

# Pediatric Thermal Burns

Burns are a leading cause of unintentional injury and death in children, with the vast majority of cases occurring in the home<sup>1</sup>. Regardless of the burn depth or extent, these injuries can have significant long-term functional, aesthetic, and psychological consequences for the child.

## Pediatric Considerations

- » Relatively thinner skin results in deeper burns at any given temperature.
- » Larger skin surface area to body mass ratio predisposes to greater fluid and heat loss.
- » Larger head to body ratio results in different distribution of *Total Body Surface Area* (TBSA) calculation compared to adults.
- » Smaller and shorter airway results in earlier onset of upper airway obstruction secondary to inhalational burn-related edema.
- » Higher metabolic rate causes increased oxygen and glucose demand, respiratory rate, and insensible fluid losses.
- » Burns without clear explanation or an explanation that does not match the pattern of injury are concerning for maltreatment. Refer to [TREKK's Recommendations for Suspected Physical Child Maltreatment](#). Patterns that may raise concern for an inflicted burn include:
  - Immersion patterned scald burns (e.g. stocking and/or glove distribution, symmetrically burned buttocks, and/or genitals)
  - Patterned contact burns (well-demarcated burns mirroring a hot object; e.g. cigarette, iron, lighter, or hair dryer)

## Emergency Department Management

Although wound care is a major component of thermal burn injuries, management of associated airway, breathing, and/or circulation emergencies must always be prioritized. Refer to [TREKK's Pediatric Multisystem Trauma Algorithm](#) for further information.

### AIRWAY & BREATHING

- » Assess for stridor, hoarseness, and/or respiratory distress; if black sputum, singed nose hairs or facial swelling are present, prepare all necessary pediatric airway equipment and have a low threshold for early intubation.
- » Administer 100% oxygen if there is concern for burns resulting from flash or flame in a closed space. Consider co-oximetry testing and the administration of Cyanokit™ (hydroxocobalamin) for any potential carbon monoxide and/or cyanide exposure.
- » Protect the cervical spine with spinal motion restriction if any concern for associated head or neck trauma.
- » Elevate the head of the bed to help decrease edema if significant head or neck burns are present.
- » Do not trim endotracheal tube length as swelling of face and airway may leave it too short, leading to inadvertent extubation.
- » Widespread full thickness burns to the thorax/trunk may require escharotomy to allow for ventilation; do not attempt this procedure without sufficient experience and/or guidance from an expert.

### CIRCULATION

- » Elevate any limbs with significant burns to help decrease edema.
- » Check for signs of impaired perfusion and consider the need for escharotomy for circumferential burns to the extremities.

### FIRST AID

- » Remove any restrictive items such as clothing or jewelry as soon as possible, before tissue edema worsens.
- » If technically feasible, place the affected site under cool running water for 20 minutes duration as soon as possible after injury. This is beneficial even when there is a delay of up to 3 hours.
- » Applying wet towels or gauze is a second-line option to cool wounds but is less desirable as the towels/gauze require frequent changing and if left too long may contribute to hypothermia. **Never use ice** as it may cause secondary tissue injury.
- » Apply plastic cling wrap to burn wounds after cooling (avoiding the head and neck) to decrease pain and prevent heat loss, water evaporation, and contamination<sup>2</sup>. The plastic cling should be applied lengthwise, not circumferentially.
- » Provide tetanus booster if last tetanus immunization was more than 5 years prior or is unknown.

### PAIN MANAGEMENT (Refer to [TREKK Recommendations for Pain Treatment](#))

- » Use a validated pain scale to monitor effectiveness of analgesia (e.g. FLACC, FPS-Revised).
- » Use acetaminophen and/or ibuprofen for mild pain. Moderate to severe pain will require stronger analgesia (e.g. fentanyl IN/IV).
- » Strongly consider using distraction techniques and procedural sedation to facilitate wound care and dressing changes.
- » Use procedural sedation for any burn debridement expected to last more than 10-15 minutes or if distraction/analgesia is not providing adequate pain relief (Refer to [TREKK Recommendations for Procedural Sedation](#)).

### HYPOTHERMIA

- » Monitor body temperature closely and keep the treatment room warm.
- » Dress wounds with easily removable dressings such as sterile green surgical towels or plastic cling wrap. Apply lengthwise and directly on the skin once the burn is debrided to allow for repeated wound assessments while preventing heat loss.
- » Keep the child warm using blankets and do not repeatedly expose the child.

## MEASURING TOTAL BODY SURFACE AREA OF THE BURN

- » Use a [burn diagram](#) (e.g. Lund-Browder) to more accurately calculate the TBSA.
- » If you cannot access a burn diagram resource, note that the size of a **child's** entire palmar surface represents approximately 1% TBSA.
- » **DO NOT** include areas of skin with erythema only (i.e. superficial epidermal/1<sup>st</sup> degree burns) to the TBSA calculation for fluid resuscitation. See a sample [burn depth assessment chart](#).

## FLUID MANAGEMENT

- » Use warmed Ringer's Lactate for fluid resuscitation to help prevent hyperchloremic acidosis and hypothermia.
- » Use the **Parkland/Modified Brooke Formula** to estimate the fluid volume requirements for the first 24 hours for patients with burn wounds that measure **greater than 10% TBSA** as a starting point for fluid resuscitation; adjust based on perfusion and urine output.

**Parkland/Modified Brooke Formula: 2-4 mL of IV fluid per kilogram of body weight per % TBSA:** Total volume is given over 24 hours, with half of this volume given in the first 8 hours after injury and the second half given over the next 16 hours.

- » **Add maintenance fluid** (e.g. use the 4:2:1 rule) to the Parkland Formula fluid estimate in children **under 30 kg**.
  - » Use 5% dextrose in normal saline (D5NS) for this maintenance fluid as hypoglycemia can develop in younger children.
- » **Monitor urine output** using a Foley catheter to confirm adequate fluid resuscitation:
  - » Less than 30 kg: target urine output **1 mL/kg/h**
  - » Greater or equal to 30 kg: target urine output **0.5 mL/kg/h**

Example: 24 kg child with 50% TBSA burned:

1. 3 mL/kg x 24 kg x 50% TBSA = 3600 mL Ringer's Lactate resuscitation IV fluid required in first 24 hours post-burn. Give 1800 mL in first 8 hours at 225 mL/hr, followed by remaining 1800 mL at 112 mL/hr over next 16 hours.
2. For children < 30 kg, add D5NS maintenance IV fluid using 4:2:1 rule. For 24 kg child = 64 mL/hr D5NS in addition to Ringer's Lactate resuscitation fluid above.
3. Adjust Ringer's Lactate rate to target urine output of 24 mL/hr (1 mL/kg/hr).

Monitor mentation, blood pH, and peripheral perfusion in addition to urine output.

- » Delayed or overly aggressive fluid resuscitation (i.e. under or over-estimation of fluid requirements) can cause increased morbidity; complications include burn wound progression, acute respiratory distress syndrome, and/or compartment syndrome.

## WOUND DEBRIDEMENT

- » Use sterile water-soaked 4x4 gauze pads to gently wipe/scrub the wound.
- » Evidence regarding blister management is limited<sup>3</sup>. We recommend de-roofing and debriding any large blisters and/or those overlying joints. Thick blisters on the palms and soles of the feet may be left intact if the child can still make a fist and/or walk.
- » Evidence for enzymatic debridement materials (e.g. Plurogel™) is promising, but limited<sup>4</sup>. Refer to your local guidelines for use.

## BURN DRESSINGS

- » Use topical antimicrobial ointments (e.g. Polysporin™, Bacitracin™) for small superficial burn wounds. Discontinue use within 1 week to avoid sensitivity reactions (e.g. rash).
- » Clean facial burns with soap and water, and apply petroleum-based ointment (e.g. Vaseline™) twice daily.
- » Whenever possible, apply long-term dressings (e.g. Aquacel Ag™, Mepilex™) immediately after wound cleaning and debridement. Alternatively, apply petroleum-based non-stick gauze (e.g. ADAPTIC™) however this option requires dressing changes every 2-3 days. For patients needing outpatient follow-up at a referral centre, we recommend that you clarify which of these two options your burn specialist prefers as an initial dressing.
- » Avoid using silver sulfadiazine (e.g. Flamazine™, Silvadene™) as it impairs re-epithelization<sup>5</sup> and causes higher rates of infection<sup>6</sup>.
- » For large burn wounds that require emergent transfer to a specialized burn centre, the wounds should be dressed with easily removable dressings (e.g. plastic wrap or dry green towels). Definitive dressings will be applied at the burn centre.

## Criteria for Burn Centre Referral (see [Burn Centre Referral Criteria](#))

- » Partial thickness burns of greater than 10% TBSA
- » Circumferential burns
- » Full thickness / 3<sup>rd</sup> degree burns
- » Concomitant trauma in which the burn injury poses the greatest risk of morbidity and mortality
- » Electrical burns including lightning injury
- » Inhalational injury
- » Burns of face, hands, feet, genitalia, perineum, major joints
- » Pre-existing medical disorders that could complicate burn management, prolong recovery or affect mortality
- » Concern for burn due to child maltreatment or unsafe social situation
- » Consider referral if concern for dressing non-compliance

The purpose of this document is to provide healthcare professionals with key facts and recommendations for the diagnosis and treatment of pediatric thermal burns in the emergency department. This summary was produced by the pediatric thermal burns content advisors for the TREKK Network, Dr. Tighe Crombie & Dr. Claudia Malic of CHEO, and uses the best available knowledge at the time of publication. However, healthcare professionals should continue to use their own judgment and take into consideration context, resources and other relevant factors. The TREKK Network is not liable for any damages, claims, liabilities, costs or obligations arising from the use of this document including loss or damages arising from any claims made by a third party. The TREKK Network also assumes no responsibility or liability for changes made to this document without its consent. This summary is based on:

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2. Liao AY, Andresen D, Martin HCO, Harvery JG, Holland AJA. [The infection risk of plastic wrap as an acute burns dressing](#). *Burns*. 2014 May;40(3):443-5.
3. Ro HS, Shin JY, Sabbagh MD, et al. [Effectiveness of aspiration or de-roofing for blister management in patients with burns](#). *Medicine* 2018 Apr;97(17):e0563.
4. Kirsner RS, Amaya R, Bass K et al. [Effects of a surfactant-based gel on acute and chronic paediatric wounds: a panel discussion and case series](#). *J Wound Care*. 2019 Jun 2;28(6):398-408.
5. Rashaan ZM, Krijnen P, Klamer RR et al. [Nonsilver treatment vs. silver sulfadiazine in treatment of partial-thickness burn wounds in children: a systematic review and meta-analysis](#). *Wound Repair Regen*. 2014 Jul-Aug;22(4):473-82.
6. Nimia HH, Carvalho VF, Isaac C et al. [Comparative study of Silver Sulfadiazine with other materials for healing and infection prevention in burns: A systematic review and meta-analysis](#). *Burns* 2019 Mar;45(2):282-292.