Initial Assessment and Management of Thermal Burn Injuries in Children

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Author Disclosure
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Educational Gap

Burns are a frequent cause of injury in children and adolescents. Clinicians should be familiar with initial assessment and management of burns and be capable of identifying burn injuries appropriate for referral to a regional burn center.

Objectives

After reading this article, readers should be able to:

1. List 3 types of burn injuries.
2. Describe the initial evaluation of a burned child in terms of burn depth, size, and associated injuries or medical conditions.
3. Describe appropriate burns for outpatient management.
4. Estimate initial fluid resuscitation requirements for the first 24 hours in children with large (>25% total body surface area) partial-thickness burns.
5. Describe 2 methods of dressing management for a 5% total body surface area partial-thickness burn.
6. Recognize indications for transfer of a burned child to a regional burn center.

Introduction

Death from fires and burn injuries is the third leading cause of fatal home injury and the third leading cause of unintentional death in children younger than 14 years in the United States. (1) In 2009, the Centers for Disease Control and Prevention estimated 437 deaths and 120,761 nonfatal burn injuries in children age 0 to 19 years. (2) Although hospitalization rates for children with burns appear to be decreasing in the past decade, annual cost estimates of approximately 10,000 inpatient hospitalizations for pediatric burn care exceeded $211 million in 2000. (3) Although it is difficult to estimate the global incidence rate, morbidity, and mortality of burn injuries, it is clear that burns are a major cause of injury in both developed and developing countries. (4) Burns are one of the most physiologically and psychologically stressful injuries that occur in children and adults. Given the high frequency of pediatric burn injuries, physicians caring for children should be familiar with initial burn assessment and management. It is also important to identify children with burn injuries appropriate for referral to a regional burn center.

Children with burn injuries are evaluated in a variety of settings, including emergency departments, urgent care centers, and primary care pediatric clinics. Although assessment of burn injuries is relatively standardized, management strategies vary between individual practitioners and institutions. From a public health and patient education standpoint, most pediatric burn injuries are preventable, and conscientious efforts at risk reduction and safety in the home should be emphasized during well-child visits.

Types of Burns

A burn is an acute injury to the skin or soft tissue due to thermal energy transfer or trauma. Burn injuries also include skin or tissue injury due to sun exposure, radioactivity, electricity, chemical exposure, or friction. Frostbite injuries due to cold exposure are also a type of injury from thermal energy transfer. In practice, the mechanism of burn injury is an

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important consideration because other medical and surgical issues may coexist or occur shortly after injury. Electrical injuries are generally more common in older children and adolescents and result from exposure to faulty wiring, leaking current from electrical appliances, contact with high-voltage lines, or lightning. Although they may generate limited visible injury, survivors of severe electrical burns may have extensive deep tissue injury, with significant nerve and muscle damage that leads to arrhythmia, unconsciousness, loss of extremity function, and rhabdomyolysis. Chemical burns typically involve topical or mucosal exposure to alkaline or acidic agents, and the management is generally specific to the chemical class involved. Unintentional injury from chemicals has become less common since the enactment of the US Poison Prevention Packaging Act in 1970. A detailed evaluation and management of electrical and chemical injuries in children are beyond the scope of this review; therefore, focus will be placed on the more commonly encountered thermal injuries.

Common thermal injuries observed in infants and children include scald and contact burns associated with either cooking or consuming food. Specifically, injuries from spilled hot coffee, hot liquids, and ramen noodle soup comprise most outpatient pediatric burn wounds. Contact burns from hot space heaters, barbecue grills, fireplace grates, stoves, and ovens typically occur from a child's inadvertent hand or extremity contact with the heat source. Finally, contact burns from hot irons, curling irons, campfires, and fireworks are common among children.

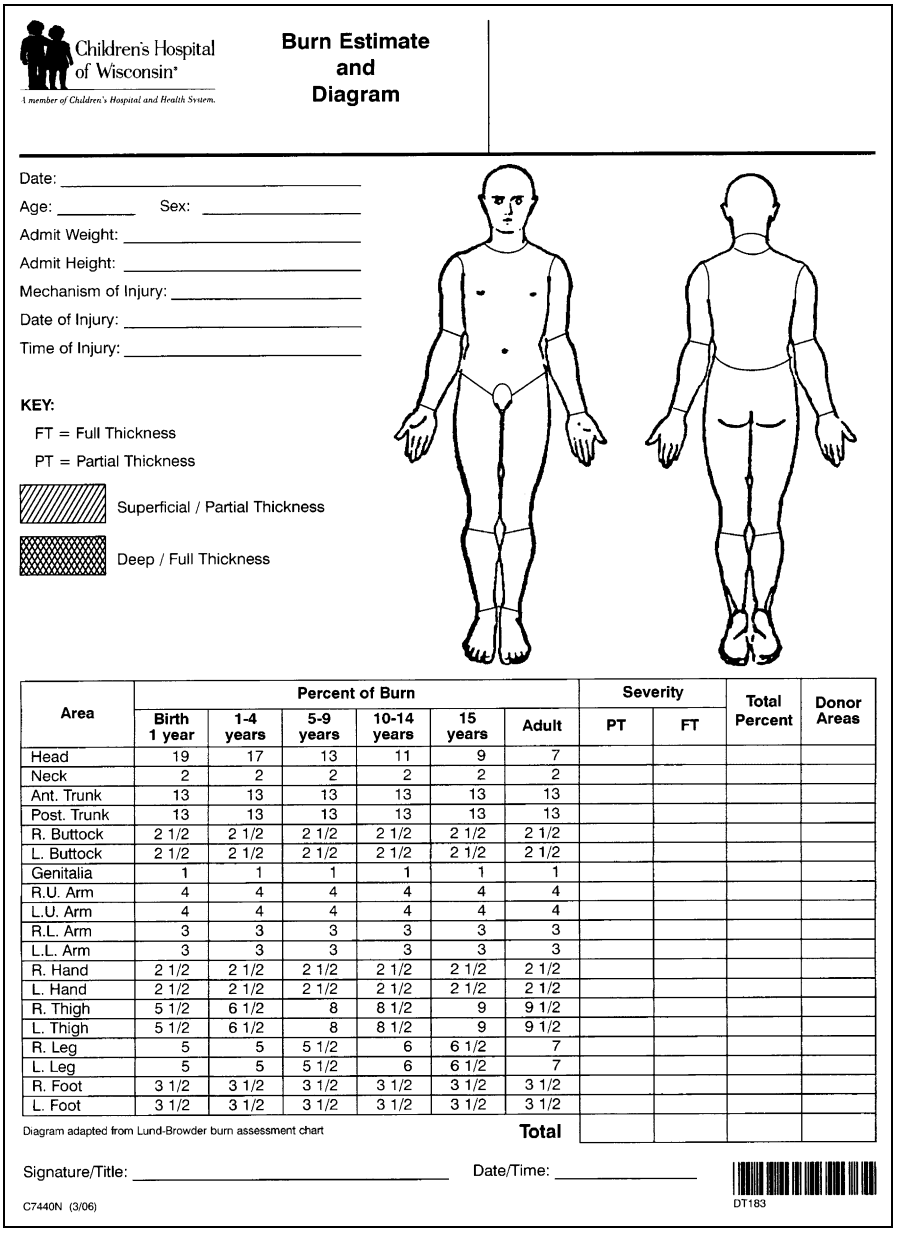
Initial Evaluation

The initial evaluation of the burned child should take into account the clinician's experience and the immediate institutional resources available for burn management. Triage will be dictated, in part, by the clinician's estimate of burn injury severity. Most children with minor burn injuries, for example, partial-thickness scald burns of less than 5% total body surface area (TSBA), may be managed on an outpatient basis. Children with moderate to severe burn injury require attention to the ABCDEF's (airway, breathing, circulation, disability, exposure, and fluid resuscitation requirements) of traumatic and thermal injury evaluation. Emergency assessment of the airway, adequacy of ventilation, oxygenation, and circulation is essential. Clothing, including diapers, should be removed to prevent further smoldering or scalding injury in a temperature-controlled environment. (5) Unless the institution has significant experience with moderate to severe burn injuries in children, direct communication with a regional burn center is imperative to facilitate safe, expedient transfer. Clinicians performing initial assessment of a burned child should focus on gathering data necessary to initiate burn management. This information includes patient demographics and medical history, mechanism of injury, and estimated severity of the burn wound.

Estimating Burn Severity

Estimating the severity of a burn requires clinical evaluation of the following: (1) the child's age and medical history; (2) the mechanism of injury; and (3) the surface area, depth, and pattern of the burn injury. Infants and children younger than 2 years and children with clinically significant medical problems (eg, diabetes mellitus, sickle cell disease, and children receiving chemotherapy) have greater risk of burn-related morbidity and mortality. Rapid estimate of the TBSA of a burn injury in adolescents and adults can be performed using the "rule of 9's." On the basis of this guideline, the surface area of each arm is approximately 9% TBSA, each leg is 18%, the anterior and posterior torso (including the pelvis) are 18% each, the head is 9%, and the perineum is 1% TBSA. Because anatomical body surface area varies with age, a more accurate estimation of burn surface area in infants, children, and adults is achieved with a Lund-Browder chart widely available in printed and electronic formats (Figure 1). (6) The percentage of TBSA involved with a burn wound has significant implications for the physiologic impact of the injury. Pediatric burn wounds that involve greater than 10% TBSA will induce a more profound systemic inflammatory response characterized by increased microvascular capillary leak, interstitial edema formation in both injured and noninjured tissue, and intravascular hypovolemia.

Burn depth is another important variable in assessing severity of injury. The depth of burn strongly influences the predicted degree of physiologic derangement induced by the injury. In addition, in conjunction with the surface area involved, burn depth has direct implications for wound management and the likelihood of potential disfigurement. Table 1 outlines historical and contemporary nomenclature for describing the depth of burn injury. Accurate clinical description of burn wound depth indicates the degree of injury to the dermis. The common sunburn is a superficial burn injury in which the epidermis is injured, but the underlying epidermal cells and dermis remain intact. The injured epidermis will eventually peel after a few days, but new epidermal skin cells will be regenerated. Given their limited physiological



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Burn Estimate and Diagram

Date: _____

Age: _____ Sex: _____

Admit Weight: _____

Admit Height: _____

Mechanism of Injury: _____

Date of Injury: _____

Time of Injury: _____

KEY:

FT = Full Thickness

PT = Partial Thickness

Superficial / Partial Thickness

Deep / Full Thickness

Area	Percent of Burn						Severity		Total Percent	Donor Areas
	Birth 1 year	1-4 years	5-9 years	10-14 years	15 years	Adult	PT	FT		
Head	19	17	13	11	9	7				
Neck	2	2	2	2	2	2				
Ant. Trunk	13	13	13	13	13	13				
Post. Trunk	13	13	13	13	13	13				
R. Buttock	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2				
L. Buttock	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2				
Genitalia	1	1	1	1	1	1				
R.U. Arm	4	4	4	4	4	4				
L.U. Arm	4	4	4	4	4	4				
R.L. Arm	3	3	3	3	3	3				
L.L. Arm	3	3	3	3	3	3				
R. Hand	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2				
L. Hand	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2				
R. Thigh	5 1/2	6 1/2	8	8 1/2	9	9 1/2				
L. Thigh	5 1/2	6 1/2	8	8 1/2	9	9 1/2				
R. Leg	5	5	5 1/2	6	6 1/2	7				
L. Leg	5	5	5 1/2	6	6 1/2	7				
R. Foot	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2				
L. Foot	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2				
Diagram adapted from Lund-Browder burn assessment chart						Total				

Signature/Title: _____ Date/Time: _____

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Figure 1. Modified Lund Browder chart for estimating size of burn in terms of total body surface area. Partial-thickness, full-thickness, and indeterminate-depth burns are used in the calculation. Adapted from Lund and Browder (6) and courtesy of the Trauma Program, Division of Pediatric Surgery, Children's Hospital of Wisconsin.

effect, superficial burn injuries are not used to calculate TBSA involvement. Scald burns that cause blisters to form are prototypical partial-thickness injuries. The skin is partially injured, and if the blister is ruptured, the underlying wound will appear pink and moist. A limited, correctly managed partial-thickness burn wound should be expected to epithelialize in approximately 7 to 14 days. Full-thickness burns are characterized by irreversible injury to the dermis and the skin's epithelial elements. Full-thickness burns will not regenerate epithelium; therefore, injuries of this depth uniformly require surgical management (Figure 2). Infants and younger children have much thinner dermis than in adolescents and adults, and it can be difficult to determine the complete extent of skin injury either initially or during the first few days of care. Equivocal partial-thickness injuries are best characterized

Table 1. **Nomenclature for Depth of Burn Injury**

Depth of Burn Injury		Extent of Injury
First degree	Superficial	Epidermis injured; dermis intact
Second degree	Partial thickness	Dermis partially injured but skin remains viable
Third degree	Full thickness	Dermis completely injured and skin nonviable
Indeterminate		Dermis partially injured; cannot determine skin viability

as indeterminate depth wounds. Partial-thickness, full-thickness, and indeterminate-depth burn wounds are used to calculate estimated percentage of TBSA burn involvement. Characterizing burn wounds based on the depth of injury allows for determination of treatment based on their expected evolution.

The mechanism of burn injury is often helpful in estimating severity and identifying associated potential problems. Burns to the face, head and neck, hands, feet, and genitalia are generally considered injuries that may require specialized, multidisciplinary evaluation and care. Children with facial burns that involve the orbit should have their corneas assessed for injury by an ophthalmologist. Full-thickness burn injuries that involve the entire torso can cause restriction of breathing due to inadequate chest wall excursion; similarly, full-thickness burns that involve an entire extremity can cause venous and/or arterial insufficiency of the extremity. Escharotomies, or incisions in the full-thickness burn (eschar), may be necessary to prevent the tourniquet effect of the eschar. Burn injuries that involve closed-space structural fires create high risk for associated inhalational injury, including carbon monoxide poisoning and combustion byproduct inhalation. Burns that occur in motor vehicle crashes and explosions can be accompanied by significant brain, thoracic, and abdominal injury that requires emergency intervention. Finally, infants and children are at risk for intentional burn injuries; these children are also at risk for other injuries that require emergency management. Pediatric burn injuries in which there is delay in seeking treatment or isolated scald or contact burns to the hands, feet, genitalia, or buttocks without a clearly defined mechanism should prompt further investigation. Unusual patterns of burn injuries occur with intentional immersion of hands or feet into scalding water, causing glove-like or sock-like injuries that lack surrounding splash burns. Suspicious patterns of contact burns with hot clothing irons, heaters, or cooking pans that do not correlate with the reported history should be thoroughly investigated. If there is any concern regarding the mechanism or distribution of a burn injury, communication with child protective services and referral to a pediatric burn center are necessary. Table 2 lists a burn severity grading system from the American Burn Association as a guideline for treatment.

Treatment

Treatment of infants and children with burn injuries should follow recommendations for the treatment of any pediatric trauma patient, with initial attention directed at identifying adequate airway, breathing, and circulation. For minor partial-thickness burns less than 5% TBSA, treatment is aimed at provision of analgesia and wound care. Preemptive analgesia and sedation may be required to perform initial wound assessment to avoid escalating or repetitive psychological trauma associated with wound care. Initial care of a minor partial-thickness burn is straightforward and involves debridement, or removal, of any sloughing epidermis using sterile normal saline and gauze. The exposed wound will be moist and painful, and prompt placement of a burn dressing will help to reduce pain associated with convection of air on the wound. Most minor burns can be effectively managed on an outpatient basis with a low-cost, relatively easy-to-use dressing using a topical antimicrobial agent that prevents wound desiccation and inhibits bacterial colonization or invasion. Typical burn antimicrobial agents include silver sulfadiazine or bacitracin ointment. (7) Between dressing changes, the wound may become covered with exudative drainage. The exudate should be gently wiped off daily with a clean cloth or gauze in the shower or bathtub and dressed with a topical antimicrobial agent and gauze. Minor partial-thickness burn injuries can be expected to epithelialize in 7 to 14 days.

An alternative management strategy for minor and moderate (5%-10% TBSA) partial-thickness burn injuries is wound coverage with a biological dressing, such as pigskin, or a biocomposite temporary dressing. Biocomposite dressings are composed of semipermeable silicone and nylon mesh coated with porcine collagen

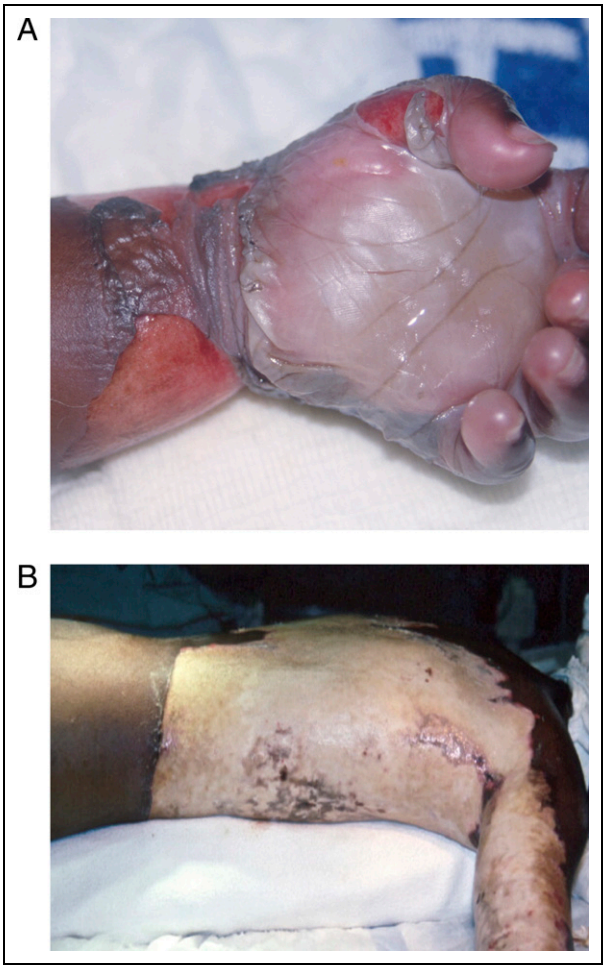

Figure 2. Estimating depth of burn injury. A. A partial-thickness scald burn to the hand has caused epithelial sloughing; the underlying epidermis and dermis are injured but will regenerate skin. This burn has a glovelike distribution suggestive of intentional immersion injury. Note the acute soft tissue edema from the burn. B. A full-thickness flame burn to the torso has completely injured the epidermis and dermis. This burn wound will require excision and grafting.

(Biobrane®; UDL Laboratories, Sugar Land, TX) or semipermeable silicone with a hyaluronic acid pad (Hyalomatrix®; Anika Therapeutics, Padova, Italy). After wound assessment and nonexcisional debridement, the burn wound is covered with the dressing, and once adherent, the dressing is allowed to remain in place until new epithelium grows underneath it. The dressings are typically kept dry for 1 week. The dressing will begin lifting off in 7 to 14 days as the new epithelium becomes confluent. In addition, there is generally less pain and analgesic requirement once these dressings are adherent. (8) There are several emerging silver-impregnated, flexible, and self-adhesive synthetic burn wound dressings that also provide similar wound management function as well. The addition of silver ions into the dressing provides broad-spectrum antimicrobial function. The advantages of biological and biocomposite wound dressings include dressing flexibility, durability, less frequent dressing changes, and reduced exposure of the healing skin to mechanical shear. However, these dressings may not be readily available outside regional burn centers.

Severe burn injuries require specialized management and are best cared for in a regional pediatric burn center. Indications for referring an infant or child to a regional burn center are listed in Table 3. A description of the child's history, mechanism of injury, estimated percentage of TBSA burn, and associated issues should be assessed and provided. For moderate or major burns, control of the airway and assisted ventilation may be required. Infants and children with stigmata of inhalational injury, including a history of closed-space structural fire, soot in the nose or mouth, elevated carboxyhemoglobin level greater than 10%, and a Pao_2 to Fio_2 ratio less than 200 have a high probability of requiring mechanical ventilation. Infants and children with suspected inhalational injury and/or carbon monoxide poisoning who require intubation should initially receive ventilation with 100% oxygen. Wounds may be covered with a clean, dry sheet; wet dressings should be avoided to prevent hypothermia. Infants and children with moderate or severe burn injuries greater than 10% TBSA should undergo intravenous (IV) fluid resuscitation. Before transfer, IV access should be established and fluid resuscitation initiated. The resuscitative phase of burn injury includes consideration of the adequacy of the airway, establishment of effective gas exchange, and maintenance of circulating intravascular volume. For severe burn injuries, the latter requires clinically significant IV fluid volume resuscitation because the burn injury creates a systemic inflammatory response that affects both injured and noninjured tissues. As a result, marked intravascular fluid loss and extravascular fluid sequestration lead to hypovolemia in the first 24 hours after injury. The goal of fluid resuscitation is maintenance of end-organ perfusion through preservation of intravascular volume. The most commonly used resuscitation formula used to estimate IV fluid requirements after burn injury is the Parkland, or Baxter, formula. (9) This calculation is based on estimated percentage of TBSA burn and the child's weight in kilograms. The IV fluid requirement for the first 24 hours after burn injury is calculated as follows:

Table 2. American Burn Association Burn Injury Severity Grading System (Children)

Minor (Outpatient)	Moderate (Admit to Hospital)	Severe (Refer to Burn Center)
<5% TBSA burn	5%–10% TBSA burn	>10% TBSA burn
<2% TBSA full-thickness burn	2–5% TBSA full-thickness burn	>5% TBSA full-thickness burn
	High-voltage injury	High-voltage burn; chemical burn
	Suspected inhalational injury	Known inhalational injury
	Circumferential burn	Burn to face, eyes, ears, genitalia, joints
	Associated medical problems (diabetes, sickle cell disease)	Associated medical problems; intentional burns
		Significant associated injuries (major trauma)

TBSA=total body surface area.
Adapted from Guidelines for the Operation of Burn Centers, Resources for Optimal Care of the Injured Patient 2006, Committee on Trauma, American College of Surgeons.

Intravenous Fluid Volume (in Milliliters) = Body Weight (in Kilograms) × Percentage of TBSA Burn × 3 to 4 mL of Lactated Ringer Solution

Therefore, a 20-kg child with a 20% TBSA burn requires an estimated 1,200 to 1,600 mL of lactated Ringer solution in the first 24 hours after burn injury for IV fluid resuscitation. Half of the total fluid volume is given in the first 8 hours, and half is given in the next 16 hours after burn injury. For children younger than 2 years, maintenance IV fluid that contains dextrose should be provided in addition to burn resuscitation fluid. Controversy exists over the administration of colloid solutions during burn resuscitation, but in most burn centers that practice albumin administration, it is generally started after initial resuscitation. Adequacy of resuscitation is initially best assessed by hourly urinary output; therefore, with moderate to severe burn injuries, a urinary catheter should be placed. IV fluid resuscitation should be adjusted to prevent persistent hypovolemia or unnecessary fluid overload. Early establishment of enteral feeding is recommended in all severely burned children because caloric needs will be substantial. Burn wounds that involve more than 40% TBSA induce a profound hypermetabolic inflammatory response. Currently, β-blockade using propranolol has been demonstrated through randomized clinical trials to be one of the most efficacious methods of significantly reducing the catabolism in severe pediatric burn injuries. (10)(11)

Table 3. American Burn Association Criteria for Referral to a Burn Center

- Partial-thickness burns >10% TBSA
- Burns to the face, hands, feet, genitalia, perineum, or major joints
- Full-thickness burns (any)
- Electrical or chemical burns
- Burns associated with inhalational injury
- Presence of comorbid conditions that may affect resuscitation and treatment
- Significant associated injuries (major trauma, such as motor vehicle crashes and explosions)
- Burn injuries that exceed specialist or institutional capacity
- Burn injuries with special long-term social, emotional, or rehabilitative needs
- Suspected intentional injury

TBSA=total body surface area.
Adapted from Guidelines for the Operation of Burn Centers, Resources for Optimal Care of the Injured Patient 2006, Committee on Trauma, American College of Surgeons.

Full-thickness burns and deep dermal burns in which spontaneous healing would lead to significant functional loss require specialized surgical management. (12) A common surgical principle for full-thickness burn injuries includes early excision of the eschar and wound coverage typically using skin grafts (Figure 3). Early excision and grafting lead to more prompt resolution of the inflammatory response, better functional outcome, and reduced hospital length of stay. The use of split-thickness skin grafts allows harvest of the graft from a nonburned area of the body. Split-thickness skin grafts are generally taken as thin grafts that measure 8/1,000-in thickness that include the epidermis and a thin layer of dermis. For larger burn wounds with limited donor sites, the skin graft may be meshed to provide greater coverage of the burn

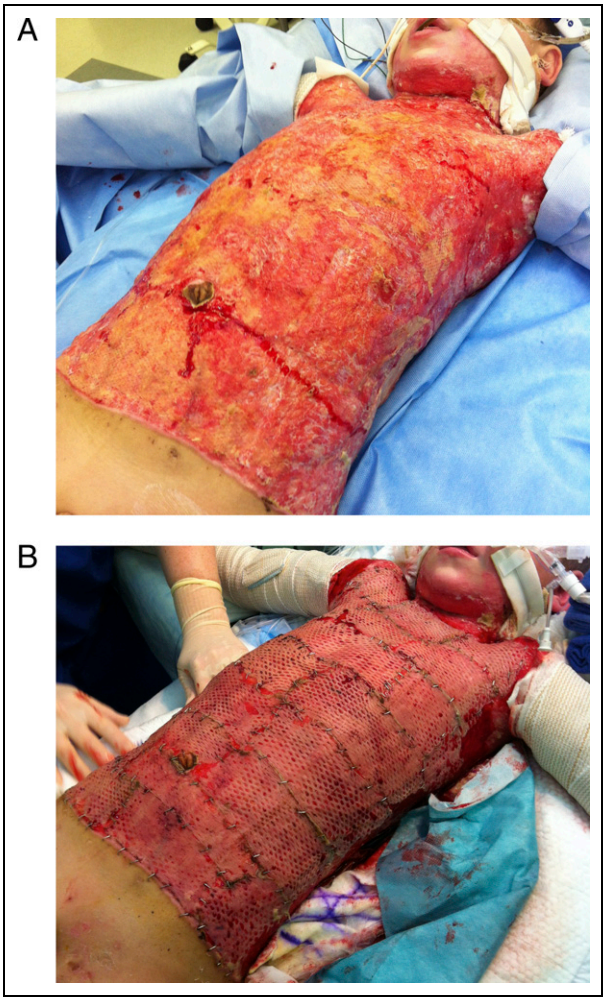

Figure 3. Severe full-thickness burn injury. A. The eschar has been completely removed using tangential excision. B. Appearance of split-thickness skin grafts on postoperative day 5; the grafts were meshed to provide greater surface area coverage from the donor skin.

wound. The donor site is generally treated as a uniform, partial-thickness wound; it will heal within 7 to 14 days of harvest, and the donor site may be used for graft harvest more than once. In some instances of full-thickness dermal burn, after eschar excision a dermal template composed of either collagen and chondroitin sulfate or acellular cadaveric dermis may be deployed. Once the dermal template has undergone neovascularization, a split-thickness skin graft can be placed on the implant. The use of dermal templates may allow for improved functional and cosmetic outcome, particularly around joints and extremities. Smaller full-thickness burn wounds may be managed with excision and primary wound closure or placement of a full-thickness skin graft typically harvested from the groin.

Long-Term Management and Expected Outcome

A goal of contemporary burn management is to provide a burned child adequate function, range of motion, and acceptable cosmesis while addressing psychological and emotional needs. Most minor burn injuries managed on an outpatient basis will heal without functional impairment. However, virtually all partial-thickness and full-thickness burn wounds will heal with scarring. Hypertrophic scar formation after burn injury is common in infants and children, and a multidisciplinary approach is used in scar management. For both minor and severe burn injuries, the liberal use of lotion and massaging or rubbing the scar may help to reduce the inflammatory response and itching associated with healing burn wounds. Reduction or avoidance of sun exposure and the use of sunscreen are essential to prevent injury to the healing burn scar. There is an array of silicon-based scar dressings and custom-fit pressure garments that assist with maintaining skin moisture and direct pressure on scars to reduce hypertrophy. Compression dressings and garments help to reduce scar hypertrophy during the inflammatory and remodeling phases wound healing. Some burn scars will require reconstructive surgery to maintain or increase function, range of motion, or comesis. Occupational and physical therapy are essential for successful rehabilitation and preservation of the child's ability to perform activities of daily living. Self-image issues and psychosocial concerns are common in children and should be addressed prospectively, particularly in school-aged children. Regional burn centers have dedicated physicians, psychologists, nurses, and social workers who coordinate the return of a child recovering from a severe burn injury to home and school. Many children with moderate to severe burn injuries will need multidisciplinary, long-term follow-up for several years after the injury.

Frequently Asked Questions

Should Blisters Be Left Intact or "Popped"?

For minor burn wounds, intact blisters provide a protective environment in the form of a biological dressing. Intact blisters may be left intact as long as they are not crossing joints or otherwise limiting activity. There is no benefit of placing antimicrobial ointment on intact blisters. Once blisters rupture, they generally require debridement to promote wound healing and prevent infection underneath the sloughing epithelium. The ruptured

blister should be completely unroofed to prevent debris and bacterial trapping and antimicrobial ointment placed on the exposed wound.

How Should a Facial Burn Be Managed?

Children who present with acute thermal facial burns should be assessed for airway patency, associated inhalational injury, and eye involvement. Burn wounds that involve airway issues, inhalational injury, eyes, ears, or significant mouth involvement should be referred to a burn center. Minor partial-thickness burns of the face can be managed with facial soaks using normal saline or water several times a day, followed by application of bacitracin ointment or other topical antimicrobial agent. Many burn centers will deploy either a biological or biocomposite dressing for larger partial-thickness facial burns to reduce wound care issues. Protection of the head and face burn from sunburn is important during the short-term and long-term phases of wound healing.

Should an IV Catheter Be Placed Through Burned Skin?

It is preferable to place IV catheters through intact skin, but in infants and children with severe, large burns, this may not be a reasonable option. IV catheters or an intraosseous catheter may be placed through burned skin when necessary for transport or short-term resuscitation. This is preferable to central venous catheter placement unless otherwise indicated for hemodynamic monitoring.

Do All Burn Injuries Require Systemic Antibiotics?

The acute systemic inflammatory response elicited by moderate to severe burn injuries includes fever, tachycardia, and interstitial fluid sequestration that may mimic systemic infection. However, there is no role for empiric systemic antibiotic administration with minor, moderate, or severe burn injury. Systemic antibiotic administration should be reserved for clear evidence of infection by examination of the burn wound or quantitative cultures. Given the loss of epidermal protection and consequent dermal exposure to bacteria in partial- and full-thickness burns, topical antimicrobial dressings and early excision of full-thickness burns are the most useful methods to prevent invasive infection.

Will the Burn Leave a Scar?

The degree of scar formation is related to the depth of the burn wound, host wound healing capacity, and environmental factors. Despite the fact that skin regenerates itself, partial- and full-thickness burn wounds treated with excision and grafting should be expected to heal with scar formation. In general, partial-thickness burns that require longer to epithelialize will heal with greater scarring. Protecting a healing partial-thickness burn wound from mechanical disruption of the healing epithelium may help to reduce scarring.

Summary

- Burn injuries include skin or tissue injury due to sun exposure, radioactivity, electricity, chemical exposure, friction, heat, or cold. The mechanism of burn injury remains important because there may be other medical and surgical issues associated with the type of injury.
- On the basis of strong research evidence and consensus (8,12), burn severity should be described by estimated depth (superficial, partial thickness, or full thickness), total body surface area (TBSA) involved with partial- or full-thickness burn (size), and identification of associated problems, for example, airway control, breathing, circulation, eye involvement, and/or inhalational injury.
- Primarily on the basis of consensus due to lack of relevant clinical studies, pediatric burns appropriate for outpatient management may include partial-thickness burns that involve less than 5% TBSA or full-thickness burns that involve less than 2% TBSA. A clinician must use discretion and judgment and have planned follow-up for all outpatient burns.
- On the basis of strong research evidence (9) and consensus, severe burn injury requires significant intravenous (IV) fluid volume resuscitation because the burn injury creates a systemic inflammatory response that affects both injured and noninjured tissues. Fluid resuscitation is used to restore intravascular volume and maintain perfusion. Estimation of initial fluid resuscitation requirements in the first 24 hours after burn injury can be calculated by the following equation:

IV Fluid Volume (in Milliliters)
= Body Weight (in Kilograms)
× Percentage of TBSA Burn
× 3 to 4 mL of Lactated Ringer Solution

Half of the estimated IV fluid volume is given in the first 8 hours and the remaining half during 16 hours.

- On the basis of some research evidence (7)(8) and consensus, contemporary wound care management for a 5% TBSA partial-thickness burn includes antimicrobial ointments, such as silver sulfadiazine, biocomposite temporary skin substitutes, and silver ion–impregnated, flexible, self-adhesive dressings.

- On the basis of some research evidence (5)(8)(9) and consensus, indications for referral to a regional burn center include full-thickness burns; partial-thickness burns greater than 10% TBSA; electrical or chemical burns; inhalational injury; associated traumatic injuries or comorbid conditions; burns to the face, hands, feet, genitalia, or joints; suspected intentional injury; and burns that exceed local specialist or institutional capacity.

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New Minimum Performance Level Requirements

Per the 2010 revision of the American Medical Association (AMA) Physician's Recognition Award (PRA) and credit system, a minimum performance level must be established on enduring material and journal-based CME activities that are certified for *AMA PRA Category 1 Credit™*. In order to successfully complete 2013 *Pediatrics in Review* articles for *AMA PRA Category 1 Credit™*, learners must demonstrate a minimum performance level of 60% or higher on this assessment, which measures achievement of the educational purpose and/or objectives of this activity.

In *Pediatrics in Review*, *AMA PRA Category 1 Credit™* may be claimed only if 60% or more of the questions are answered correctly. If you score less than 60% on the assessment, you will be given additional opportunities to answer questions until an overall 60% or greater score is achieved.

1. A 14-year-old girl is seen in the emergency department after she spilled hot liquids from a large pot filled with beef stew that she was preparing for her family. She has reddened skin and blisters over the right arm, anterior chest, abdomen/pelvis, and right thigh. Which of the following estimates of total body surface area involvement is most accurate?
   A. 9%.
   B. 18%.
   C. 27%.
   D. 36%.
   E. 45%.

2. For the girl in question 1, who has reddened skin and blister burns, after how many days should one expect the wound to epithelialize?

   A. 3 to 5.
   B. 5 to 7.
   C. 7 to 14.
   D. 14 to 21.
   E. 21 to 28.

3. A 3-year-old child who is rescued from a house fire and has soot in the nose and mouth is suspected of having an inhalational injury. Which of the following carboxyhemoglobin levels puts him at high risk for requiring mechanical ventilation?

   A. 2%.
   B. 4%.
   C. 6%.
   D. 8%.
   E. 10%.

4. A 6-year-old girl has partial-thickness burns after a space-heater contact injury. The emergency department physician and primary care physician confer to determine management. How extensive should this type of burn be regarding total body surface area to mandate intravenous fluid resuscitation?

   A. >3%.
   B. >5%.
   C. >7%.
   D. >10%.
   E. All partial-thickness burns.

5. A 5-year-old boy has a partial-thickness burn with multiple blisters. Which of the following management plans regarding blisters is most appropriate?

   A. Intact blisters should be left intact regardless of location.
   B. Intact blisters should be dressed with antimicrobial ointment.
   C. Ruptured blisters should be left without debridement.
   D. Ruptured blisters should be unroofed to prevent bacterial trapping.
   E. Ruptured blisters should air dry without antimicrobial entrapment.

Parent Resources From the AAP at HealthyChildren.org

The reader is likely to find material relevant to this article to share with parents by visiting these links:

- English: http://www.healthychildren.org/English/health-issues/injuries-emergencies/Pages/Treating-and-Preventing-Burns.aspx
- Spanish: http://www.healthychildren.org/spanish/health-issues/injuries-emergencies/paginas/treating-and-preventing-burns.aspx
- English only: http://www.healthychildren.org/English/safety-prevention/all-around/Pages/First-Aid-For-Burns.aspx