Pediatric Burns: Abusive, Neglectful or Simply Accidental?

Steven L. Moulton, MD
Director, Trauma and Burn Centers
Children’s Hospital Colorado

Professor of Surgery
University of Colorado, School of Med
Disclosures

• Co-inventor on multiple patents
  – IP assigned to Regents of the University of Colorado
• Consultant/Co-founder Flashback Technologies, Inc.
  – CU start-up; licensed technology from CU
• Research supported by:
  – National Institutes of Health UL1 TR000154
  – State of Colorado Business Development Grant (BDEG)
  – Department of Surgery, University of Colorado

Today’s topic will not reference anything related to the above disclosures
Objectives

• Variables to consider
• How to calculate depth and extent
• Treatment options
  – 21 day rule
• Accidental vs. non-accidental burn injuries
  – concerning behaviors/patterns
• Case Examples
Pediatric Burn Care

1st DEGREE - SUPERFICIAL

- Limited to the epidermis
- Red, dry and painful
- Blanche when pressed, often slough the next day
- After intense sun exposure; periphery of 2nd degree burns
- Heal spontaneously without intervention
2nd DEGREE-
SUPERFICIAL

- Involves epidermis and superficial dermis
- Hallmark is blister, often still intact
- Painful, moist
- Commonly caused by hot liquids or contact
- Heal spontaneously in $\leq 21$ days with simple wound care
2nd DEGREE PARTIAL AND DEEP PARTIAL THICKNESS

- Involves epidermis and deeper dermis
- Blisters usually ruptured on presentation
- Moist, painful
- Grease, heat contact, flame
- Hair follicles common epithelial source
- May need grafting, i.e. may not heal by 21 days
Pediatric Burn Care

3rd DEGREE-FULL THICKNESS

- Burn extends into subcutaneous tissue
- Dry, leathery, insensate and waxy; do not blanch
- Usually white, yellow or brown color
- Commonly caused by flame or heat contact
- Will need grafting
Pediatric Burn Care

4th DEGREE-DEEP FULL THICKNESS

- Burn extends into muscle, tendons, ligaments and bone
- Hard, black eschar
- Minimal pain, destruction nerve endings
- Caused by closed space flame burns; prolonged heat contact
- Will need grafting
1st degree burns NOT included in TBSA calculation

Surface Area of Palm is 1% of TBSA

Area of Palm + fingers is 1.5% of TBSA

Lund Browder Burn Diagram

<table>
<thead>
<tr>
<th>Circle Age:</th>
<th>Percent of Areas Affected by Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>H=½ if the Head</td>
<td>9½</td>
</tr>
<tr>
<td>T=½ of a Thigh</td>
<td>2½</td>
</tr>
<tr>
<td>L=½ of a Leg</td>
<td>2½</td>
</tr>
</tbody>
</table>

ESTIMATION OF SIZE OF BURN BY PERCENT

Calculate extent of burn

<table>
<thead>
<tr>
<th></th>
<th>Anterior</th>
<th>Posterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. Arm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. Forearm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. Hand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. Arm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. Forearm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. Hand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trunk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buttock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perineum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. Thigh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. Leg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. Foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. Thigh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. Leg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. Foot</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subtotal

% Total Area Burned

Signature Person Completing Form:

Date:
Extent of Burns

Patient’s palmar surface (hand + fingers) is 1% TBSA
Immediate Treatment on scene

- Cool the burn wound (“stop the burning process”)
- Apply clean moist towel
- Seek medical help if needed

IV Fluid

- Age < 5 yrs D5LR or LR at 125 ml/hr
- Ages 6-14 yrs LR at 250 ml/hr
- Age > 14 yrs LR at 500 ml/hr
Pediatric Burn Care

In ED

• You can peek, but o/w keep burn covered
  – Prevent desiccation (drying)
• Medicate for pain; get supplies for dressing
• When ready
  – Uncover
  – Assess and diagram
  – Redress, then calculate TBSA

Definitive local care versus referral to burn center
Anschutz Medical Campus
ABA Burn Referral Criteria

University Hospital: ages ≥ 15
CHCO Burn Center: ages 0 – 14 (≤ 60% TBSA)

• (Partial thickness, age < 2, > 5% TBSA)
• Partial thickness, age ≥ 2, > 10% TBSA
• Burns of: face, hands, feet, genitalia, perineum, major joints
• Full thickness burns
• Electrical (incl. lightning)/chemical burns
• Special considerations: infant, trauma, etc.
Pediatric Burn Care

Indications for Admission (IV Fluid)

- **Infants (< 2 years old)**
  - > 5%TBSA
  - Maintenance IVF (D5LR); pain control; urine output > 1 cc/kg/hr

- **Young children (ages 2 – 10 years)**
  - TBSA burn > 10%
  - Maintenance IVF (LR); pain control; urine output ~ 1 cc/kg/hr

- **Older children and adults (ages > 10 years)**
  - TBSA burn > 15%
  - Maintenance IVF (LR); pain control; urine output = 0.5 – 1 cc/kg/hr

- **Burns > 20% TBSA**
  - 3 cc’s/ kg / % TBSA = 24 hr IVF requirement; give ½ in first 8 hrs
  - urine output = 0.5 – 1 cc/kg/hr; start tube feeds ASAP
Pediatric Burn Care

- Blisters--if FLAT leave INTACT
- Cleanse burn wound: Saline or Shur-Clens
- Topical agents
  - Triple antibiotic ointment (TAO) or Neosporin/Bacitracin in non-adherent gauze (Adaptec)
    - Inexpensive, easy to apply/remove; soothing
    - Change once or twice per week for small area burns
    - Change daily/QOD for larger burns
  - Sulfamylon for burn wound or donor infections
- Follow 21-day rule
Apply triple antibiotic ointment in Adaptec to all open areas.

Wrap with Kling or Kerlix f/b Coban or Co-Flex
1. Leave blistered skin on burn
2. Cover all open areas of the hand with TAO impregnated Adaptec, f/b Kling or Kerlix
3. Wrap with Co-flex or Coban. Include wrist joint to anchor dressing
4. Soft cast as needed
Non-Accidental Burn Injuries

- Burns represent about 10% of NAT cases
  - 10-20% of pediatric burn admissions

- Children are intentionally burned for different reasons

- Intentional burns often leave characteristic patterns

- Scald type burns are most common inflicted burn
  - Often overlooked at accidental

- History, psychosocial risk factor assessment and pattern of injury are critically important
Non-Accidental Burn Injuries

• Explanation consistent with injury?
  – Contradictory or varying accounts among witnesses?
  – Burn attributed to a sibling?

• Delay in seeking care?

• Other injuries present?
  – Look for bruising!!
  – Consider bone survey
  – Consider ophthalmologic exam if < 2

• Anger or resent toward child?
  – Inappropriate affect?
Non-Accidental Burn Injuries

- Physical findings associated with NAT
  - History incompatible with physical exam
    - Anatomic location of burn injury; sparing of flexion creases
    - Presence or absence of clothing at time of injury
    - Scald: spill/splatter vs. flow vs. immersion pattern
    - Heat contact burns are usually branding type; mirror object
  - Burn incompatible with developmental age
    - Location of child at time of burn
  - Sharply delineated burn margins
  - Localized burns of perineum, genitalia, buttocks
  - Burns older than history given
  - Other injuries
    - Cigarette burns, bruises, fractures
Suspicious for Non-accidental Trauma

Inflicted Iron Burn
Non-accidental Trauma

Immersion Type Burns

Lines of demarcation
- History not consistent
- Deep burns
- No splash marks
Flow pattern with areas of sparing
Neglect?

Spill pattern scald type burns:
Accidental trauma
4 year old male
Step MOC soaking his hands in warm water
She left room to care for other child
Pt reportedly turned on hot water burning hand
Seen in ED, unexplained facial and other bruises
Child very quiet in room w/ FOC and Step MOC

Type of burn?
History consistent with injury?
4 year old male
Step MOC soaking his hands in warm water
She left room to care for other child
Pt reportedly turned on hot water burning hand
Seen in ED, unexplained facial and other bruises
Child very quiet in room w/ FOC and Step MOC

Type of burn? Scald, flow pattern
History consistent with injury? No
Discharged to foster care; investigation ongoing
21 month old male playing in bathroom sink during Broncos game
FOC hears patient crying at top of stairs, notes skin sloughing from feet
Calls 911
Brings patient to ED, refuses to repeat hx after speaking with police

Type of burn?
History consistent with injury?
21 month old male playing in bathroom sink during Broncos game
FOC hears patient crying at top of stairs, notes skin sloughing from feet
Calls 911
Brings patient to ED, refuses to repeat hx after speaking with police

Type of burn?  **Scald, immersion pattern with flow**
History consistent with injury? No, but other adults in home corroborated hx
Discharged with parents; ruled neglect
3 year old female in kitchen with mom making dinner
Mom steps away to answer phone, MGMOC remains in kitchen
Child pulls chair up to stove to check boiling water in pot on stove?
Mom hears crying, notes child with burns

Type of burns?
History consistent with injury?
3 year old female in kitchen with mom making dinner
Mom steps away to answer phone, MGMOC remains in kitchen
Child pulls chair up to stove to check boiling water in pot on stove
Mom hears crying, notes child with burns

Type of burns? Scald, flow pattern (finger tips are spared, palmar deeper)
History consistent with injury? No
Child in custody of mom; MGMOC removed from home, DHS monitoring
11 month old male with nasal congestion
Parents instructed by MD to place child in humidified environment
Father fills tub with hot water while intoxicated
Holds child over hot water in tub, child’s extremities immersed

Type of burn?
History consistent with injury?
11 month old male with nasal congestion
Parents instructed by MD to place child in humidified environment
Father fills tub with hot water while intoxicated
Holds child over hot water in tub, child’s extremities immersed

Type of burn? **Scald, immersion pattern**
History consistent with injury? Yes, one hand, forefeet
Dad jailed; substance abuse rehab (alcohol and meth). Home with mom
4 year old female
Father claims she touched hot pot
Father later claims she touched hot stovetop

Type of burn?
History consistent?
4 year old female
Father claims she touched hot pot
Father later claims she touched hot stovetop

Type of burn? Heat contact
History consistent? No, palm/dorsum
Mom later confessed, jailed
23 month old female, potty training
Poops in her pants
Mom places child in shower
Notes skin sloughing
Next day father notices burns, brings child to ED

Type of burn?
History consistent?
23 month old female, potty training
Poops in her pants
Mom places child in shower
Notes skin sloughing
Next day father notices burns, brings child to ED

Type of burn? Scald, immersion
History consistent? No, delay in care
Mom remorseful, ruled accidental
6 month old male reportedly napping indoors next to window w/o blinds “sunburn” noted, treated at home with topical antibiotic for 5 days No improvement; seek medical care

Type of burn?
History consistent?
6 month old male reportedly napping indoors next to window w/o blinds
“sunburn” noted, treated at home with topical antibiotic for 5 days
No improvement; seek medical care

Type of burn? Scald, spill pattern with sparing
History consistent? No, delay in seeking care
Discharged in care of MGFOC
2 year old male in c/o father’s GF
Potty training; later playing in toilet
GF washed his hands, skin peeling
GF believes chemicals in toilet water
O/E in ED, blood in both ears, bruises
and abrasions

Type of burn?
History consistent?
2 year old male in c/o father’s GF
Potty training; later playing in toilet
GF washed his hands, skin peeling
GF believes chemicals in toilet water
O/E in ED, blood in both ears, bruises and abrasions

Type of burn? Scald, flow pattern
History consistent? No
Placed in foster care

Sparing of palms and fingertips
4 MO male had “poopy diaper”
FOC placed pt in sink, ran water
Returned, skin peeling, calls mom
FOC takes pt to local ED
25% TBSA burn, bite mark

Type of burn?
History consistent?
4 MO male had “poopy diaper”
FOC placed pt in sink, ran water
Returned, skin peeling, calls mom
FOC takes pt to local ED
25% TBSA burn, bite mark

Type of burn?  Scald, flow
History consistent?  No
3 week old infant
Mom warming frozen BM in pot of hot water
Carries infant and pot with hot water/BM
Stumbles, spills hot water on infant
Mom distraught in ED

Type of burn?
History consistent?
3 week old infant
Mom warming frozen BM in pot of hot water
Carries infant and pot with hot water/BM
Stumbles, spills hot water on infant
Mom distraught in ED

Type of burn? Scald, spill/splatter
History consistent? Yes, accidental
It will take several months for pigment to return post burn.

Burns heal, but the scars may last a lifetime!
Caring For Children With Burn Injuries is a Team Sport

Improving the Lives of Burn-Injured Children
Centers for Disease Control and Prevention. Comparison of External Cause of Injury Mortality Matrix


<table>
<thead>
<tr>
<th>When an intentional scald must be excluded</th>
<th>When an intentional scald must be considered</th>
<th>When an intentional scald is unlikely</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical features</strong></td>
<td><strong>Physical features</strong></td>
<td><strong>Physical features</strong></td>
</tr>
<tr>
<td><strong>Mechanism:</strong></td>
<td><strong>Pattern:</strong></td>
<td><strong>Mechanism:</strong></td>
</tr>
<tr>
<td>• Immersion</td>
<td>• Uniform scald depth</td>
<td>• Spill injury</td>
</tr>
<tr>
<td><strong>Agent:</strong></td>
<td>• Skin fold sparing</td>
<td>• Flowing water injury</td>
</tr>
<tr>
<td>• Hot tap water</td>
<td>• Central sparing buttocks</td>
<td><strong>Agent:</strong></td>
</tr>
<tr>
<td><strong>Pattern:</strong></td>
<td><strong>Distribution:</strong></td>
<td>• Non tap water (hot beverage)</td>
</tr>
<tr>
<td>• Clear upper limits</td>
<td>• Glove and stocking distribution</td>
<td><strong>Pattern:</strong></td>
</tr>
<tr>
<td>• Scald symmetry (extremities)</td>
<td>• 1 limb glove / stocking</td>
<td>• Irregular margin and burn depth</td>
</tr>
<tr>
<td><strong>Distribution:</strong></td>
<td><strong>Clinical features</strong></td>
<td>• Lack stocking distribution</td>
</tr>
<tr>
<td>• Isolated scald buttock / perineum</td>
<td>• Previous burn injury</td>
<td><strong>Distribution:</strong></td>
</tr>
<tr>
<td>• +/- lower extremities</td>
<td>• Neglect / faltering growth</td>
<td>• Asymmetric involvement lower</td>
</tr>
<tr>
<td>• Isolated scald lower extremities</td>
<td>• History inconsistent with assessed</td>
<td>limbs</td>
</tr>
<tr>
<td><strong>Clinical features</strong></td>
<td>development</td>
<td>• Head, neck and trunk or face and</td>
</tr>
<tr>
<td>• Associated unrelated injury</td>
<td><strong>Historical / Social features</strong></td>
<td>upper body</td>
</tr>
<tr>
<td>• History incompatible with examination</td>
<td>• Passive, introverted, fearful child</td>
<td></td>
</tr>
<tr>
<td>• History inconsistent with examination findings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Co-existing fractures</td>
<td><strong>Historical / Social features</strong></td>
<td></td>
</tr>
<tr>
<td>• Previous abuse</td>
<td>• Soiling / enuresis / misbehaviour</td>
<td></td>
</tr>
<tr>
<td>• Domestic violence</td>
<td>• Differing historical accounts</td>
<td></td>
</tr>
<tr>
<td>• Numerous prior accidental injuries</td>
<td>• Lack of parental concern</td>
<td></td>
</tr>
<tr>
<td>• Sibling blamed for scald</td>
<td>• Unrelated adult presenting child</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Child known to social services</td>
<td></td>
</tr>
</tbody>
</table>
20 month old male reportedly climbs into bathroom sink, turns on hot water. Mom hears child cry, finds him on counter with steaming water running.

Type of burn?
History consistent with injury?