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What's SO special about Pediatric Burns

Or

“I’m getting a burn? *#$! I hate burns.”
Objectives

• Reduce your Burn anxiety
• Demonstrate a stepwise process for burn assessment.
• Understand the acute care of burn wounds in children.
• Establish an set of criteria for transfer.
• How to properly prepare a patient for transfer.
Objectives

Understand how the child is different from the adult in:

- Size
- Body surface, including temperature regulation
- Skin thickness
- Metabolic rate
- Psychological & developmental characteristics

- Discuss principles of management for pediatric patients with thermal, electric, or chemical burns
- Know how to recognize & report burns due to suspected child abuse
US children 0-17

250,000 burns serious enough to seek medical attention
1,100 deaths from burns
15,000 hospital admissions
Scalds 100,000  tap water scald 5000
Irons: 10,000
Curling irons: 9,000
Range : 10,000
Fireworks : 3,500
Scald burns

♦ Most common thermal injuries in children less than 3 years of age
♦ Prevalent in child abuse

♦ Flame burns most common thermal injuries in children over 3 years of age
Same old thing

- A - Airway
  - Burns to the airway/face
- B - Breathing
  - Chest expansion problems
- C - Circulation
  - Co poisoning
Same New thing

• D - Disability
• E - Expose
• F - Fluids
• G - "Get them the heck out of here"
Burns by the numbers

• Depth
  - 1st, 2nd, 3rd “4th”
  - Or partial deep partial or full

• Size
  - TBSA
  - Rule of Nines
Anatomy of the Skin

- Epidermis
- Dermis
- Appendages
- Subcutaneous

Functions Crucial to Survival
- Protection from infection & injury
- Prevention of loss of body fluids
- Regulation of body temperature
- Sensory contact with environment
Zones of Injury

- Zone of Coagulation
- Zone of Stasis
- Zone of Hyperemia
Clinical Importance of depth determination

- Dictates necessary wound care
- Need for grafting
- Ultimate functional & cosmetic outcome
Injury Depth

- Epidermis
- Dermis
- Appendages
- Subcutaneous

1st Degree
- Partial Thickness
- 2nd Degree
- Full Thickness
- 3rd Degree
Partial Thickness: First Degree

- Epidermis only
- Pain & redness
- Heals in few days; outer injured epithelial cells peel
- Seldom clinically significant
Partial Thickness: Second Degree

- Entire epidermis & portion of dermis
- Pain, blisters, moist, capillary refill
- Uninjured dermis & epidermal appendages at risk
Partial Thickness: Second Degree

- Heals spontaneously in 2-3 weeks
- Skin graft may improve functional & cosmetic outcome
Entire thickness of epidermis & dermis

Decreased pain, blisters, dry, absent capillary refill
Initial estimate, 2\textsuperscript{nd} & 3\textsuperscript{rd} degree: “Rule of Nines”

- Adult anatomical areas = 9\% BSA (or multiple)
- Not accurate for infants / children due to larger BSA of head & smaller BSA legs.
- Burn diagrams illustrate adult – child differences
Body Surface Area

- Children have greater BSA / kg of body weight
  
  Example: 7kg child
  - Wt = 10% of average 70kg adult
  - BSA = 33% of the adult BSA

- Larger BSA = greater environmental contact
  
  Relatively greater fluid needs & evaporative water loss / kg body weight

- BSA / wt ratio set by age 15
Body Surface Area

- Children < 2 years of age have disproportionally thin skin
  Responsible for occurrence of full-thickness burns following heat exposure that would produce partial-thickness burn in older patients

- Burns that appear partial-thickness may actually be full-thickness
Temperature Regulation

- BSA—Weight ratio compromises body heat conservation
- Small muscle mass hampers shivering to generate heat
  - Infants < 6 months of age rely on metabolic temp controls & environment
  - Older children can produce heat by shivering
- Highly susceptible to development of hypothermia
**Pathophysiology**

**Injury Depth / Exposure Time**
**Temperature of Burning Agent**

**Child**

- Almost instantaneous Full Thickness Burn
- Tissue Destruction: 5 Sec.
- Severe Damage: 10 Sec.
- Tolerated for Time

**Adult**

- Almost instantaneous Full Thickness Burn
- Severe Damage: 30 Sec.
- Tolerated for Time

160°F
140°F
130°F
111°F
Types of Inhalation Injury

- Carbon monoxide poisoning
- Injury above the glottis
- Injury below the glottis
### Carbon Monoxide Poisoning

Hemoglobin Affinity 200X that of $O_2$

<table>
<thead>
<tr>
<th>CO (%)</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-10</td>
<td>Mild Headache and Confusion</td>
</tr>
<tr>
<td>11-20</td>
<td>Sever HA, Flushing, Vision Changes</td>
</tr>
<tr>
<td>21-30</td>
<td>Disorientation, Nausea</td>
</tr>
<tr>
<td>31-40</td>
<td>Irritability, Dizziness, Vomiting</td>
</tr>
<tr>
<td>41-50</td>
<td>Tachypnea, Tachycardia</td>
</tr>
<tr>
<td>&gt;50</td>
<td>Coma, Seizures, Death</td>
</tr>
</tbody>
</table>
Carbon Monoxide Poisoning

Examination

- Cherry red skin color
- *Agitation*, decreased LOC

- Cyanosis & tachypnea unlikely (CO$_2$ removal unaffected)
- P$_a$O$_2$ and S$_a$O$_2$ likely to be normal (normal pulse ox )
- Only carboxyhemoglobin level may be abnormal
Injury Above the Glottis

- Heat exchange capacity efficient
- Most heat damage occurs above vocal cords
- Resulting edema severe: may occlude airway
- Early intubation preferable but only if has true inhalation injury
Bronchoscopic exam:

- Erythema
- Edema
- Ulceration
- Enlarged vessels

Almost always a chemical injury

Aldehydes, sulfur oxides & phosgenes adherent to surface of smoke particles cause direct damage to epithelium of large airways
Injury Below the Glottis

Additional physiological changes

- Impaired ciliary activity
- Inflammation
- Hypersecretion
- Edema formation
- Ulceration of airway mucosa
- Increased blood flow
- Bronchospasm
- Impaired immune defenses
Caution!

- Severity of inhalation injury & extent of damage are clinically unpredictable based on history & initial exam

- Chest X-rays commonly normal

- Markedly worsens overall prognosis

- Inadequate fluid resuscitation may worsen situation
Most experienced person should perform procedure.
By means most familiar to that person.

Secure the tube!
May be impossible to replace due to edema.
Secure with umbilical or trach tape tied around the head.
Emergency cricothyroidotomy rarely needed.
Pediatric Airway: Special Considerations

- Anatomical airway differences from adults
  - Larynx located more cephalad
  - Angulation of glottis more acute
  - Glottis more anterior
  - Narrowest point is cricoid, not glottis

- Gauge tube size by external nares or small finger diameter
- NG tube decompression indicated
Prepare for transfer to burn center
Endotracheal intubation indicated in infants & children with
- Significant respiratory distress
- Upper airway compromise by edema
- Large % BSA burns and large volume resuscitation

Assess airway & secure prior to transport
Inhalation Injury Manifested By

- Pathology and dysfunction of the airway and respiratory system from thermal and chemical injury from products of incomplete combustion (smoke)
- Present in 10-20% of burn patients
- Identified in 60-70% of patients who die in burn centers
82% full thickness
Breathing

• Inhalation injury
• Chest wall burns
  – Escarotomy
Chest Wall Escharotomy

- Circumferential torso burns
- Restriction of ventilation
- Children's chest wall is compliant
Immediate Resuscitation

**Escharotomy**

- Extremity or torso release may be necessary
- Rarely required prior to transfer to burn center
- Consult with burn center surgeon
Circulation

• Blood volume changes
  - Burn leak
  - Cardiac depressant factor
  - Increased SVR

• CO poisoning
  - Beware the pulse ox

• ?? Your readings
Immediate Resuscitation

Circulation: Monitor Response

- Sensorium
- Blood pH
- Peripheral circulation
- UOP
- Delay or underestimation of fluid needs may increase mortality
- Consult with burn center for ongoing fluid requirements
Disability

• Electrical injury
  - EKG and Troponin
  - High voltage vs. low voltage
• Trauma or no trauma
Expose

- Stop the burning
- See the skin
- Protect yourself and decontaminate
Fluids

- Foley Cath
- IV fluids
- Increased fluids for electrical burns
- Maintenance fluid for kids
Fluid Needs: Immediate Post Burn

Related to Extent of Burn & Body Size

- Influenced by patient age since children have greater surface area / unit body mass
- Estimated using patient weight & % TBSA burn
Children have greater surface area / unit body mass compared to adults

- Require relatively greater amounts of resuscitation fluid
- Have lesser intravascular volume/unit surface area burned
- Are more susceptible to fluid overload and hemodilution
They are rapidly exhausted by early post-burn elevation of endogenous steroids and catecholamines.

Blood glucose levels must be monitored.

Glucose containing electrolyte solutions may need to be continued.
Resuscitation fluid

• Pre hospital
  - Infants 10 ml/kg
  - Children 250 ml
  - Older children 500 ml
Initiate Resuscitation Using the Following Calculations of Fluid Needs

**Adults & Older Children**

\[ LR \ (\text{Ringer’s Lactate}) \ 2 \text{ ml} \times \text{Kg wt} \times \% \text{TBSA burn} \]

**Infants & Younger Children**

\[ LR \ 3-4 \text{ ml} \times \text{Kg wt} \times \% \text{TBSA burn} \]

Plus D5LR at maintenance rate

Adjustments to fluid rates will be dependent upon patient response in subsequent hours
Immediate Resuscitation

Circulation

- Begin fluid resuscitation prior to transfer
- Establish large bore peripheral IV access
- Administer maintenance **PLUS** resuscitation fluids
  - Maintenance: $D_5$LR for infants & small children
    - $1^{st}$ 10 Kg: 100 cc/kg/24 hr
    - $2^{nd}$ 10 Kg: 50 cc/kg/24 hr
    - Each Kg above 20 Kg: 20 cc/kg/24 hr
  - Resuscitation (Ringers Lactate)
    - Begin at 3-4 cc X Kg X BSA Burn

![Image of a foot with a IV catheter]
Circulation: Example

23 Kg child with 20% deep burn

- **Resuscitation (Ringer’s Lactate)**
  \[ 3 \text{ ml} \times 23 \text{ Kg} \times 20\% \text{ Burn} = 1380 \text{ mls} \]
  \( \frac{1}{2} \text{ in 1st 8 hrs post burn} = 86 \text{ cc/hr} \)

- **Maintenance (D\(_5\)LR)**
  - 1st 10 Kg: 100 cc/kg/24hr = 1,000 cc/24 hr
  - 2nd 10 Kg: 50 cc/kg/24hr = 500 cc/24 hr
  - Remaining 3 Kg: 20cc/kg/24hr = 60 cc/24 hr
  \[ 1560 \text{ cc/24 hr} = 65\text{cc/hr} \]

**TOTAL Hourly Fluid Rate Estimate:** 86 cc/hr LR + 65 cc/hr D\(_5\)LR
Fluid calculation is an ESTIMATE
Individual patient response dictates therapy
↑ fluid needs common in patients with
- Associated injuries
- Electric injury
- Inhalation injury
- Resuscitation delay
- Prior dehydration
- ETOH &/or drug abuse
- Very deep burn injury
Small children with small burns
Monitoring Resuscitation

- Actual fluid volume depends on patient response
- Easier to infuse more fluid than remove excess fluid
- Optimally, try to minimize volume & salt loading
  - Prevents acute renal failure
- Low incidence pulmonary & cerebral edema
Cardiac output is commonly “normal” in latter half of 1st post-burn day, **IF NOT:**

- Consider myocardial infarction or insufficiency
- Invasive monitoring may be required

- General patient condition reflects resuscitation adequacy
- Assess mental status frequently
- Anxiety & restlessness are early signs of hypovolemia and hypoxemia
Maintain adequate urine output

Adult
0.5 ml / kg / hr (30 – 50 cc/hr)

Children weighing <30 kg
1 ml / kg / hour

Indwelling urinary catheter most available & reliable resuscitation guide

Incrementally ↑ or ↓ IV rate in response to UOP
Most often result of inadequate resuscitation

Associated with $\uparrow$ SVR & $\downarrow$ CO

Requires more rapid fluid administration

Diuretics contraindicated
Must suspect child abuse when

- Injury pattern not compatible with history given
- Lines of demarcation between normal & burned skin are straight ("glove" or "stocking" pattern)
- There was a delay in seeking medical attention
Chemical burns

• Water only
  - Do not try to neutralize
  - HF acid burns into Ca Gluconate

• Protect yourself

• Ice only for tar
Electrical burns

- Tip of the iceberg
- High vs. low voltage
- Cardiac monitoring
Management of Hemochromogrenuria

Myoglobinuria & Hemoglobinuria (Red Pigmented Urine)

- High voltage electric injury or soft tissue injury due to mechanical trauma
- Administer fluids to maintain UOP 1.0-1.5 ml/kg/hr in adults
- Often clears urinary heme pigments & eliminates need for diuretic
3 weeks post shock injury
Initial Evaluation

- Events leading to injury
- Past medical history
- Consider potential for abuse
- Immunization & health care history
- Allergies
Immediate Resuscitation

Wound Care

1) Stop the burning process
2) Remove all clothing
3) Examine the entire body surface
4) Cover burns with dry clean linen
5) Keep warm
6) Transfer
The ABA identifies the following as injuries requiring a Burn Center referral:

- **2nd degree burns > 10% TBSA**
- **Burns to face, hands, feet, genitalia, perineum, major joints**
- **3rd degree burns**
- **Electrical burns (lightening included)**
- **Chemical burns**
- **Inhalation injuries**
- **Burns accompanied by pre-existing medical conditions**
- **Burns accompanied by trauma, where the burn injury poses the greatest risk of morbidity or mortality**
- **Burns to children in hospitals without pediatric services**
- **Patients with special social, emotional or rehabilitative needs**
Tetanus Immunization

- Consistent with American College of Surgeons recommendations
- Tetanus prophylaxis may be delayed 72 hours to determine status, BUT document deferral to prevent omission of needed immunization
SAMPLE
TRANSFER INFORMATION FORM

Today’s date: __________ Time: __________

Information Obtained From: __________________ Referring Agency: __________________

Referring Physician: __________________ Phone #: __________________

Patient’s Name: ___________________________ Age: ___ Sex: ___ Wt: ___ lb = ___ kg

Time of Burn: __________ Source of Burn: __________________ Est %BSA: __________

Body Areas Burned: _____________________________________________________________

Associated Injuries: ____________________________________________________________

Other procedures performed (e.g., x-ray): __________________________________________

Allergies: ____________________________________________________________________

Current Meds: __________________________________________________________________

Past Medical History: ____________________________________________________________

Tetanus: _____ Analgesics Given: __________ Route/Dosage: __________ Time: __________

Inhalation: Yes No Intubated: Yes No O₂ __________ per __________

Circumferential: Yes No Where: __________ Distal Pulses: Yes No

Escharotomies: Yes No Where: __________ Pulses After: Yes No

IVs: 1. __________ Rate __________ /hr.

2. __________ Rate __________ /hr

Total IV since burn __________ ml

Output (Foley) __________ past hr. Total Output post burn __________ ml

Rx of Burn: __________________________________________________________________

Present status of pt: BP __________ P __________ R __________ Combative: Yes No

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Stabilization: Prepare to Transport

Documentation

- Circumstances of injury
- Physical findings
- Flow sheet of resuscitation measures
- History & physical
- Treatments & medications administered
Healing
CARBON MONOXIDE - WHAT YOU NEED TO KNOW.

Carbon Monoxide (CO) is a colorless, odorless gas. Carbon monoxide appears after the incomplete burning of fuels and is present from multiple sources such as wood burning stoves, kerosene lanterns, gas-fired appliances, charcoal grills, and vehicle exhausts.

Carbon monoxide is extremely dangerous when levels build up in a home, garage, or other enclosed building.

Everyone is at risk, and the symptoms vary depending on the level of Carbon monoxide the person has encountered.

SYMPTOMS INCLUDE:

- Fatigue
- Dizziness
- Headache
- Impaired vision and coordination
- Nausea
- Confusion
- Flu like symptoms

All clear up after leaving the home. At very high levels of Carbon Monoxide the results can be fatal within minutes.

- More safety tips on the back -
St. John’s Injury Prevention Program recommends that every home have a carbon monoxide alarm. A professional should inspect all fuel-burning appliances including furnaces, stoves, water heaters, space heaters and fireplaces to detect leaks of deadly carbon monoxide. The inspection should be done every year.

**Carbon Monoxide Alarms**

- The alarm needs to be installed per the manufacturer's recommendations in a central location outside of sleeping areas.

- Test the CO alarm monthly and replace the unit per the manufacturer’s recommendations.

- Insure that everyone in the home knows the difference in sounds of the CO alarm and smoke detector.

- CO alarms are not smoke detectors. CO alarms only detect carbon monoxide. A separate smoke detector is needed in the home to detect smoke from fires.

- If the CO alarm sounds, exit the area to a location of fresh air and call for help. Do not return to the area until emergency personnel inform that it is safe.

**How to prevent Carbon Monoxide buildup**

- Never use your range, oven, or charcoal grill to heat your home.

- Never keep your car running inside the garage. Even if the door is open, the normal air circulation will not provide enough fresh air to reliably prevent the buildup of carbon monoxide.

- Never run a generator inside a building. A toxic buildup of exhaust can lead to dangerous levels of CO. Generators need to be operated outside in a well-ventilated location away from doors and windows.

- When using a fireplace, insure that the flue is open for proper ventilation.
CAMPFIRE SAFETY

Campfires are warm, provide light and cook food. Unfortunately, campfires can also be dangerous. The best way to insure a fun time is to plan ahead and follow some safety tips.

When planning a camping trip, one important step is needed: check if your campsite allows a campfire. Depending on the time of year and weather conditions some areas have a burn ban. St. John's Injury Prevention Program recommends that you check with the local fire department to see if campfires are allowed.

When making a Campfire, safety should be first.

- **Use a designated fire pit.** If a pit is not available, the ground needs to be cleared to create an open area. The size of the area varies depending on the size of the fire. A good rule of thumb is 15 feet. Insure that no branches overhang the fire.

- **Build the fire downwind of the campsite.** This helps to prevent the wind from carrying hot sparks and igniting tents and other combustibles.

- **Never use flammable liquids like gasoline to start or make a fire bigger.** This can cause dangerous flare ups.

- **Do not leave the fire unattended.** Fires can be unpredictable and spread rapidly.

- **When finished with campfire, douse the fire and coals completely with water.** Recheck campfires prior to leaving to insure that the fire is completely out.

Remember – be safe and have fun.
THE HIGH PRICE OF GASOLINE

Gasoline fires kill hundreds, injure thousands, and cost millions yearly in the United States.

Gasoline should never be used as an accelerant to start a fire. Accelerants on fires are the number one cause of burn admissions at St. John's. Burn injuries can be devastating, and forever change your life.

Some Safety Tips:

✓ Do not use gasoline to start a fire or grill.

✓ Never throw gasoline on a fire.

✓ Keep gasoline away from children.

✓ Do not store gasoline near ignition source-electrical devices, hot water heaters, stove, or any portable heating device.

✓ Never use gasoline as a cleaning agent.

✓ Do not smoke when handling gasoline.
FIREWORKS

Fireworks are popular around Independence Day and New Years Eve. Unfortunately every year thousands of people are seen in emergency departments throughout the United States with firework related injuries. St. John’s Injury Prevention Program recommends that fireworks be left to the professionals.

Fireworks result in a significant amount of injuries yearly, and children and teenagers are at high risk. According to the Centers for Disease Control, 1 out of every 3 people injured from fireworks are less than 15 years old. Almost half of all injuries are to people less than 20 years old. Injuries to the hand and eyes are the most common. While more than half of all injuries are burns.

Safety Tips:

✓ Never allow small children to play with fireworks. Sparklers burn at more than 1000 degrees Fahrenheit, and account for more than 1/3 of injuries to children less than 5 years old.
✓ Read and follow all directions written on fireworks.
✓ Only light one firework at a time.
✓ Only use fireworks outdoors.
✓ Wear eye protection.
✓ Never aim or point fireworks at other people or pets.
✓ Fireworks are to only be ignited on smooth, flat surfaces away from homes, dry leaves, and flammable materials.
✓ Keep a bucket of water available in case of fire.
✓ Never try to relight a malfunctioning firework.
✓ If fireworks start a fire or become uncontrolled; call 911.
✓ Never drink alcohol and ignite fireworks, this can be a deadly combination.

ST. JOHN’S TRAUMA SERVICES

ST. JOHN’S/KOHLS INJURY PREVENTION PROGRAM

1 out of every 3 people injured from fireworks are less than 15 years old

ST. JOHN’S
POWERFUL MEDICINE
SCALD BURNS-OUCH... THAT IS TOO HOT!

Scald injuries happen when skin contacts hot liquid or steam. Children less than 4 years old are at high risk for this type of burn. A curious child can turn on the hot water, or pull hot liquids off a table or stove. Young children have thinner skin than adults which puts them at higher risk of burn injury.

St. John's Injury Prevention Program recommends that children stay out of the kitchen during meal preparation because of the dangers of hot liquids, grease, and hot foods. These items spilled on a child can cause serious burns.

Tips to prevent scald injuries and burns:

✓ Supervise young children at all times
✓ Never hold a child and carry hot foods or drinks
✓ Avoid using table cloths with hot items on them. Children can pull items down on themselves.
✓ Check food and bottle temperature prior to giving to children.
✓ Check your hot water heater. It should be set at 120 degree F.

ST. JOHN’S TRAUMA SERVICES

ST. JOHN’S/KOHL’S INJURY PREVENTION PROGRAM

KOHL’S

ST. JOHN’S
POWERFUL MEDICINE
SMOKE ALARMS

If you don’t have a smoke alarm, you need to get one. If you have a smoke alarm, make sure it works.

When smoke alarms are properly installed and maintained, they help provide extra warning to give you and your family time to escape a fire.

Types of Smoke Alarms

- **Ionization**: A small amount of radioactive ions flow between two sensors. When smoke enters the path of the ions, a disruption occurs and the alarm sounds.
- **Photoelectric**: This type of alarm aims a light source into a chamber away from a sensor. When smoke enters the alarm, light is redirected onto the sensor and the alarm sounds.

Both types of alarms have played a significant role in improving fire safety. The Ionization type is generally more receptive to flaming fires and the Photoelectric is generally more receptive to smoke-based fires. The National Fire Protection Association recommends that homeowners have both types installed.

Recommendations about Smoke Alarms

✔ Only purchase alarms that are listed by the UL and have a UL marking on the package.
✔ Do not install smoke alarms near windows, doors, or ducts. The draft may cause malfunctioning.
✔ Check the function of your smoke alarm each month and replace the battery at least once a year. It is good to pick a common time, for example your birthday or when you change the clocks in the fall. Consider installing a smoke alarm that has a "long life" 10-year battery.
✔ Smoke alarms are equipped with "chirping" alarms to notify you of weak batteries. Do not disable the alarm. A battery change is required.
✔ Never borrow a battery from your smoke alarm. It is easy to forget to replace it later.
✔ Smoke alarms are only good for a certain period of time. It is recommended that you replace your alarm every 10 years.
✔ Do not paint smoke alarms. This can cause the alarm to not function appropriately.
CHILDREN AND FIRE... A BAD MATCH

Parents spend a lot of time and effort protecting their children. One area of protection that is often overlooked is the area of fire and burn prevention.

According to the SafeKids USA, approximately 500 children die and 136,600 are injured from fire and burn related incidents each year. Many of these incidents could be avoided by following a few safety guidelines.

Safety Guidelines:

- Teach children to never play with matches or lighters.
- Be alert of signs that children are playing with matches or lighters. Often children hide burnt matches under beds or in closets.
- Teach about the dangers of candles, fireworks, and cigarettes.
- Smoke alarms save lives. Install and maintain one on each level of your home and outside of sleeping areas.
- The kitchen is a dangerous place, small children need constant supervision. Hot items can be pulled off tables and counters posing a burn risk.
- Practice emergency exit plans with the entire family.
- Determine a safe meeting place outside of the home if there is a fire.
- Post and know emergency contact numbers in your area.