

# Pediatric



# Initial response, lasting effects

# burns

**Timely assessment and intervention impact your young patient's chances of survival and the subsequent rehabilitation process.**

By Tracy E. Green, BSN, RN, CPN



**2.3**

ANCC  
CONTACT HOURS



ADAM GAULT/GETTY IMAGES

THREE-YEAR-OLD JAMILA SCOTT is rushed into the ED by her mother, who's crying out for help because her child's skin is "coming off." The mother reports to you that she was cooking and Jamila pulled down a pan of hot gravy from the stove onto herself.

You begin the primary survey, including assessment of ABCs, which are intact, to immediately identify and correct life-threatening problems. Jamila is alert and responds to verbal commands, but she's crying because of the pain associated with her burn injuries on her chest and abdomen.

Next, you assess Jamila's burn injuries and observe a large, moist, pink wound extending from the midsternal area to the umbilical region, with some intact fluid-filled blisters. You also observe blistering involving the upper, inner thighs bilaterally sparing the perineum.

You move onto secondary survey. Vital signs are stable: temperature 98.8° orally, heart rate 124 and regular, respirations 28/minute without dyspnea, and BP 110/65. Jamila

reports her pain intensity score as “Hurts Whole Lot” by choosing Face 5 on the Wong-Baker FACES Pain Rating Scale.

You obtain peripheral vascular access with a 20-gauge I.V. catheter using Jamila’s upper left extremity and obtain blood specimens for lab testing. You initiate an infusion of lactated Ringer solution (LR), as prescribed by the attending physician, and based on evaluation of the extent of Jamila’s burn injury.

You quickly obtain Jamila’s health history from her mother, including information about the circumstances surrounding Jamila’s burn injury, and complete the physical assessment.

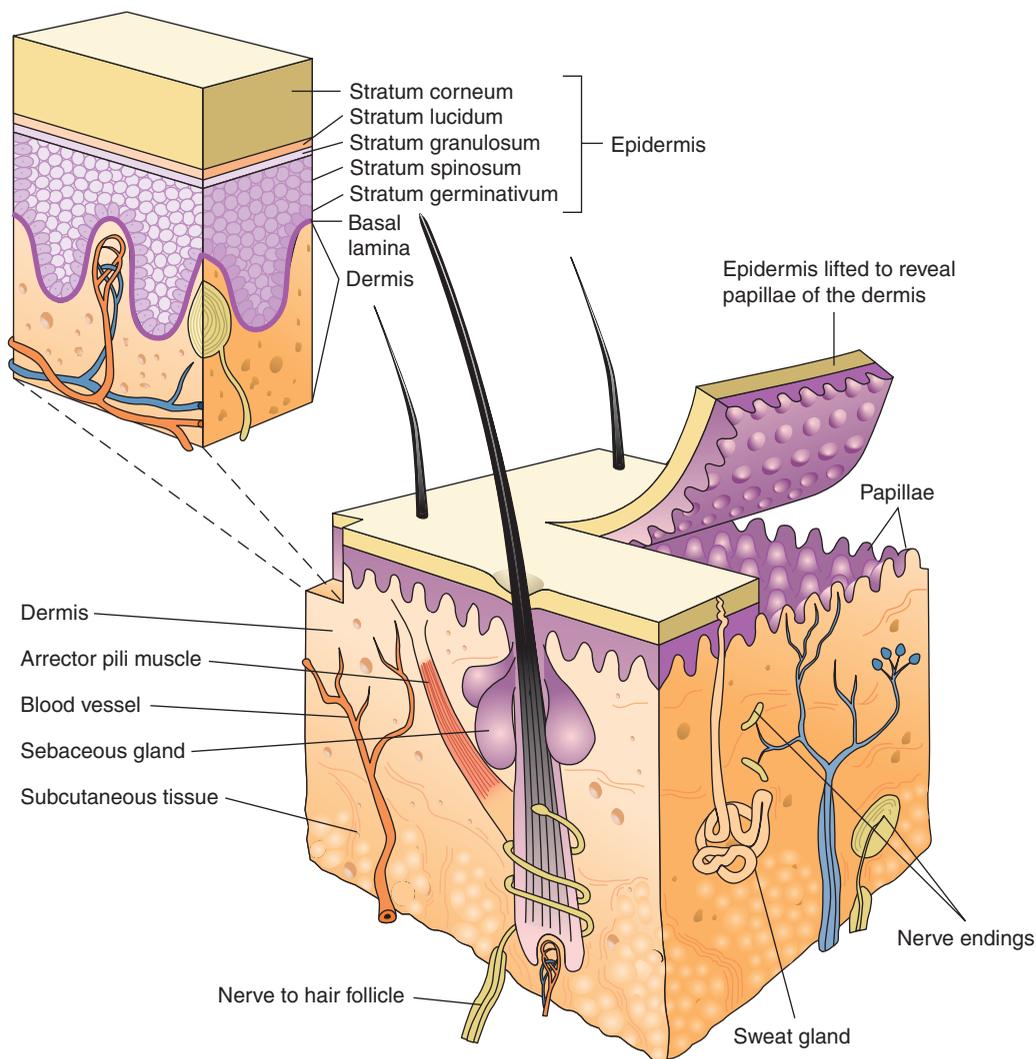
What should you do next?

Because burn centers aren’t widely available, many children with burns are initially seen in a local community ED or urgent care facility. Clinicians with a firm knowledge of basic burn wound assessment and management can

dramatically improve the level of care provided during the initial stage of treatment (see *So what’s a burn?*). This article discusses mechanisms of burn injury, burn injury depth and extent assessment, fluid resuscitation, and pain management for patients like Jamila. You’ll also learn when to initiate referral to a burn center. A timely referral significantly improves your young patient’s chances of survival and successful rehabilitation.

### Layers of protection

The skin is composed of three layers: the epidermis (outer layer), the dermis (inner layer), and the subcutaneous fat layer. The basal lamina (basement membrane) divides the first two layers. The subcutaneous tissue, a layer of loose connective and fatty tissue, binds the dermis to the underlying tissues of the body and supports the blood vessels and nerves that pass from the underlying tissues to the dermis.



## Common but usually preventable

Pediatric burns are the third leading cause of injury-related deaths of children age 9 and younger.<sup>1</sup> In many instances, burns involving children are preventable, associated with poor adult supervision, child inquisitiveness, inability to get away from the burning agent, or intentional abuse.<sup>2</sup> Of the burn types, thermal burns are the most common in childhood; scald burns from hot liquids cause 80% of all thermal injuries involving pediatric patients.<sup>1</sup> Flame burns are more common in older children.<sup>2</sup>

## Pathophysiology of burns

The skin is the human body's first line of defense, protecting against infections, regulating body temperature, and preventing body fluid loss. (See *Layers of protection*.)

A major burn injury can adversely impact all organ systems, depending upon the depth and extent of the burn injury, and the temperature and duration of exposure to the heat source.<sup>3</sup>

Each burn wound consists of three local zones of injury:

- The *zone of coagulation* is located at the center of the burn injury and contains necrotic tissue.<sup>4</sup>
- The *zone of ischemia/stasis* is the zone of microvascular injury that immediately surrounds the zone of coagulation and contains tissue that is oxygen/nutrient deprived. This tissue can survive with adequate fluid resuscitation and prevention of infection. However, without proper fluid resuscitation, this tissue can become necrotic.<sup>4</sup>
- The *zone of hyperemia* surrounds the zone of ischemia. It's a zone of vasodilation and increased perfusion due to biochemical mediators released during the acute inflammatory response to injury in adjacent tissue.<sup>4</sup>

## Do the ABCs

The severe appearance of a burn may draw your attention to the



## Scald burns from hot liquids cause 80% of all thermal injuries involving pediatric patients.

wound at first, but as always, remember your ABCs. The initial assessment of airway, breathing, circulation, disability, and exposure/environment remain the same for any trauma patient. According to the American Burn Association's (ABA's) Advanced Burn Life Support (ABLS) protocol, you should rapidly assess the pediatric patient's airway while protecting the cervical spine.<sup>5</sup>

If your patient is unresponsive or the airway is compromised, maintain a patent airway by using a head tilt-chin lift maneuver or by using a jaw thrust maneuver if head or neck trauma is suspected. As indicated, to maintain the airway, use basic airway adjuncts, such as an oropharyngeal or nasopharyngeal airway, or assist with insertion of an advanced airway device, such as an endotracheal tube.

Keep in mind that airway edema may not pose a threat until 48 hours postburn injury. Because of their much smaller airways, pediatric patients should be endotracheally intubated as soon as possible if airway compromise is likely.<sup>1</sup> Evaluate the patient's respiratory status by assessing the rate, depth, and quality of respirations, as well as exposing the patient's chest and observing chest wall movement, and auscultating bilateral breath sounds.<sup>5</sup> ABLS guidelines recommend providing 100% oxygen via non-rebreathing mask to every burn victim.<sup>5</sup>

Be aware that circumferential burns involving the chest may compromise respiratory status. Observe for signs suggesting an inhalation injury, such as singed eyebrows or nasal hairs. (See *Signs of inhalation injury*.)<sup>6</sup>

While maintaining an open airway, assess circulation status, including the presence, quality, rate, and rhythm of pulses. Assess for signs of hypoperfusion, such as capillary refill time.

After stabilizing your patient, assess for disability by evaluating neurologic status. ABLS protocol recommends using the mnemonic AVPU to assess level of consciousness.<sup>5</sup> Is your patient alert? Does your patient respond to verbal or painful stimuli? Or is he or she unresponsive?

Most burn patients are alert and oriented. If the patient seems in any way neurologically impaired, assess for burn-associated injuries, such as hypoxemia, carbon monoxide poisoning, or other evidence of smoke inhalation. Other possible causes of neurologic impairment include drug abuse or a pre-existing medical problem.<sup>5</sup>

### So what's a burn?<sup>5</sup>

"...a burn is defined as an injury to the skin or other organic tissue primarily caused by thermal or other acute trauma. It occurs when some or all of the cells in the skin or other tissues are destroyed by hot liquids (scalds), hot solids (contact burns), or flames (flame burns). Injuries to the skin or other organic tissues due to radiation, radioactivity, electricity, friction, or contact with chemicals are also identified as burns."

During the exposure/environment phase of the primary survey, remove the patient's clothing but keep burn wounds covered to prevent heat loss. Skin that's no longer intact can't maintain the patient's temperature.<sup>6</sup> Keep the environment warm.

Assess your patient for other potentially life-threatening injuries. If circumferential burns involving the extremities are present, prepare for possible escharotomy to restore compromised perfusion.<sup>1</sup> (See *All about escharotomy*.)

### Get the details

After completing the primary survey, perform a systematic and complaint-focused physical assessment to look for other possible life-threatening injuries.

Obtain vital signs and assess for pain or discomfort. Insert a large-bore vascular access device, such as an 18- or 20-gauge short peripheral catheter. You may need to place the device through burned skin if no other sites are available. Or, if the patient is severely burned, the healthcare provider may insert an intraosseous device for vascular access, which can be used for fluid resuscitation and medication administration, as well as for initial blood sampling.

Gather details of when, where, and how the burn injury occurred and events surrounding the incident.<sup>5</sup> If your assessment findings lead you to suspect a nonaccidental burn injury, contact your facility's social services department and local child protective team for further investigation. (See *Suspicious burn injuries in children*.)<sup>6</sup>

Obtain a brief health history, including information about the child's allergies, medications, time of the last food and fluid intake, and immunization



### Gather details about when, where, and how the burn injury occurred and events surrounding the incident.

status, especially date of last tetanus immunization.

Provide tetanus prophylaxis according to current recommended guidelines:

- If the patient hasn't received a tetanus immunization within the last 5 years, give a tetanus booster.<sup>1</sup>
- For children under age 7, administer DTaP (diphtheria, tetanus, and acellular pertussis).<sup>1</sup>
- For patients younger than age 7 who shouldn't receive pertussis vaccine—for example, because they've had a reaction to pertussis vaccine in

the past—administer DT (diphtheria and tetanus toxoid).<sup>2</sup>

- Children 7 years and older should receive Td (tetanus toxoid and adult diphtheria). Td is similar to DT, but it has a lower concentration of diphtheria toxoid than DT. Per the CDC, Td is used for routine 10-year boosters.

- Children who've never been immunized against tetanus should receive tetanus immune globulin for immediate immunity and tetanus vaccine for longer-term immunity.<sup>1</sup>

Review the results of your patient's lab work, including the complete blood cell count, comprehensive metabolic panel, urinalysis, and arterial blood gases, that can provide valuable information about your patient, including fluid volume status, electrolyte balance, acid-base imbalances, renal function, and oxygenation.

### Delving deeper: Wound classification

A child's skin is thinner than that of an adult. Burn wounds are classified by mechanism of injury (for example, thermal, chemical, electrical), depth of burn injury (see *Burn depth and classification*), and total body surface area (TBSA) involved.

**Superficial or epidermal burns**—formerly known as first-degree burns—involve the epidermis only. Superficial burns are red, painful, and don't blister; a common example is a sunburn.<sup>6</sup>

**Partial-thickness burns**, previously known as second-degree burns, involve the epidermis and portions of the dermis and can be further classified as superficial partial-thickness or deep partial-thickness.<sup>6</sup>

- **Superficial partial-thickness burns** characteristically form blisters between the epidermis and dermis, which may not appear for some hours after the injury.<sup>5</sup> Pain is severe compared to a superficial burn.

- **Deep partial-thickness burns** extend deeper into the lower layers of the dermis.<sup>5</sup> These wounds are also very painful.

**Full-thickness (third-degree) burns** involve all layers of the dermis and often involve underlying subcutaneous adipose tissue as well.<sup>5</sup> These burns are usually black, brown, or white, and look leathery and dry.<sup>6</sup> They may not be painful due to destruction of pain nerve

### Signs of inhalation injury<sup>6</sup>

- singed eyebrows or nasal hairs
- stridor or hoarseness
- carbonaceous sputum
- burns near mouth or nose
- edematous lips
- black nasal or oral secretions
- facial burns
- hypoxemia
- history of enclosure in smoke-filled area

receptors, but the patient may have significant pain in surrounding tissue. Some full-thickness burns not only involve all skin layers, but extend into deeper structures such as muscle, tendon, ligament, and bone. These are classified as deep full-thickness burns.<sup>5</sup>

Burns may be difficult to classify due to varying depths of a single-burn injury. For example, a full-thickness burn may be surrounded by a deep partial-thickness burn.<sup>6</sup> Also, the full extent of injury may not be determined for 24 to 48 hours.<sup>6</sup> For example, a burn injury initially assessed as a deep partial-thickness burn may progress to a full-thickness burn after a few days, possibly due to inadequate fluid resuscitation.

After identifying the mechanism of injury and depth of burn injury, estimate the extent of burn injury. The extent of burn injury is expressed as a numerical value indicating a calculated percentage of TBSA injured by partial-thickness or full-thickness burns. Therefore, when

### Suspicious burn injuries in children<sup>6</sup>

These assessment findings suggest possible child abuse.

- any burn injury involving a child
- burns in a pattern
- history and physical findings inconsistent with the burn injury
- burn injuries incompatible with child's developmental level
- burns to buttocks, perineum, or genitals
- excessive delay in seeking treatment
- burns involving immersion into hot tap water
- multiple old and new burns in different stages of healing
- presence of splash marks, areas of skin that weren't burned, and burns that are symmetrical in a stocking or glove distribution
- burns involving the bottom of the feet
- presence of other nonburn injuries.

### All about escharotomy<sup>5</sup>

**Definition:** An escharotomy is a surgical incision through burn eschar (necrotic skin). This procedure is usually performed within the first 24 hours of burn injury. Burn eschar has an unyielding, leathery consistency and is characterized by denatured proteins and coagulated vessels in the skin, which are the result of thermal, chemical, or electrical injury.

**Purpose:** When the burn eschar circumferentially surrounds any body structure (including digits, extremities, abdomen, chest, or neck), the tissues within are subject to increasing interstitial pressures exacerbated by tissue edema that develops during the acute phase of burn resuscitation in the first 48 hours after injury. As interstitial pressure rises, venous outflow is initially impaired, followed by diminution of arterial inflow. This condition, often termed *compartment syndrome*, will cause dysfunction, ischemia, or necrosis within or distal to that body structure, often within hours. In the limbs, nerve and muscle cellular death may occur causing permanent functional impairment or even the need for amputation. In the abdomen, impaired blood supply to the bowels, kidneys, and other internal organs results in the rapid onset of intestinal ischemia, renal and hepatic failure, and restriction of diaphragmatic excursion. Compression of the chest by burn eschar worsens pulmonary compliance associated with smoke inhalation injury.

calculating TBSA, exclude superficial burns.<sup>6</sup> The TBSA is the basis for determining fluid resuscitation requirements.

The rule of nines, which divides the body into areas of 9% and provides a gross estimate of TBSA, is useful for adults, but not very accurate for children. You can use the patient's palm to estimate TBSA when burns are small or patchy and are distributed over multiple surfaces. The patient's palm defines approximately 1% of TBSA.<sup>7</sup>

Consider using a Lund-Browder diagram because it takes into consideration the patient's age (specific categories for birth to 1 year; 1 to 4 years; 5 to 9 years; 10 to 14 yrs; 15 years; and adult) and associated body surface area.<sup>3</sup>

Not all pediatric patients need I.V. fluid resuscitation. Some children with burns of less than 15% TBSA may be treated with oral rehydration and I.V. fluid supplementation.<sup>8</sup>

### Balancing act: Fluid resuscitation

The ultimate goal of fluid resuscitation is to maintain tissue perfusion to the zone of ischemia to prevent destruction of salvageable tissue and expansion of burn wound injury.<sup>9</sup>

Many fluid resuscitation formulas are available, but the ABA recommends the Parkland Burn formula: isotonic I.V. fluids, such as LR or 0.9% sodium chloride, 4 mL/kg body weight/percentage of TBSA burn. LR is preferred because of its distinct advantages over 0.9% sodium chloride. For example, LR has a much lower sodium content (130 mEq/L versus 154 mEq/L) as well as a higher pH (6.5 versus 6.0), which is closer to normal arterial pH (7.4).<sup>4</sup> In addition, LR contains lactate (28 mmol/L), a buffering agent that may alleviate metabolic acidosis, a common complication of burns.<sup>4</sup>

Children age 6 months to 5 years should also receive maintenance fluid containing dextrose, such as D5LR, to prevent hypoglycemia.<sup>6,7</sup> For example, a 3-year-old, 15-kg child with superficial partial-thickness burns involving the anterior trunk and right and left upper arms (TBSA of approximately 20%) will require 1200 mL of fluid resuscitation (0.9% sodium chloride or LR), plus a maintenance infusion of a solution containing dextrose for the first 24 hours.

Following the formula guidelines, administer half the calculated volume in the first 8 hours postburn

## Burn depth and classification<sup>1,5,6,7</sup>

Burn wound depth	Level of skin injury	Characteristics	Time to heal
Superficial or epidermal	Epidermis	Erythema, pain 2 to 3 days, minor skin changes; no blisters	Injured epithelium peels away from newly healed epidermis below it, usually by day 4
Superficial partial-thickness and deep partial-thickness	Epidermis and portions of the dermis	<b>Superficial:</b> Erythema, pain, and blisters; weeping, moist appearance; bleeds easily <b>Deep partial-thickness:</b> white or pale, also painful	<b>Superficial:</b> most heal spontaneously in less than 3 weeks <b>Deep partial-thickness:</b> If not infected, will heal in 3 to 9 weeks; hypertrophic scarring common; best treated by excision and grafting
Full-thickness	Epidermis and entire dermis; often injure underlying subcutaneous adipose tissue; deep full-thickness burns may involve deeper structures such as muscle, tendon, ligament, and bone	May be black, brown, white, dry, or charred. Lack of pain or touch sensation, leathery texture without capillary refill. Doesn't bleed.	Without surgery, heal only by wound contracture and epithelialization from the wound margins. Deep full-thickness burns may require amputation

injury and administer the remaining volume divided equally over the next 16 hours.

Closely monitor the patient for signs and symptoms of fluid volume overload, and adjust the rate of fluid resuscitation to achieve urine output of 0.5 to 1 mL/kg/hour.

### Under control: Pain management

Inadequate pain control can increase emotional distress for the patient and family members involved in their child's care. Perform a comprehensive pain assessment, including use of an age- and developmentally appropriate pain intensity rating tool. Older children and teenagers can use the numeric pain intensity scale to quantify pain on a scale from 0 (no pain) to 10 (worst possible pain). The Wong-Baker FACES pain rating scale is appropriate for children age 3 years and older. The FLACC pain scale, commonly used for children younger than age 3, assesses Facial expression, Leg movement, Activity, Cry, and Consolability.<sup>10</sup>

Superficial burns such as sunburns are usually treated with topical anesthetics and oral analgesics,

such as ibuprofen or acetaminophen.<sup>6</sup> Children with superficial burns rarely meet hospital admission criteria. On the other hand, superficial partial-thickness, deep partial-thickness, and full-thickness burns require a more aggressive approach often including the use of I.V. opioids, such as morphine sulfate.<sup>6</sup>

When administering these opioids, closely monitor the patient's sedation level and respiratory status, and have an opioid antagonist, such as naloxone, immediately available.<sup>6,11</sup>

Some experts recommend patient-controlled analgesia pump usage in children age 8 years and older, and short-acting anesthetic agents.<sup>3</sup>

Don't forget to provide nonpharmacologic interventions in addition to pharmacologic interventions, such as distraction and guided imagery to help alleviate pain.

### Referral guidelines

Healthcare providers working in local EDs, urgent care facilities, and primary care offices should follow the ABA's criteria for referral to a

### Burn center referral criteria<sup>5</sup>

- any patient with partial-thickness burns involving more than 10% TBSA
- any patient with burns to the face, hands, feet, genitalia, perineum, or major joints
- any patient with third-degree burns, regardless of age
- any patient with chemical and/or electrical burns, including injury by lightning
- any patient with inhalation injury
- any patient with concomitant medical problems that could exacerbate management, recovery, or mortality
- any patient with burns and concomitant trauma in that the burn injury presents the greatest risk
- burned children in hospitals without qualified staff or equipment to care for children
- any patient who will need specialized social, emotional, or long-term rehabilitation as a result of burn injuries.

burn center (see *Burn center referral criteria*). If referral is indicated, the referring facility needs to contact the regional burn center for patient transfer. Fluid resuscitation should begin before transfer and continue en route to the burn center. Wound debridement shouldn't be attempted if referral to the burn center occurs within 24 hours of injury.

The patient should remain covered during transport. The ABA recommends using a clean, dry sheet or blanket to prevent heat loss. Don't apply creams, ointments, ice, or cold water to burns, and leave all blisters intact.<sup>5</sup>

If referral to a burn center is delayed more than 24 hours postinjury, contact the burn center for further instructions regarding wound care. In this case, the ABA recommends the following interventions:

- Debride blisters more than 2 cm in diameter.

- Clean burn wounds with chlorhexidine gluconate antibacterial soap.
- Rinse soap from wound and apply an antibacterial cream such as silver sulfadiazine or mafenide acetate cream.
- Wrap with gauze dressing.<sup>5</sup>

### Steady steps

Caring for a pediatric burn patient presents special challenges. Remembering key trauma protocols, providing fluid resuscitation based on TBSA, and ensuring proper referral to a regional burn center can make a huge difference in your pediatric patient's outcome. ■

#### REFERENCES

1. Reed JL, Pomerantz WJ. Emergency management of pediatric burns. *Pediatr Emerg Care*. 2005;21(2):118-129.
2. Hazinski MF, Mondozi MA, Baker RA. Shock, multiple organ dysfunction syndrome, and burns in children. In: McCance KL, Huether SE, eds. *Pathophysiology: The Biologic Basis for Disease in Adults and Children*. St. Louis, Mo: Elsevier Mosby; 2006:1655-1680.
3. Merz J, Schrand C, Mertens D, Foote C, Porter K, Regnold L. Wound care of the pediatric burn patient. *AACN Clin Issues*. 2003;14(4):429-441.
4. Oliver RI, Spain D, Stadelmann W. Resuscitation and early management of burns. *Emedicine*. <http://www.emedicine.com>.
5. American Burn Association. *Advanced Burn Life Support*. Chicago, IL: American Burn Association; 2007.
6. DeBoer S, O'Connor A. Prehospital and emergency department burn care. *Crit Care Nurs Clin North Am*. 2004;16(1):61-73.
7. Sidor MI, Benson BE, Schwartz RA, Desposito F, Lucchesi M. Thermal burns. *Emedicine*. <http://www.emedicine.com>.
8. Schulman CI, King DR. Pediatric fluid resuscitation after thermal injury. *J Craniofac Surg*. 2008;19(4):910-912.
9. Hettiaratchy S, Papini R. Initial management of a major burn: assessment and resuscitation. *BMJ*. 2004;329(7457):101-103.
10. Willis MH, Merkel SI, Voepel-Lewis T, Malviya S. FLACC behavioral pain assessment scale: a comparison with the child's self-report. *Pediatr Nurs*. 2003;29(3):195-198.
11. Mowery BD, Suddaby E, Kang KA, Cooper L. The art of procedural sedation and analgesia. *Pediatr Nurs*. 2008;34(6):490-492.

Tracy E. Green is a certified pediatric nurse at Tampa General Hospital, in Tampa Fla.

The author has disclosed that she has no financial relationships related to this article.

DOI-10.1097/01.NURSE.0000383896.57848.7a

> For more than 38 additional continuing-education articles related to pediatric topics, go to [Nursingcenter.com/CE](http://Nursingcenter.com/CE). <

**CE CONNECTION** Earn CE credit online: Go to <http://www.nursingcenter.com/CE/nursing> and receive a certificate within minutes.

INSTRUCTIONS

### Pediatric burns: Initial response, lasting effects

**TEST INSTRUCTIONS**

- To take the test online, go to our secure Web site at <http://www.nursingcenter.com/ce/nursing>.
- On the print form, record your answers in the test answer section of the CE enrollment form on page 50. Each question has only one correct answer. You may make copies of these forms.
- Complete the registration information and course evaluation. Mail the completed form and registration fee of \$21.95 to: **Lippincott Williams & Wilkins, CE Group**, 2710 Yorktowne Blvd., Brick, NJ 08723. We will mail your certificate in 4 to 6 weeks. For faster service, include a fax number and we will fax your certificate within 2 business days of receiving your enrollment form.
- You will receive your CE certificate of earned contact hours and an answer key to review your results. There is no minimum passing grade.
- Registration deadline is August 31, 2012.

**DISCOUNTS and CUSTOMER SERVICE**

- Send two or more tests in any nursing journal published by Lippincott Williams & Wilkins together by mail, and deduct \$0.95 from the price of each test.
- We also offer CE accounts for hospitals and other healthcare facilities on nursingcenter.com. Call **1-800-787-8985** for details.

**PROVIDER ACCREDITATION**

Lippincott Williams & Wilkins, publisher of *Nursing2010* journal, will award 2.3 contact hours for this continuing nursing education activity.

Lippincott Williams & Wilkins is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center's Commission on Accreditation.

Lippincott Williams & Wilkins is also an approved provider of continuing nursing education by the District of Columbia and Florida #FBN2454. This activity is also provider approved by the California Board of Registered Nursing, Provider Number CEP 11749 for 2.3 contact hours.

Your certificate is valid in all states.

The ANCC's accreditation status of Lippincott Williams & Wilkins Department of Continuing Education refers only to its continuing nursing educational activities and does not imply Commission on Accreditation approval or endorsement of any commercial product.