Scope of the Problem

- Incidence of abusive burns in hospitalized burned children has been reported from low estimates of less than 11% to high estimates of 25% (1-11).
- Burned children presenting to ER’s have a frequency of abuse or neglect ranging up to 19.5% (12-13).

Epidemiology of Child Abuse by Burning

- Abusive burns typically occur in children younger than age 6 and have the greatest percentage of hospitalizations for treatment (18,19).
- Childhood abusive burn victims are more likely to have previous or concomitant signs of abuse/neglect and previous reports to child protective services (3,9,16,23,29-31).

Classification of Burn Injuries

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial Partial</td>
<td>Superficial layer of the epidermis characterized by redness only</td>
</tr>
<tr>
<td>Full Thickness</td>
<td>Entire dermis, appendages, nerves destroyed, no pain</td>
</tr>
<tr>
<td>Fourth Degree</td>
<td>Extends into the muscles, bones and joints</td>
</tr>
</tbody>
</table>

Skin Anatomy

Skin is comprised of epidermis, dermis, and subcutaneous tissue.

Types of Burns and Medical Evidence Suggesting Maltreatment

Burns are also classified by the source of damage to the skin and are divided into the following categories:
- Thermal
- Chemical
- Electrical
- Radiation
- Friction/pressure tissue injury
Thermal Burns

- Are the most common form of accidental and non-accidental burns in children and consist of tissue damage from scalds and contact injury.
- Scald burns are further subdivided into immersion, flowing liquid, splash, and splatter injury.

How Rapidly Does a Burn Injury Occur to a Child’s Skin

- Children comfortably bathe at a temperature of 101 degrees Fahrenheit (38 degrees Celsius).
- Hot tubs typically have temperatures fluctuating between 104-108 degrees Fahrenheit (49).
- Adults sense water as painfully hot between temperatures of 112-114 F (43-45 C) (49,50).
- Deep 2nd degree burn for adults and children at 113 degrees Fahrenheit.

Time-Temperature Scales

<table>
<thead>
<tr>
<th>Temp. (F)</th>
<th>Adult Skin</th>
<th>Child Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>127</td>
<td>60 seconds</td>
<td>60 seconds</td>
</tr>
<tr>
<td>130</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>140</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>150</td>
<td>2</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>158</td>
<td>1</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>


Abusive Scald Burns

- Up to 14% of all scald burns are secondary to abuse (36,44-46).
- Scalding by immersion in hot tap-water is most frequently reported for abusive burns (11,19,28).
- For suspected immersion scald injury, the pattern of injury greatly assists the medical provider and investigators in analyzing the case for accidental versus inflicted mechanisms.

Abusive Immersion Scald Injury

- Burn patterns demonstrating uniformity of burn depth suggest the child was restrained or not moving during the time of injury occurrence (23).
- Bilateral burn symmetry in the absence of splash marks suggests forced immersion (23,28).
- Bilateral, symmetric lower extremity burn distribution pattern occurs more frequently in abused children (28).

Abusive Immersion Scald Injury

Immersion burns typically present with patterned injury demonstrating:

- Uniform burn depth
- Flexion sparing
- Linear/sharply defined contour between the burned and unburned skin areas
- Absence of splash marks
- Can have skin sparing in areas where the skin was in contact with cooler surfaces.
Characteristics/Location of Thermal Burns
Suggesting Abuse
Immersion Injuries

Level of water results in uniform demarcation line
Flexing results in apposition of skin surfaces and burn protection
Surface contact protects skin from hot water

Immersion burns often result in typical patterns that give clues to mechanism of injury

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Characteristics/Location of Thermal Burns
Suggesting Abuse
Immersion Injuries

Immersion demarcation line
Areas of skin spared by flexion

Typical immersion burn. Uniform degree of injury with interspersed protected areas.

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Scene Investigation

• All suspicious burns should be investigated by individuals experienced with scene assessment and evidence collection
• In cases of hot water burn injury, a detailed scene investigation is necessary to assist with the critical analysis of the injury by a multidisciplinary team

Photographing The Scene

Use Four Basic Views Methodology
• Overall (establishes location)
• Medium (portrays segment of scene)
• Close-up (gives specific isolated detail)
• Specific Evidence (taken with scale for comparative or metric analysis)

Scene Reenactment
Can Children Crawl In/Out of the Bathtub?

- There have been many cases in which a caretaker described a child climbing into a tub or sink and becoming immobilized by pain
- Explanation offered to explain symmetrical uniform contour burn injury on child’s lower extremities
- Allasio et al studied 176 children between 10-18 months to determine at what age a child can climb into a 14-inch bathtub
- 35% of children were able to perform this task and success improved with advancing age
Hot Water Splash Burns

- Splash burn injury requires a minimum temperature of 140 degrees F (60 degrees Celsius) in order to produce tissue injury
- Lower water temperatures will cool to a point where thermal cutaneous injury will not occur
- Scald patterns due to splash or flowing liquid can be altered based on the presence/absence of clothing

Pull-Down Splash Burns

- Typically have a “triangular” appearance with the area of greatest burn injury occurring at the area of immediate skin contact
- Scalding liquid then typically has a trickle-down drip pattern

Characteristics/Location of Thermal Burns Suggesting Abuse Scald/Splash Injuries

- The majority of all scald burns are accidental and due to splash/spill injury by fluids other than tap water, such as soups, hot beverages and other cooking liquids and occur in the home environment
- Having a child in the kitchen while cooking is one of the greatest risk factors for sustaining a burn injury

Scald Burns

- Toxic epidermal necrolysis produces skin peeling and sloughing
  - Typically associated with an infectious cause or hypersensitivity to medications
- Staphylococcal scalded skin syndrome
  Produces blistering of the skin with subsequent exfoliation secondary to toxins produced by bacterial infection

Scald Injuries Resulting from Liquids Other than Water

- Hot beverages, foods, grease, oils, or wax can reach temperatures much greater than the boiling point of water (212 F)
- Have greater viscosity
- Result in deeper, more significant burn due to higher heat source and prolonged contact with the skin

Abusive Thermal Burn Mimics

- Scald Burns
  Scald or splash injury from liquids usually results in single burn that diminishes in intensity from point of contact

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Contact Burns

- Result in thermal injury to the skin secondary to prolonged contact with the hot or smoldering source \(^{(70)}\)
- Typically produce a branding injury characterized by:
  - Distinct margins
  - Grouped burn lesions
  - Clearly inscribed patterns
  - Injuries on parts of the body normally covered

Dry Contact Burns

- May include injuries resulting from objects such as a curling iron, steam iron, flat iron, radiator/grill grate, cigarette lighter, or various kitchen utensils
- The pattern left on the skin by curling iron burns can help in differentiating accidental from abusive injury mechanisms

Characteristics/Location of Dry Contact Burns Suggesting Abuse

Cigarette Burns

- Cigarette diameter 8 mm
- Inner circle of tissue more deeply burned

Chemical Burns

- Chemical burns resulting from caustic ingestions can be the result of neglectful child supervision as well as intentional acts
- Can result in deep burns and the agent continues to damage tissue until properly removed from the skin
- Alkali burns are associated with deeper penetration and more extensive burns than acids

Chemical Burns

- Adult drug use is a risk factor for pediatric caustic ingestions
- Concentrated bleach does not immediately produce pain and therefore causes skin lesions that develop slowly and worsen with prolonged contact
- Laxative-induced buttock dermatitis frequently is confused with abusive immersion burns of the buttocks

Flame Burns

- Most often secondary to house fires in the pediatric population
- Abusive flame burn injury secondary to holding a child's skin in contact with flame or to ignition of clothing as a consequence of abuse or neglect also occurs
- \(~10\%\) of abusive pediatric burns were caused by fire or flames \(^{(6,8)}\)
Electrical Burn Injury

- Represents ~2-3% of all burns requiring treatment in the emergency department (97)
- Most occur in the home setting and involve children less than age 5 (97-100)
- Most due to lack of supervision
- Low-voltage injuries are more common in younger children while high-voltage injuries are seen more frequently in the older pediatric population (88)

Friction/Pressure Burns

- Innocent pressure injuries may be confused with dry contact burns
- Constricting bands from tight clothing causes a cutaneous pressure injury resembling a ligature mark
- A non-circumferential injury can be produced if pressure form the constricting garment is augmented in certain anatomic locations

Burns and Neglect

- Andronicus et al reported both neglect and inflicted injury as contributing to nonaccidental burn causation in children (2)
- 9.3% of burn cases diagnosed in one study occurred secondary to neglect (14)
- Burns resulting from neglect are more likely to have deeper tissue injury requiring surgical intervention (14)

Characteristics of Abusive Burn Perpetrators

- Abusive pediatric burns occur more commonly in families with a single, young, socially isolated parent from a lower socioeconomic class (2,9,13,15, 17, 21, 22, 29, 30, 36, 37)
- One study found that most parents of burn abused children were unemployed with incomes of less than $20,000 per year (17)
- The abusive burn perpetrator is most frequently the child’s parent or the mother’s boyfriend (17)

Medical Investigations

Information needed for investigation

- Anatomic location of the burn
- Source producing the injury
  - Hot tap water:
    - Water heater temperature
    - Water coming from the faucet
    - Free flowing or pooled water
  - Chemical:
    - Source contact time
- Explanation of the burn injury (Are there varying accounts?)

Richardson A. Cutaneous manifestations of abuse. In Reece RM: Child Abuse Medical Diagnosis and Management, 1994
Information needed for investigation

- Date/time the burn injury reportedly occurred
- Location of the child at the time of the burn
- Presence or absence of clothing
- Presence or absence of witnesses to the burn
- Time from burn occurrence to presentation for medical care
- Child and parent’s reaction to the burn
- Developmental level of the child
- Prior injury or accidents
- Family composition and home environment

Concerns for abuse

- History reported not consistent with mechanism of the injury
- Unexplained delay in seeking medical care
- History of previous injury or repetitive accidents
- Presentation of coexisting injuries
- Presence of supervisory and/or environmental neglect
- Presentation for care with a non-related adult or non-parental relative
- Multiple/changing explanations for the injury
- Unwitnessed injury
- Injury attributed to siblings and/or pets
- Apathetic parents regarding the child’s injury
- Explanations of burns in a delayed child
- Developmental level of the child inconsistent with reported mechanism of injury
- Submissive child with flat affect or lack of appropriate emotional response to pain

Physical Examination Findings

Areas Highly Concerning for Inflicted Injury:

- Hands
- Feet
- Genital region
- Buttocks

Patterns of Injury Concerning for Abuse

- Large surface area of burn
- Uniform degree of burn injury
- Full thickness burn
- Presence of sharply delineated burn margin
- Symmetrical burns
- Absence of burn in areas of skin flexion
- Sparing of skin with surrounding burn secondary to contact with cooler surfaces (doughnut burns)
- Scald injury without splash/drip marks

Other Findings Concerning for Abuse or Neglect

- Infected burns
- Chronic burns
- Burns in various stages of healing
- Burn appearance is older than stated history
- Concomitant cutaneous injuries

Additional Medical Testing: Need for a Skeletal Survey?

- Hicks and Stoffi evaluated the frequency of occult fractures in children with suspicious burns compared to children with other forms of physical abusive injury (129)
- Study found 14% of pediatric burn cases with positive skeletal surveys with occult fracture (129)
- Newer information documents 16.3% of children presenting with burns also had fractures present (130)
- Supports the need for skeletal survey imaging in children less than age 2 with suspicious burns

Conclusion: Strength of the Medical Evidence

- History of prior accidents
- History incompatible with physical exam
- Burns inconsistent with the developmental level of the child
- Differing or inconsistent historical accounts of the injury
- Inappropriate parental affect
- Delay in seeking care
### Conclusion: Strength of the Medical Evidence

The following are frequently reported in the literature as being present in inflicted burn injury:

- Patterned of injury
- Burns localized to the genitalia, perineum, buttocks, and bilateral lower extremities
- Presence of additional injuries
- Older injuries

### Effective investigation of child abuse by burning requires a coordinated effort between the investigators and the medical professionals

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### Contact Information

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