LESSONS FOR PRACTICE:
- Burned patients should be kept warm & dry at all times
- Lactated ringers is the fluid of choice for resuscitation of the pediatric burn patient
- Aggressive airway management should occur early with suspected inhalation injury
- Transfer to a verified pediatric burn center should occur as quickly as possible if indicated

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PEDIATRIC BURN CARE

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Introduction

Each year more than 45,000 Americans are admitted to the hospital with a burn injury. Of these patients admitted, children under 5 account for 17% of the cases. Fluid choice and amount is essential when considering resuscitation techniques in pediatric patients. Fluid resuscitation is based on dry weight and patient response; burn care is not “one size fits all”, and should be individualized. Specialized care of these patients begins in the pre-hospital setting, and care within the first hours can impact overall outcomes for the burn patient.

Caring for the Pediatric Burn Patient

Determining severity.  The depth of burns is based on intensity and duration of thermal exposure. Superficial burns (1st degree) are erythematous and painful. Only the outer layer of epidermis is involved and fluid loss is not an issue. First degree burns heal without scarring in 4–5 days (Fig 1). Partial thickness, or 2nd degree burns, are classified as superficial partial thickness and deep partial thickness. Superficial partial thickness 2nd degree burns appear red and painful with blister formation. There is partial destruction of dermis and they have a weeping/moist appearance. Healing occurs in 7–10 days with minimal scarring (Fig 2). Deep partial thickness 2nd degree burns involve greater than 50% of the dermis being lost. The skin appears white, pale and may be less painful as nerve fibers are destroyed. These burns take 2–3 weeks to heal with severe scarring and may require skin grafting. Full thickness or 3rd degree burns appear white, waxy and leathery. These burns have no bleeding and are painless (Fig 3). There is a high risk of infection and fluid loss with 3rd degree burns.

Calculating total body surface area (TBSA).  In pediatric patients, the modified “rule of nines” is utilized based on the body surface area of the pediatric patient. Pediatric patients typically have larger heads than the adult patient, therefore burns involving the head/scalp equate to a possible 18% TBSA. This is compared to the 9% in the adult. The legs in a child represent 14% TBSA as opposed to the adult 18% (see figure XX).

Initial management.  The initial management of any burn patient is similar in any age group. The primary, initial goal is to stop the burning process, which is done by the pre-hospital providers. If the burn is thermal in nature, you want to ensure that the source of fire is removed from the patient. If chemical, contact poison control for specific treatment information related to the specific chemical, but initial decontamination is essential. Patient should be rinsed with copious amounts of fluid. Protect yourself and make sure that as a healthcare provider, you are maintaining body substance precautions. For every chemical burn, immediate removal of the contaminated clothing (including under-wear, gloves, shoes, jewelry and belongings) is critical. This is not only clothing related at the injury site, but all jewelry and clothing should be removed early to prevent constriction. Keep the patient warm and DRY at all times. Once clothing is removed, ensure the patient is in a warm environment to prevent chills. Finally, ensure to obtain the complete history of the injury event and ensure to evaluate for associated injuries. Often the focus of care is aimed at the burn, but there may be other injuries present based on mechanism. For example, if the patient jumped from a building to escape a fire, there could be injuries to the lower extremities or spine.

*Keep the patient warm and dry, obtain complete history and evaluate for associated injuries*

![Figure 1](image1.png)
![Figure 2](image2.png)
![Figure 3](image3.png)
Airway management. Aggressive and appropriate airway management must be considered early in the care of the pediatric burn patient. Because of the nature of the pediatric airway, even minimal swelling can cause for difficult definitive airway intervention when needed. All patients should be placed on 100% oxygen during the initial assessment period. Inhalation must be considered if:

- Injury occurred in an enclosed space
- Presence of facial burns, singed nasal hairs, carbonaceous sputum, soot on teeth or tongue, inflamed oral airway (consider administration of CYANOKIT®)

Airway assessment should occur frequently during the care of the burn patient. Airway status can change quickly and staff should be prepared to intervene quickly. To assess for airway distress, the clinician should have a high suspicion for inhalation injury if the following signs and symptoms are present:

* Rapid respiratory rate * Stridor
* Agitation * Cyanosis
* Hoarse voice or cry

*If inhalation injury is suspected, consider early intubation**

Carbon monoxide and cyanide. The potential for carbon monoxide poisoning mandates that a carboxyhemoglobin level be obtained in all patients with moderate or severe burns. Standard pulse oximetry is not reliable with significant carbon monoxide toxicity. A standard arterial blood gas reports the concentration of oxygen dissolved in blood and cannot be used to establish or rule out the diagnosis of carbon monoxide or cyanide poisoning.

An invisible, odorless gas, carbon monoxide has a much stronger affinity for hemoglobin than does oxygen (Figure 5), thus leading to a tremendous reduction in the oxygen-carrying capacity. The shortage of oxygen at the tissue level is made worse by a concomitant leftward shift of the oxyhemoglobin dissociation curve.

CyanoKits should be administered to patients presumptively. Any patient who has had an inhalation of smoke in a closed space, has the presence of hypotension, lactate level > 10, high venous O2 and may have an almond odor should have a CyanoKit administered. CyanoKits contain Hydroxocobalamin which binds with cyanide to create vitamin B12 (cyanocobalamin). Cyanocobalamin, once formed, is non-toxic and excreted by the kidneys. Side effects of the CyanoKit may include reddish flush to skin, urine and mucous membranes. CyanoKits may interfere with some lab studies (glucose, iron and creatinine). No allergic reactions to hydroxocobalamin have been documented.
**Fluid resuscitation.** Accurate and thoughtful fluid resuscitation is vitally important to the successful resuscitation of the pediatric burn patient. Fluid volumes are based on patient weight, not age, and the total burn surface area affected. Fluid resuscitation should be considered as primary management goal in all patients suffering 2nd and 3rd degree burns over 20% TBSA. Lactated ringers solution should be the first choice for fluid resuscitation in the pediatric burn patient, as lactated ringers is pH neutral and contains less chloride than normal saline solution. The steps to fluid resuscitation and calculation are as follows:

- Place 2 large bore IVs (attempt in non-burn, may place through burned skin if necessary)
- Calculate total body surface area burn (TBSA) (based on the Rule of Nines – See figure XX)
- **Parkland Formula for Adults (>15 years)**
  - LACTATED RINGERS 2mL X kg of body weight X TBSA
- **Parkland Formula for infants and children**
  - LACTATED RINGERS 3-4mL X kg of body weight X TBSA
- Infants <1 year old need maintenance fluid with dextrose (D5LR)
  - For the 1st 10kg of body weight 100cc/kg/24hrs
  - For the 2nd 10kg of body weight 50cc/kg/24hrs
  - For each remaining kg of body weight above 20 kg 20cc/kg/24hr
- This fluid should be in combination with maintenance fluids. Maintenance fluids should NOT be titrated based on urine output or vital signs.
- ***Monitor glucose in infants and small children***

Administer ⅓ of the RESUSCITATION fluid over the first 8 hours and the remaining over the next 16 hours.

The primary goal of fluid resuscitation is to achieve adequate organ tissue perfusion. Fluid administration should be titrated to maintain a urine output of 1 mL-2 mL/kg per hour. Approximately 50% of administered fluid is sequestered in non-burned tissues in 50% TBSA burns, owing to the increased capillary permeability that occurs particularly in the first 6 to 8 hours after injury. During this period, large molecules leak into the interstitial space to increase extravascular colloid osmotic pressure. Therefore, to maintain intravascular osmotic pressure, albumin may be added. Children younger than two years are susceptible to hypoglycemia due to limited glycogen stores, therefore special consideration to the monitoring of glucose levels should be given.

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**Maintenance fluid.** Determining maintenance fluid in a child can be challenging. Careful consideration and calculation of the maintenance fluid rate is necessary to prevent over hydration in pediatric patients. A simple formula can be utilized to determine an hourly rate. Commonly referred to as the 4:2:1 rule, the formula is utilized using the patient’s weight as a guide. Volumes are calculated using a weight-based infusion rate: for the first 10 kg, 4 mL/kg/h, for the next 10 kg, 2 mL/kg/h and 1 mL/kg/h for each kilogram thereafter. Examples of the application of the 4:2:1 rule are shown in Figure 6.

**Formula:** \[4 : 2 : 1\] rule for calculating fluid maintenance

\[
4 \text{(1st 10 kg)} + 2 \text{(2nd 10 kg)} + 1\text{(any >20kg)}
\]

For example:

- Child weighing 3 kg:
  \[4(3) = 12 \text{ mL/hr.}\]
- Child weighing 15 kg:
  \[4(10) + 2(5) = 50 \text{ mL/hr.}\]
- Child weighing 30 kg:
  \[4(10) + 2(10) + 1(10) = 70 \text{ mL/hr.}\]
- Child weighing 45 kg:
  \[4(10) + 2(10) + 1(25) = 85 \text{ mL/hr.}\]
Standard Approach

Resuscitation algorithm. Following a defined algorithm as it relates to resuscitative efforts of the pediatric burn patient can avert confusion and prevent under-resuscitation/fluid overload. A predetermined and systematic approach to the injured child guarantees recognition of life-threatening injuries and provides a method for rapid stabilization. See Fig 7 for a resuscitation algorithm example.
Wound Care.

All burns should be cleansed with a mild bar of soap. Washcloths and a gloved hand are the best debridement tools to utilize for cleaning. Make sure all blisters larger than 1 inch are removed. During debridement, all loose skin should be removed. Around hand, fingers and feet, you may need to use scissors or tweezers to assist in removal of skin. If the burns are full thickness, removal of dead skin will need to be done surgically. Burns need to be shaved as well as a one inch border surrounding the wound. Do not shave eyebrows since they may not grow back. Do not use shaving cream as it contain alcohol and will irritate the patient’s already painful wounds.

Supplies. Prior to debridement of the burn, gather all supplies. These would include:
- Mild bar soap
- Water
- Wash cloths
- Towels
- Tub or basin for water
- Scissors
- Tweezers or pick-ups
- Razors
- Clean linens for bed
- Clean gloves, gowns, mask, hat, and eye protection

Cleansing. When washing a wound you want to make sure that you always use a mild soap. This means no fragrance as well as pH balanced. Some examples of this would be Dial or Ivory. You will need clean dry towels, as well as wash cloths both wet and dry. Make sure that your basin is filled with warm water, cold water is not recommended as it can cause vasoconstriction. You will want to make sure that you have a variety of scissors and tweezers, small and large. You will need a few razors for shaving. Remember to always maintain universal precautions especially during debridement when there is a greater risk for exposure.

During initial debridement and cleaning you need to maintain universal precautions for the cleaning procedure, wash your hands, and don clean gloves, gown, mask, hat and eye protection. Make sure that the patient has received the appropriate pain medication prior to dressing. Make sure that the room temperature is warm as patients have a tendency to drop their temperature during dressing changes. If the patient is a pediatric patient make sure that the wound care is not done in their bed. On a stretcher or in another room, i.e. a procedure room is appropriate placement. Using warm water and soapy wash cloths begin to wash the patient’s skin. Washing in a circular motion will debride dead tissue better than washing back and forth. As you begin to wash away the dead tissue, bleeding may occur, this is good as you are now down to viable tissue. Sometimes not all dead tissue can be removed, especially in the case of full thickness burns, it may need to be surgically debrided. Get a new wash cloth after each area is washed to avoid cross contamination. If the burn is located in an area with hair, and the hair remains intact, the hair needs to be removed, with the exception of eyebrows. Never shave off a patient’s eyebrows. Using mild soap, work up a lather. Shaving cream is alcohol based and will irritate and be painful to the patient. Using a razor, shave the patient’s burned area and approximately 1 inch border around the burn. The hair harbor bacteria and increase the patient’s risk for infection if allowed to grow. After proper debridement, rinse each area with clean water, making sure to remove all soap residue. Pat dry with a clean towel. Once the patient is completely cleaned, change their linens so that they are on clean, dry linen. You are now ready to begin the dressing portion of wound care.

Special considerations. Pseudo eschar is an expected result of a long acting silver-based dressing, it is a brownish yellow layer covering the wound bed. Pseudo eschar is created by the dressing and is a biological protective layer with antimicrobial properties and should not be scrubbed off, but should be gently cleansed with soap and water. Aggressive scrubbing and removal of this layer will increase patient’s time of healing and cause increased pain. In regards to blister follow these simple rules. If there are large blisters that are not intact, use the washcloths or scissors to trim away the dead skin. Iris scissors can be used for smaller areas, such as fingers and toes. If there are small blisters intact on the digits or over joints, leave them intact. If the blisters look like they will open on their own, a good rule is to remove them. Large pieces of dead skin can also be trimmed away with scissors regardless of location.
Burn Type Special Treatment Considerations

**ELECTRICAL**
Cardiac monitor for dysrhythmias or ectopy
Assess for compartment syndrome
Electrical current destroys underlying tissue and may damage muscle
Assess for myoglobinuria (blood in the urine)
Maintain urine output of 75-100cc/hr.
Assess for associated blunt trauma

**CHEMICAL**
Remove clothing
Brush off powder prior to irrigation
Irrigate with copious amounts of water for at least 20 minutes

**FROSTBITE**
Rewarm in water 40-42°C for 15-20 minutes
Do not rub or massage limb
Fluid resuscitation is rarely necessary for isolated frostbite injuries
Consider transfer to a verified burn center for thrombolytic therapy

“Spring is the time of plans and projects”

Leo Tolstoy

**Criteria for transfer.** Due to the nature of burn care and recovery, transport of patients to a verified burn center is key to the long term success and recovery of patients suffering traumatic burn. Burn centers have specially trained personnel to handle not only the initial management of a burn patient, but the ongoing, lengthy emotional and physical recovery of these patients. Many patients may require skin grafts or other operative interventions that are best managed by physicians trained in the specialty of caring for patients suffering from burns. The American Burn Association (ABA) minimally suggests transfer to an ABA verified center in the following circumstances:

- Partial thickness burns that involve the face, hands, feet, genitalia, perineum, or major joints
- Third-degree burns in any age group
- Electrical burns, including lightning injury
- Chemical burns
- Inhalation injury
- Burn injury in patients with preexisting medical disorders
- Any patients with burns and concomitant trauma
- Burned children in hospitals without qualified personnel or equipment for the care of children
- Burn injury in patients who will require special social, emotional or rehabilitative intervention

**Preparing patient for transport**

- Documentation of event leading up to the injury
- Keep the patient WARM and DRY
- Do not apply topical ointment to the wound
- NO wet dressings
- Consider video or photo consultation with receiving physician

**Patient Transfer Number**

1-800-822-2233 OR
734-936-6035
Pediatric Burn FAQs

1. How long does it take for the burn to declare itself?
Once the burn has occurred it takes up to 48-72 hours for the burning process to complete itself. It is essential to stop the immediate source of heat by extinguishing the heat source, removing the patient’s clothing and cleanse the patient’s wounds. After 72 hours, the burn is at its full potential and treatment options should be decided.

2. Should I pop all the blisters?
Not all blisters should be removed. Small blisters that do not look like they are going to spontaneously erupt should be left on for a biological covering. Large blisters that are fluid filled should be removed completely.

3. Should the patient continue to move the affected area?
Range of motion and movement is a priority for burn patients. Ambulating improves both cardiac and pulmonary status; as well as decreasing the risk of deep vein thrombosis, contractures and complications. Range of motion exercises should be completed on all body areas affected to prevent joint tightness/stiffness, contractures, and increase function post injury.

4. What type of diet should the patient have?
Patients with burn injury have an increase metabolic rate due to this patient requiring increased calorie and protein intake. Patients should be on a high calorie/high protein diet. Considerations should be made for patient co-morbidities and calorie counts should be recorded on any patient taking an oral diet. If calorie counts are inadequate or the patient is unable to have an oral diet, considerations should be made for nutrition supplements.

5. Why does the burn hurt?
Burns are an extremely painful injury since with superficial or partial thickness burns the nerve ends are disrupted. Pain is a sign that indicates the burn is not full thickness and should possibly heal without surgical intervention.

6. What type of dressing should be use?
Dressing types are determined by body area affected, pain tolerance, need for long term dressing, need for frequent assessment of the wound. Refer to the wound dressing modules for full details.

7. How often should I change my dressings?
Long acting silver-based dressing duration is 5-7 days. During this time the dressing needs to be kept moist. Silvadene needs to be changed daily and the wound thoroughly washed in between each dressing application.

8. Should you remove all the loose skin prior to dressing?
All the loose skin should be removed utilizing mechanical means and if needed surgical means. Washcloths, scissors and tweezers are the best tools for debridement.

9. Why do you shave the affected area?
All affected areas should be shaved with a one inch border surrounding the wound to prevent infection. Hair harbors bacteria and can increase the infection risk. Shaving should be completed during initial debridement and each dressing change if hair is noted in the wound.

10. Is there any special consideration to healed skin?
Once the affected area has healed it should be moisturized daily to prevent skin dryness, relieve itching and assist with skin tightness. Use unscented, dye free lotions for moisturizing the affected area. A newly burned area is susceptible to sunburn or frostbite, make sure to protect the skin from the environment.

Exposure time to burn injury @ 160°
Full thickness burn almost immediate

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<thead>
<tr>
<th>Temperature</th>
<th>Exposition Time</th>
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<tbody>
<tr>
<td>120 °</td>
<td>10 min.</td>
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<td>130 °</td>
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<td>149 °</td>
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Preventing burn injuries in children. It only takes a moment of distraction, lack of knowledge, or improper supervision for lives to be changed forever by a burn injury. Every 60 seconds, someone in the United States sustains a burn injury severe enough to require treatment. Children are at particularly high risk due to their immature motor and cognitive skills, and dependence on adults for supervision and danger-avoidance interventions. In fact, each day over 300 children are seen in emergency rooms and 2 children die from burn injuries. Children represent approximately 35% of all admissions to U.S. burn center hospitals. The most common factors that contribute to burn injuries in children are:

Lack of or inadequate supervision, such as: distracted caregivers, a substance-impaired adult, use of a sibling or immature sitter, sleeping caregivers, infrequent observation, etc.

Danger is not perceived by the caregiver, and therefore protective measures are not implemented. Caregivers may be ignorant of potential burn-causing hazards in the environment and/or inexperienced in anticipating potentially dangerous situations, such as: keeping matches or lighters within reach of a child, leaving burning candle unattended and/or within reach of a child, carrying hot liquids or food while holding a child, etc.

Responsibility given to a child above their developmental ability, such as: bathing or caring for a younger sibling, cooking at a young age, burning trash/brush/weeds, lighting cigarettes or BBQ grills for parents, etc.

Abuse, such as intentional injuries from hot water, cigarettes, stove-top burners, irons, etc.

Burn injury recovery can be a life-long journey that involves overcoming many difficult physical, emotional, and psychological issues. Children with visible or functional differences can be at especially high-risk for community reintegration barriers such as staring, teasing, and/or bullying. Thankfully, burn injuries are both predictable and preventable.

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“Weeds are flowers too, once you get to know them” A. A. Milne

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