn care in adults approaching $80,000, examining areas of cost reduction is crucial.

in 2010 confirmed that > 90% of the International Society for Burn Injury and ABA members use lactated Ringer’s, and 63% use the Parkland formula to calculate fluid needs. However, there is still no definitive evidence that one solution is superior to the other. It is postulated that the addition of intravenous colloids would increase and maintain intravascular volume, but this has not been shown to change overall burn mortality.

**Summary**

Primary treatment of pediatric burn injuries should follow trauma-based protocols emphasizing attention to airway assessment and support, as well as the treatment of shock with early initiation of fluid resuscitation. Improved morbidity and mortality will accompany appropriately indicated transfers to verified burn centers in select burn cases. Emergency clinicians will treat and discharge > 90% of minor burn injuries presenting to the ED. The focus of research is now on the goal of cost reduction and treatment protocols that reduce morbidity and mortality. Ultimately, the largest cost savings strategies stem from primary prevention.

**Key Points In Management Of Pediatric Burn Injuries**

- Focus on airway, breathing, and circulation (ABCs) when initially evaluating the burned patient, particularly patients with a history involving fire in an enclosed area.
- Burns need to be classified by the depth of the injury and the percentage of the TBSA affected. The current classifications of burns are superficial, partial-thickness, and full-thickness. The percentage TBSA can be calculated using the Lund-Browder chart or the Rule of Palms.
- Prehospital care should involve cooling the burn with running tap water, irrigation of caustic intoxicants, wrapping the patient in a cool sterile sheet, or application of a hydrogel cooling dressing. Patients should be transported to a hospital as quickly as possible.
- Patients who have > 20% TBSA affected by partial- or full-thickness burns require intravenous fluid resuscitation. Lactated Ringer’s solution is the fluid of choice. Use the Parkland or Galveston formulas to calculate the fluid volume for resuscitation. Remember to add maintenance fluids to the resuscitation fluids for children aged < 5 years.
- Urine output is the most accepted way to monitor that a patient is receiving adequate fluid resuscitation.
- Remember to consider the history surrounding the burn event and to evaluate the patient for any coexisting traumatic injuries, carbon monoxide poison-
ing, or cyanide poisoning.

- Local treatment of burns includes cooling with tap water, washing with soap or iodine, consideration of debridement of blisters, and application of either a topical antibiotic or an occlusive dressing.
- Pain control is very important for burn patients. Nonsteroidal anti-inflammatory medications are excellent for superficial burns. Morphine and other opioids can be used to medicate patients with partial- and full-thickness burns.
- Always review the criteria for sending patients to an accredited burn center and follow them, as necessary.
- Maintain a high suspicion for nonaccidental trauma when evaluating the burned pediatric patient, particularly in patients aged < 2 years.

Case Conclusions

The 3-month-old’s history contained details consistent with nonaccidental trauma. The burn is inconsistent with the patient’s physical developmental abilities to harm herself, and the delayed presentation makes the diagnosis highly suspicious for an inflicted injury. You initiated care for the small partial-thickness wound, consulted a social worker, and reported the case to child protective services. Because the patient had not had ≥ 3 immunizations of DTaP and she sustained a wound that was not considered clean or minor, you administered both DTaP and Td. The patient was admitted to the hospital.

The 6-year-old’s burn to the hand was white and nonpainful on examination, which was consistent with full-thickness injury. You recalled that the ABA burn center referral criteria includes electrical injuries, injuries to special areas (such as the hand), and full-thickness burn injuries. You began local wound care, updated the patient’s tetanus immunization status, and arranged transfer to a burn center.

After examination, you assessed the 10-year-old girl to have approximately 30% TBSA involvement with the burn to the entire back, the posterior portion of her right leg, and her entire right arm. The reddened areas of superficial involvement were not included in the TBSA assessment. You began airway management and stabilization, as well as initial resuscitation. Due to the amount of her TBSA involvement and possible inhalation injury, the patient met the criteria for transfer to a burn center. While awaiting transfer, you carefully assessed the patient’s right upper extremity for a circumferential burn, ensuring that vascular flow was not impaired and that escharotomy was not necessary.

References

Evidence-based medicine requires a critical appraisal of the literature based upon study methodology and number of subjects. Not all references are equally robust. The findings of a large, prospective, randomized, and blinded trial should carry more weight than a case report.

To help the reader judge the strength of each reference, pertinent information about the study, such as the type of study and the number of patients in the study will be included in bold type following the references cited in this paper, as determined by the author, will be noted by an asterisk (*) next to the number of the reference.


32. Hammond JS, Ward CG. Transfers from emergency room to burn center: errors in burn size estimate. *J Trauma.* 1987;27(10):1161-1165. (Prospective observational study; 132 cases)


60. Todd SR, Muller PJ, Schreiber MA. Lactated Ringer’s is superior to normal saline in the resuscitation of uncontrolled hemorrhagic shock. J Trauma. 2007;62:636-639. (Review)


77. Winter GD. Formation of the scab and the rate of epithelization of superficial wounds in the skin of the young domestic pig. Nature. 1962;193:293-294. (Prospective observational animal study)


99. Adriani J. Reactions to local anesthetics. JAMA. 1966;196(5):405-408. (Review)


1. Which of the following is an indication for referral to a burn center?
   a. Full-thickness burns over a 3 cm x 3 cm area on the upper arm of a 2-year-old girl
   b. Partial-thickness burns covering 12% TBSA in an 8-year-old boy
   c. Partial-thickness burns covering 16% TBSA in a 16-year-old girl
   d. Superficial burns to the entire face of a 5-year-old boy

2. Which area of a burn is the most dependent on interventions targeting blood pressure and infection control?
   a. Zone of coagulation
   b. Zone of hyperemia
   c. Zone of stasis
   d. Zone of necrosis

3. Which of the following anatomic locations is most suspicious of abuse?
   a. Palm of hand of a 2-year-old
   b. Lower chin and upper chest in a 1-year-old
   c. Edge of mouth in a 13-month-old
   d. Bilateral buttocks in a 4-year-old

4. A 4-year-old boy sustains a scald injury in his home. The mother calls the ED while awaiting arrival of EMS. She describes the wound present on the child’s forearm which has 2 quarter-sized blisters. What should she apply to the wound?
   a. Ice
   b. Butter
   c. Cool running water
   d. Bacitracin

5. A 5-year-old boy was playing in the garbage outside his parent’s office building in an industrial park. He presents with redness and pain over both hands. Per the parents, they found the child with wet hands, which they washed immediately. An hour later, the child complained of redness, pain, and a burning sensation in his hands. Which screening test is indicated?
   a. Serum electrolyte levels
   b. Serum lactate levels
   c. Finger-stick blood glucose
   d. Urinalysis

6. A 4-year-old, 19-kg girl presents with partial-thickness burns to 25% of her TBSA after her clothing ignited at a campfire. She arrived to the ED at 7:00 pm via EMS who report that the injury occurred at 6:00 pm. The nearest accredited burn center is approximately 3 hours away. Their unit is on the way, and they would like you to begin the child’s fluid resuscitation. By the time the child arrives at the burn center at 2:00 am, you anticipate she will have received:
   a. 1900 cc of lactated Ringer’s plus 464 cc of 5.25% dextrose in normal saline
   b. 950 cc of normal saline plus 464 cc of 5.5% dextrose in normal saline
   c. 1000 cc of lactated Ringer’s plus 224 cc of normal saline
   d. 2500 cc of normal saline plus 1000 cc of 5% dextrose in normal saline

7. A 6-year-old girl presents to the ED after spilling hot oatmeal on her face. She has a 1 x 1 cm superficial partial-thickness burn on her right cheek. After cleaning the wound and confirming her tetanus status, which topical agent would be most indicated?
   a. Silver sulfadiazine
   b. Aquacel
   c. Plain gauze
   d. Biobrane

8. In advocating for burn prevention, you should recommend water heaters to be set to a maximum of what temperature?
   a. 100°F
   b. 110°F
   c. 120°F
   d. 130°F
9. Which burn depth and anatomic description are correctly paired?
   a. Superficial: wet, painful, white
   b. Superficial partial-thickness: weeping wet with scarring likely
   c. Deep partial-thickness: blisters, blanching with scarring likely
   d. Full thickness: firm, white to brown in color with scarring likely

10. Regarding burn epidemiology, which is TRUE?
    a. Approximately 5% of children presenting with burns will benefit from referral to a burn center.
    b. Despite modern treatment protocols, burn mortality has remained stable.
    c. The most common etiology of pediatric burns is flame injury.
    d. The peak incidence of scald injuries is at age 5 years.
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