

# Burns, Scalds and Thermal Injuries

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Maryanne Lobo / Bindu Bali

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# Outline

- Reminder of burns definitions
- Forensic aspects of abusive burns
- Framework for assessment

# Epidemiology

- Burn injuries causes pain, scarring and deformity
- Children below the age of 5 years are at high risk of burn injuries particularly scald burns.
- In 2006 the National Injury Surveillance Unit reported that in Australia 191 children below 4 years per 100 000 population, were hospitalised for burns.
- Rates for children between the ages of 5-9 yeas and 10-14 years were less than 50 per 100 000 population.
- 75% of the burn injury related hospitalisation in infants (predominantly in children over 7 months of age) and 63% in children aged 1-4 years were as a result of scalds.

# Risk factors for burns in children

- Male
- 1-2 yrs
- Young mother
- Single parent
- Having older siblings
- Lower SES
- Kitchen > bathroom

# Epidemiology of abusive burns

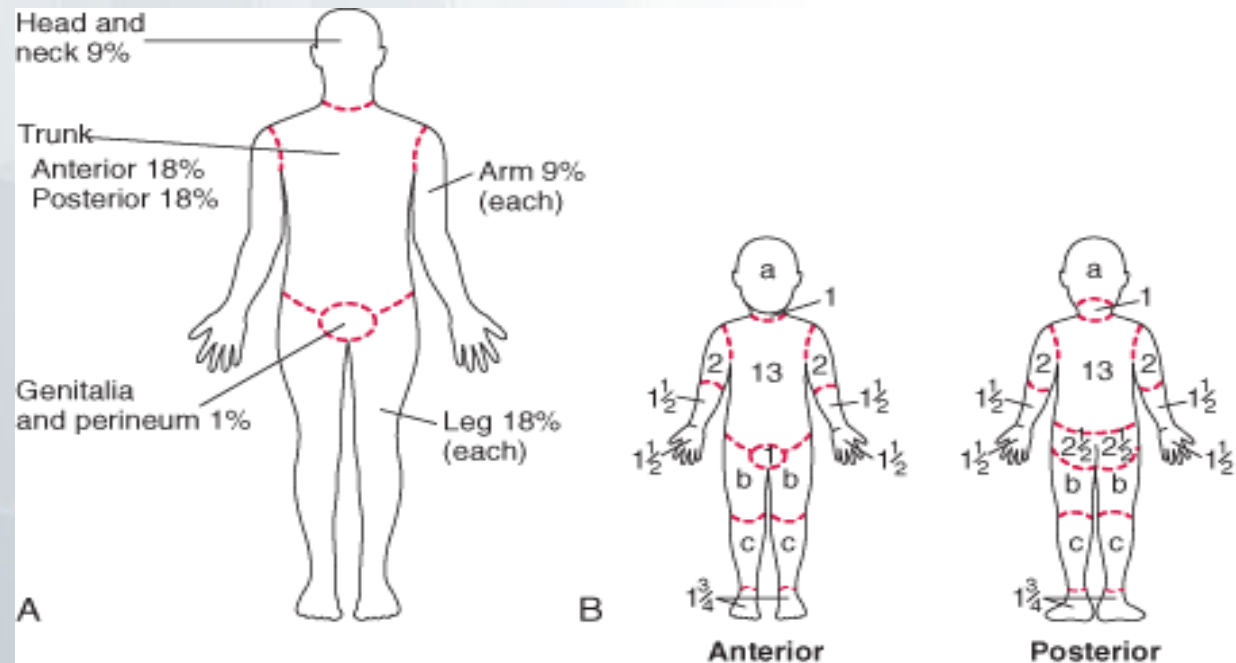
- In 1.7 - 25% of children hospitalised with burn injury the burns are inflicted
- Lower end of this range in UK, Australia and New Zealand
- Burns from neglect thought to be > than abusive burns in Australia and New Zealand
- Children with inflicted burns are younger, have longer hospital stays and have greater mortality compared to children who sustain accidental burns
- COMMONEST form of abuse after head injury and abdominal trauma

# Classification

- According to depth
- According to body surface affected
- According to cause

# Classification #1

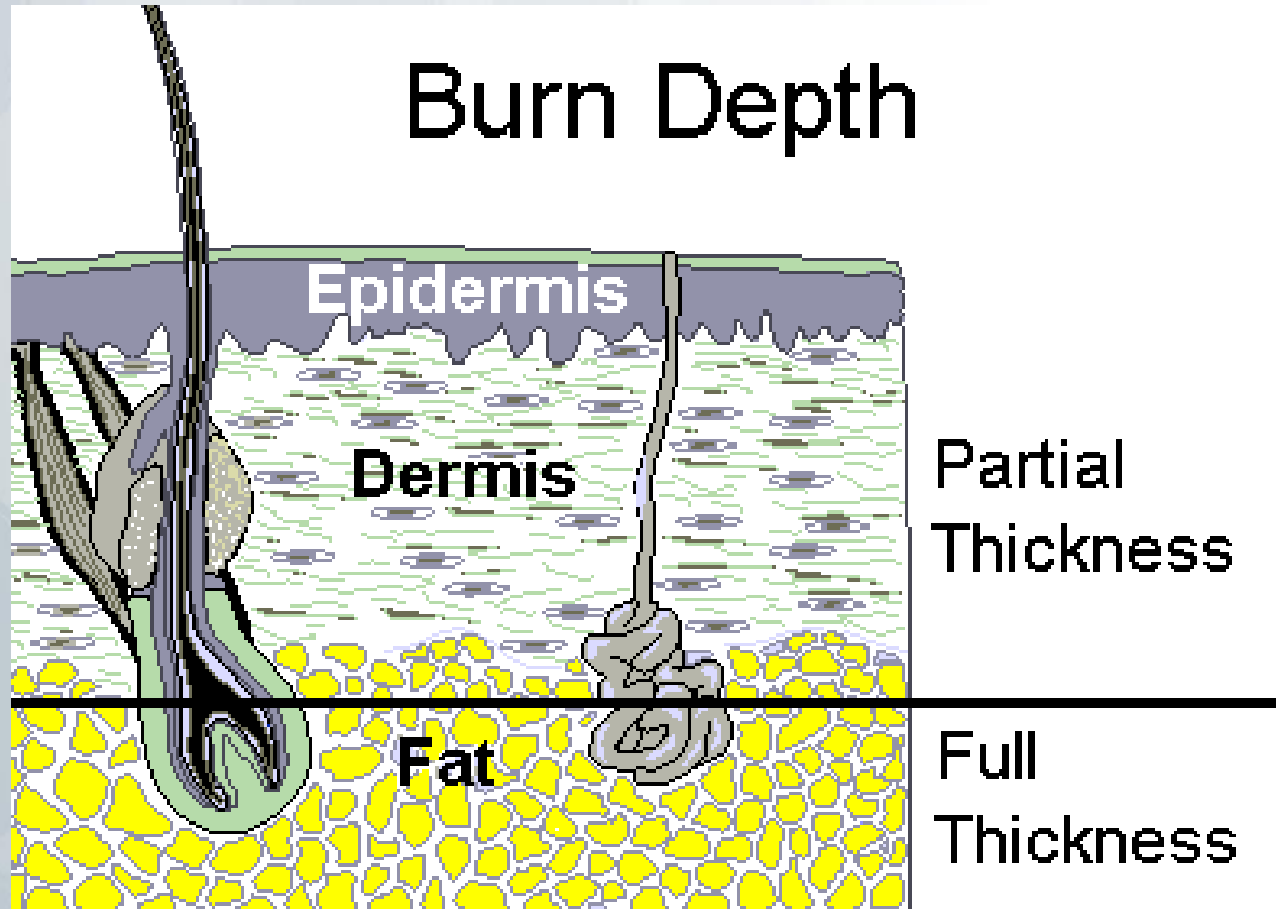
- Rule of nines for adults
- Lund-Bowder classification for children



Relative percentage of body surface area (% BSA) affected by growth

Body Part	Age				
	0 yr	1 yr	5 yr	10 yr	15 yr
a = 1/2 of head	9 1/2	8 1/2	6 1/2	5 1/2	4 1/2
b = 1/2 of 1 thigh	2 3/4	3 1/4	4	4 1/4	4 1/2
c = 1/2 of 1 lower leg	2 1/2	2 1/2	2 3/4	3	3 1/4

# Classification #2





# Superficial

Superficial burn (first degree burns):

- involves the top layer of the skin.
- painful
- dry (non blistered)
- Red
- Blanches on pressure
- heals in 3-6days without scarring
- e.g non blistered sunburn

# Superficial dermal (partial thickness)

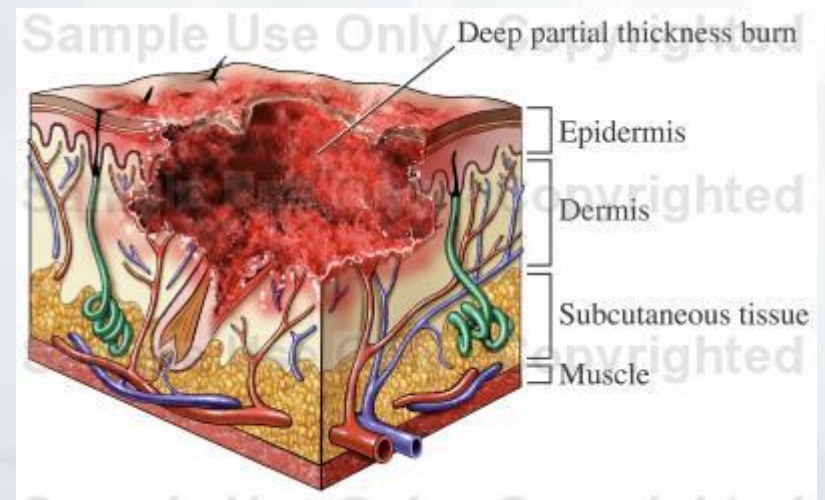
Superficial partial thickness burns  
(second degree burns)

- Involves the top 2 layers of the skin
- Painful with air movement or change in temperature
- Red, blistered and seep fluid
- Blanches with pressure
- Heals in 7-21 days
- Burned area may be darker or lighter in colour but no scarring

# Deep dermal (partial thickness)

Deep partial thickness burns (third degree burns)

- Extends deeper into the dermis
- Almost always blisters, blisters immediately and blisters may persist for several weeks
- Painful on deep pressure
- Do not blanch when pressed
- Takes more than 21 days to heal
- Always scars and the scar may be severe



# Full thickness

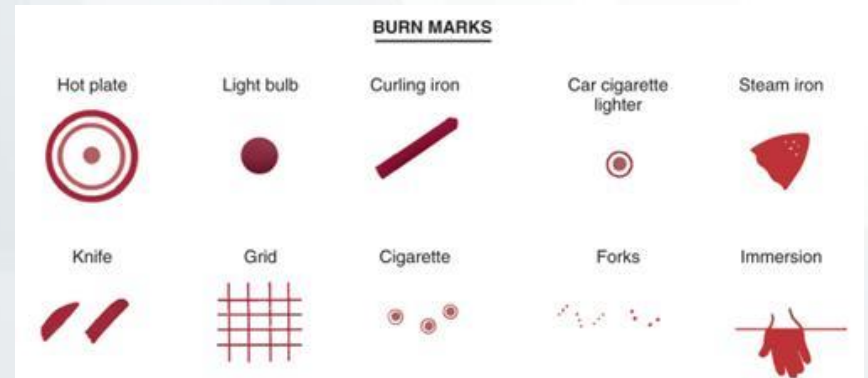
Full thickness burns (fourth degree)

- All layers of the skin completely destroying the skin
- Burned area is painless
- Burned area is waxy white, leathery grey or charred black
- Skin is dry
- Does not blanch when pressed
- Does not heal without surgery
- Scarring is severe

# Classification #3

- Contact dry burns
- Cigarette burns
- Scalds
- Fire burns
- Radiant burns
- Chemical burns
- Electric burns
- Friction burns
- Cold injury

- caused by hot objects usually metallic.
- looks like a brand mark, sharply demarcated and with the shape of the object that caused it
- burn is dry and tends to be of a uniform depth



# Examples



- Punched out,
- sharply demarcated, eschar
- Surrounding collaret of exfoliation and tissue reaction

# Cigarette burns

- Accidental burns from a cigarette are usually single, superficial, and not completely round. Common sites of accidental cigarette burns are the face, and hands.



# Scald burns

- caused by hot liquids or steam
- Patterns:
  1. Spill/Splash/Geographical or Flow type scalds also called Cascade or Pour scalds
  2. Immersion scalds

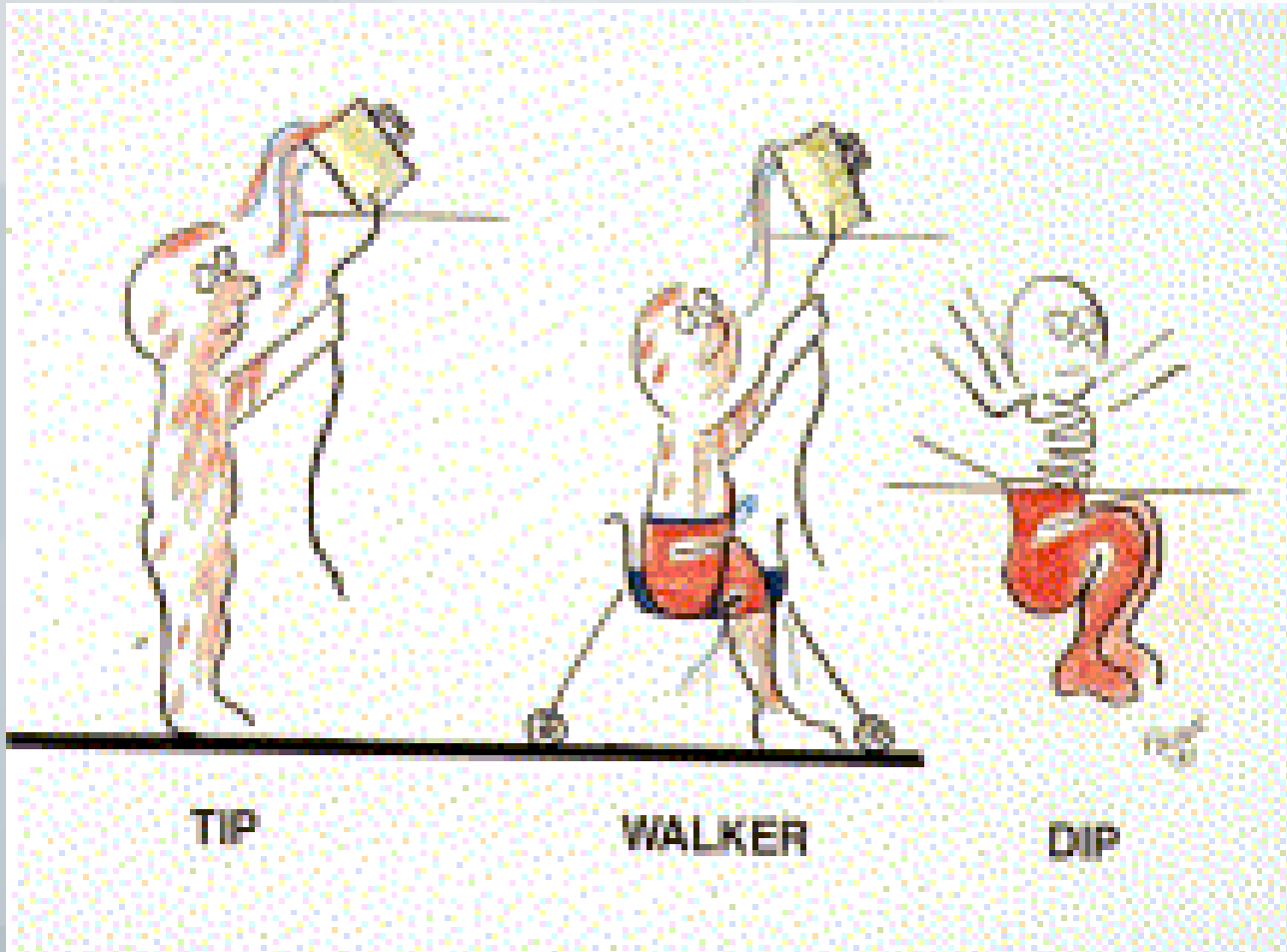
# Time to burn by water temperature

- 1 second at 65 C
- 2 seconds at 60 C
- 12 seconds at 55 C
- 2 minutes at 50 C
- The time to burn in children would be shorter given that a child's skin is thinner than that of an adult

# Features of scald burn

- Clothing wet
- Skin sodden and bleached
- Red line of demarcation between burned and non burned skin
- Vesication most marked over burned area
- Trickle and splash marks

# Splash / spill / geographic



- Hot liquid falls from height
- Accidental pulls or spills
- Splash burns at site of initial contact
- Usually superficial as contact time is short

# Splash marks

- Absence used to be thought to be suggestive of abuse
- Not current thinking as children being held could struggle / not all immersions injuries are only immersion injuries

# Accidental pattern



- In the younger child accidental spill or flow scalds are usually frontal, asymmetric and on the head, neck and upper trunk
- In the older child they may occur on the lower trunk, and limbs including legs and thighs.

# Spill burns

- Uneven in depth; deeper at the first point of contact become superficial distally as the liquid cools as it flows downwards.
- As the hot liquid flows down it causes scalds in the shape of flow tracks and ends in an inverted arrow head or arrow down shape

# Tap flow scald

- Note splash marks
- Flow track
- Arrow head at the distal end of flow



# Immersion burns

- Concerning for abuse
- Location: buttocks, perineum, extremities
- Circumferential
- Uniform depth
- Absence of splash marks
- Tide marks
- Sparing

# Location

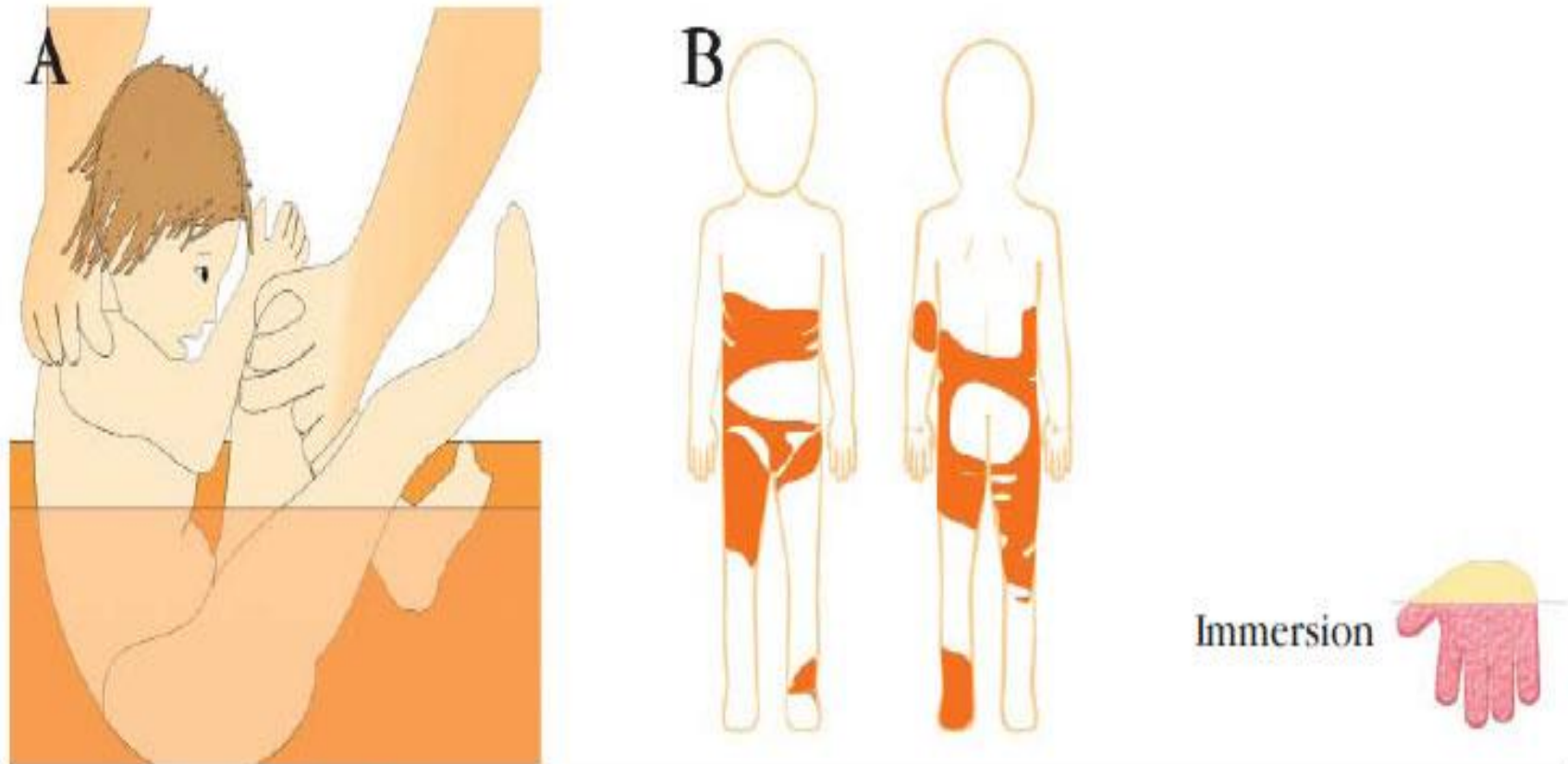
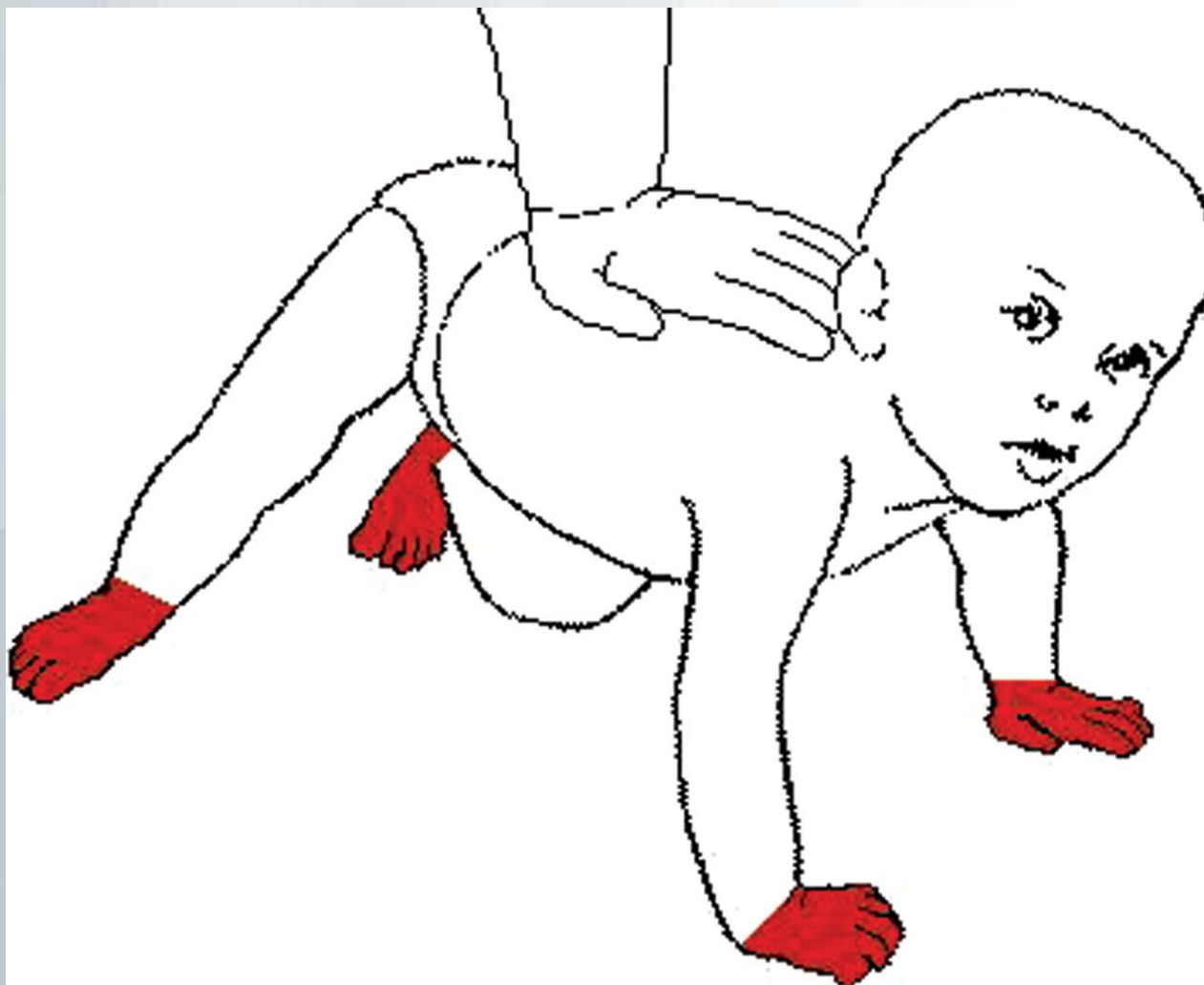


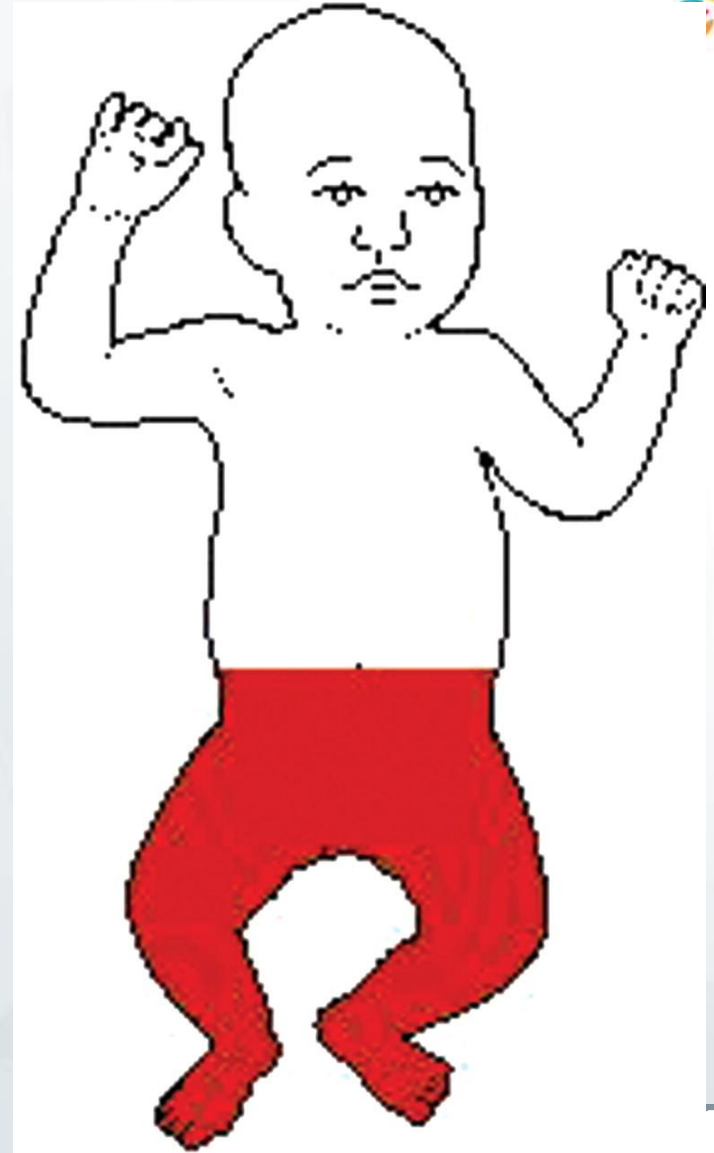
FIGURE 2: A. Scald; B. "Zebra striae" with preservation of the gluteal region (resting point) and C. "glove" burn  
*Adapted source: Kos L, Shwayder T<sup>8</sup>*

# Location



# Location

- Uniformity of depth of burns
- Water line or tide marks-horizontal marks indicating depth of immersion



# Location



- Absence of splash marks concerning for abuse
- However debatable. At temp < 54C takes time to burn so absence of splash marks neither supports or refutes abuse.
- Besides abused children could struggle and have splash marks

# Immersion patterns

- circumferential
- water tide mark
- Sparing of flexures

# Sparing

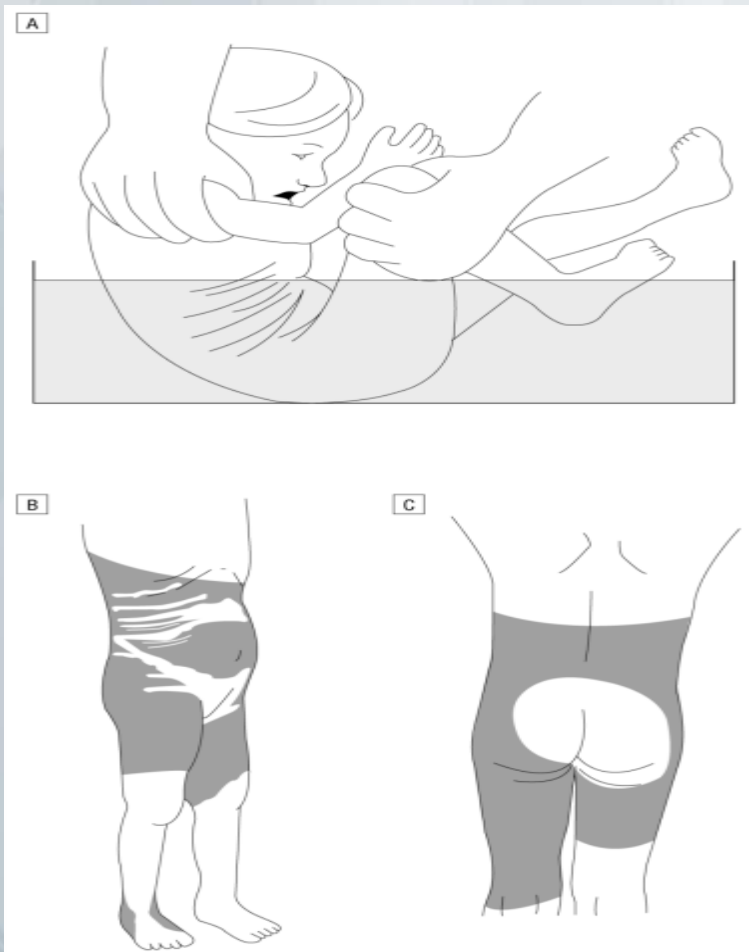


# Immersion burns - sparing

- “Hole in the doughnut” or “halo sign”
- When a child is forcibly seated in hot water in a tub the contact of the buttocks with the cooler surface of the tub causes an area on the buttocks that escapes burning or has less severe burning.



# Immersion burns - sparing



- When a child is forcibly submersed (A), if held in a flexed position, the flexural skin creases will be spared, resulting in the "zebra stripe" scald pattern (B). If the child is pushed against the bottom of the cooler container during scalding, the "doughnut hole" scald pattern may result (C).

# Flame burns

- Clothing burned
- Skin dry and charred
- Blistering may be seen at the edge of the burn
- Red line of demarcation between burned and non burned skin
- Ulceration only when burn is infected

# Radiation burns - sunburns

- Sunburns are radiant burns
- May be superficial or superficial partial thickness burns
- May be as a result of neglect

# Radiation burns – UV light therapy



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# Chemical burns

- Clothing have typical stains and odour
- Skin may be stained- black by hydrochloric acid, yellow by nitric acid, and brown by sulphuric acid
- Vesication rarely seen
- Red line of demarcation rarely seen
- Burns are deep or deep partial thickness
- Significant ulceration due to penetration and devitalisation effects of the corrosives

# Electric burns

- Low voltage burns
- Mostly in children <5 yrs
- Mouth and hand
- Contact with wire with worn out insulation
- Small burn
- But deep and involving muscle, vessels and tendons
- High voltage burns
- Entry charred centrally depressed and leathery
- exit- exploded
- Widespread tissue destruction between
- High fatality

# Friction burn

- Friction burn is a form of abrasion and burn caused by rubbing of the skin against a surface when the friction is severe enough to generate heat

# Cold injury

## Non freezing:

- Chilblains: cold wet weather, painful or itchy purple red papules or reddened swollen toes, nose, ears
- Immersion foot

## Freezing

- Frost nip
- Frost bite



# Approach to burns

- Complete history and examination
- Re-iterate the injury history to ensure that all available information in relation to injury mechanism and cause has been obtained.
- Thorough documentation of the injuries, medical photography
- Seek an explanation for the injury found
- Appropriate investigations – lab tests, imaging, injury site investigation,

# Key questions

- Does the description of how the burn was caused fit with this child's stage of development?
- Does the pattern of the burn fit with the description of cause given?
- Is the description of how this burn occurred consistent with the environment where it took place?
- Do the clinical features of the burn fit with the mechanism described?

# Causes

- Accident: Unavoidable or understandable lapse in the usual protection given to children.
- Neglect/negligence; failure to protect the child from inadequate parenting.
- Abuse: deliberately inflicting the injury

# Features concerning for abusive burns



- **History in compatible with examination findings;** Denial by carer that the injury is a burn, history not compatible with the physical features of the burns for example history stating a flow mechanism when the pattern is clearly one of immersion scalds. When the pattern of burns is incompatible with the development of the child
- **Delay in presentation for treatment of burns**
- **Child brought in someone other than parent**
- **Blaming a sibling**
- **Passive introverted fearful child**
- **Associated unrelated injury:** Bruises, lacerations and swellings are reported to be more common in children with intentional scalds compared to children with accidental scalds. Rarely scalds are associated with sexual abuse
- **Coexisting fractures:** Obvious fractures on examination of a child with burns or occult fractures on imaging suggest that burns may be inflicted
- **Scars from previous burn in injuries**
- **Clinical features of neglect and failure to thrive.**
- **Total burn surface area:** There is disagreement whether total burn surface area is greater in inflicted rather than accidental burns

When an intentional scald must be excluded	When an intentional scald must be considered	When an intentional scald is unlikely
<p style="text-align: center;"><u>Physical features</u></p> <p><b>Mechanism:</b></p> <ul style="list-style-type: none"> <li>• Immersion</li> </ul> <p><b>Agent:</b></p> <ul style="list-style-type: none"> <li>• Hot tap water</li> </ul> <p><b>Pattern:</b></p> <ul style="list-style-type: none"> <li>• Clear upper limits</li> <li>• Scald symmetry (extremities)</li> </ul> <p><b>Distribution:</b></p> <ul style="list-style-type: none"> <li>• Isolated scald buttock / perineum</li> <li>• +/- lower extremities</li> <li>• Isolated scald lower extremities</li> </ul> <p style="text-align: center;"><u>Clinical features</u></p> <ul style="list-style-type: none"> <li>• Associated unrelated injury</li> <li>• History incompatible with examination findings</li> <li>• Co-existing fractures</li> </ul> <p style="text-align: center;"><u>Historical / Social features</u></p> <ul style="list-style-type: none"> <li>• Passive, introverted, fearful child</li> <li>• Previous abuse</li> <li>• Domestic violence</li> <li>• Numerous prior accidental injuries</li> <li>• Sibling blamed for scald</li> </ul>	<p style="text-align: center;"><u>Physical features</u></p> <p><b>Pattern:</b></p> <ul style="list-style-type: none"> <li>• Uniform scald depth</li> <li>• Skin fold sparing</li> <li>• Central sparing buttocks</li> </ul> <p><b>Distribution:</b></p> <ul style="list-style-type: none"> <li>• Glove and stocking distribution</li> <li>• 1 limb glove / stocking</li> </ul> <p style="text-align: center;"><u>Clinical features</u></p> <ul style="list-style-type: none"> <li>• Previous burn injury</li> <li>• Neglect / faltering growth</li> <li>• History inconsistent with assessed development</li> </ul> <p style="text-align: center;"><u>Historical / Social features</u></p> <p><b>Trigger, such as:</b></p> <ul style="list-style-type: none"> <li>• Soiling / enuresis / misbehaviour</li> <li>• Differing historical accounts</li> <li>• Lack of parental concern</li> <li>• Unrelated adult presenting child</li> <li>• Child known to social services</li> </ul>	<p style="text-align: center;"><u>Physical features</u></p> <p><b>Mechanism:</b></p> <ul style="list-style-type: none"> <li>• Spill injury</li> <li>• Flowing water injury</li> </ul> <p><b>Agent:</b></p> <ul style="list-style-type: none"> <li>• Non tap water (hot beverage)</li> </ul> <p><b>Pattern:</b></p> <ul style="list-style-type: none"> <li>• Irregular margin and burn depth</li> <li>• Lack stocking distribution</li> </ul> <p><b>Distribution:</b></p> <ul style="list-style-type: none"> <li>• Asymmetric involvement lower limbs</li> <li>• Head, neck and trunk or face and upper body</li> </ul>

# Differentials

- Infection - HSV / impetigo / ringworm
- Irritant contact dermatitis
- Toxic Shock / TENS
- EB / chronic bullous disorders
- Birthmarks with ulceration
- Phytodermatitis
- Cultural practices

# Phytophotodermatitis

Limes/Lemons/Oranges

Celery

Grasses

Parsley

Parsnips

Sagebrush

Goldenrod

Chrysanthemum

Ragweed

Cocklebur

Tobacco

Figs

Garlic

Hot peppers



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# Phytophotodermatitis

- Temporal exposure with phototoxic furocumarins in some plants and UVA 320-380 nm = phototoxic skin eruption
- Begins 24 h after exposure peaks at 48 -72 h
- Burning sensation - erythema and blisters, look like burns, followed by pigmentation, may look like bruises
- Prior sensitisation is not required
- Bizarre patterns may be seen
- Has been mistaken for abuse when finger impressions patterns are seen as carer touches child after handling the plant material



# Cultural practices

- **Garlic is folk remedy for a variety of illnesses**
- **fresh garlic can be a potent irritant under occlusive conditions**
- **Diallyl disulfide, allyl propyl disulfide, and allicin are the principal allergens.**
- **Diallyl disulfide also causes acantholysis**
- **infants may require 6 to 8 hours of exposure to induce a chemical burn**

# Cultural practices

- Salting
- Application of salt to skin-Turkish custom to improve complexion
- Can result in epidermolysis (looks like burns) and hypernatremia

# Cultural Practices

- Coining
- Cupping

# Questions / Comments...?



# References

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- Maguire S, Moynihan S, Mann M., Potokar T, Kemp A.M. A systematic review of the features that indicate intentional scalds in children. Burns 2008; 34(8): 1072-81.
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