Pediatric Burn Management

PABLO AGUAYO, MD

BURN DIRECTOR CHILDREN'S MERCY KANSAS CITY

Objectives

- Categorize burn depth and its significance
- Identify surface area of burn and significance
- Review ABA referral guidelines and transport guidelines
- Discuss pre-burn center fluid management
- Non-accidental burns
- Transport recommendations


Some things are just
bad combinations.
Canada


NUTS
AND
GUM
TOGETHER
AT LAST!


BBQ
FIREWORKS

Epidemiology

- >500,000 people affected by burn injuries each year
- Approximately 60,000 pediatric burn admissions per year
- Nearly 4,000 deaths/year related to burns and associated complications
  - Risk of mortality proportional to extent of burn and patient's age
  - Deaths usually occur immediately after injury or several weeks later in response to infection/sepsis, multisystem organ failure, or hypermetabolic response

Epidemiology

- Fire and burn deaths 3rd leading cause of unintentional deaths in children <14yrs
  - Most occur in the home
- Burns considered one of the most pathophysiogical and psychologically stressful injuries
- TBSA and mortality
    - Historical mortality
      - 1949: 50% death for kids with >49% TBSA
      - 2018:50% death for kids with >98% TBSA


LOLPix.com
IT'S FINE
We still got this.


THEY CALL ME A
NURSE
BECAUSE APPARENTLY
BADASS
LIFE SAVER
ISN'T A JOB TITLE


THIS IS WHY EMERGENCY
ROOMS EXIST

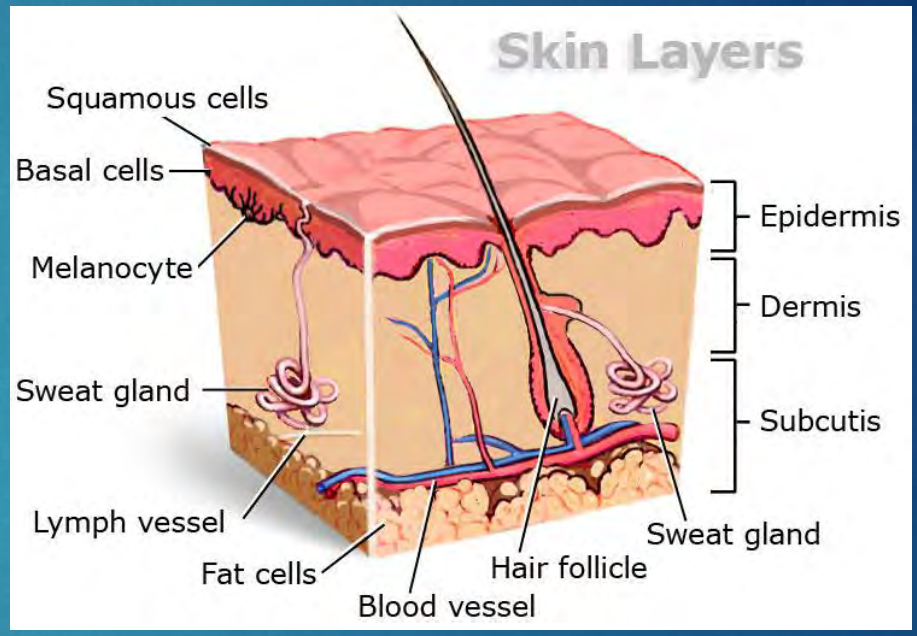
The relevance of anatomy and burns

Pediatric Burns

- Largest organ in the human body
  - Structural support
  - Immunity
  - Regulation of heat and water loss
- Comprised of three layers
  - Epidermis
  - Dermis
  - Subcutaneous tissue

Pediatric Burns

- Thickness of epidermis is variable
- Dermis constitutes majority of skin's thickness, variable as well
  - Vascular
  - Innervated
  - Mostly collagen
  - Adnexal structures



Time of contact

- In the 1940's Moritz et al documented the time required in order to sustain a full thickness burn from hot water.
- 160: <1 sec <1 sec
- 150: 2 sec <2 sec
- 140: 5 sec <5 sec
- 130: 30 sec 15 sec
- 120: 10 min 5 min

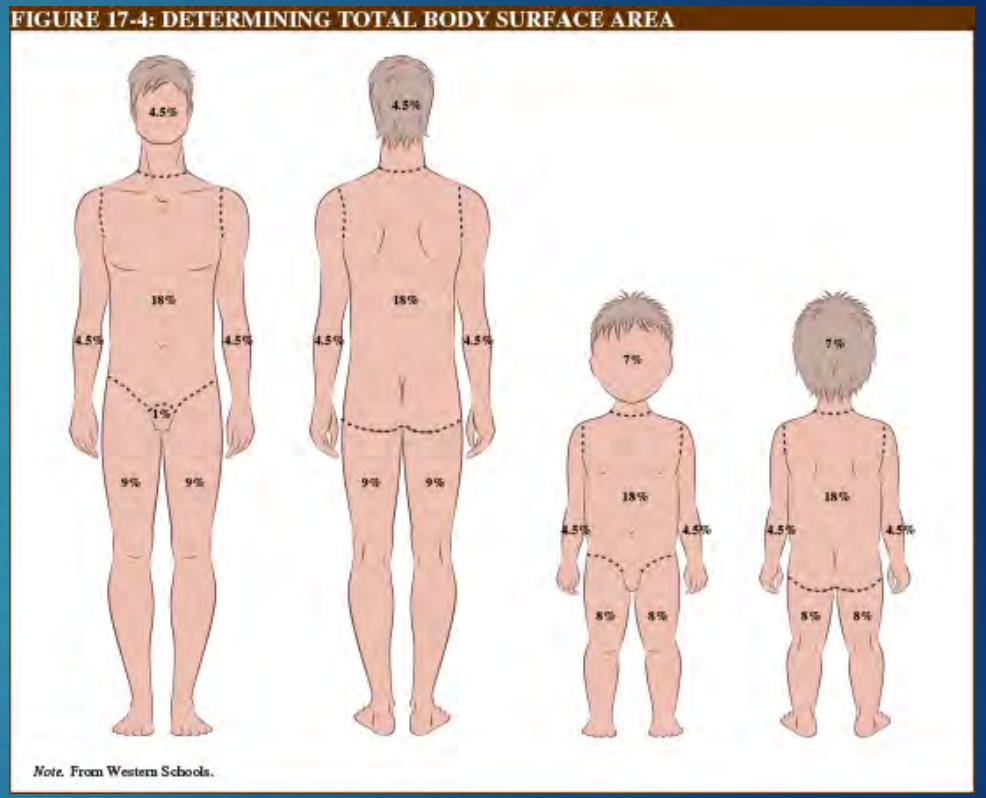
- With regards to blood supply, the more vascular an area is (is face) the more the heat can dissipate more efficiently.

Common temperatures

- 102-104 Spa/Jacuzzi
- 120 F Recommended water heater setting
- 175-180 F Holding temperature fast food coffee
- 212 F Boiling water
- 300-500F Grease frying

Pediatric Burns-Body Surface Area

- Relatively greater surface area per unit of body weight
  - A 7kg boy is 1/10 the size of adult but has 1/3 the surface area



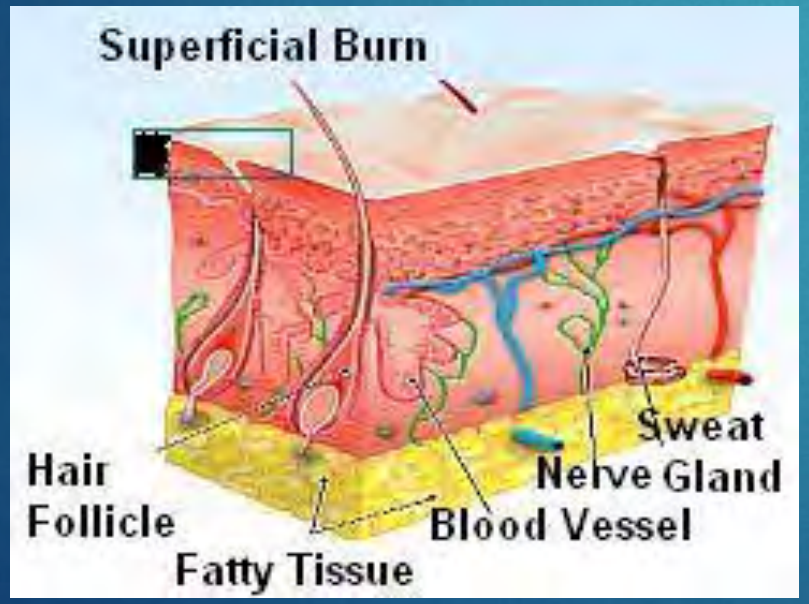
Pediatric Burns-Temp Regulation and Thickness of skin

- Body heat rapidly lost secondary to more surface area
- Babies <6 months do not shiver
- Thinner dermal layer

Burn Depth and Total Body Surface Area

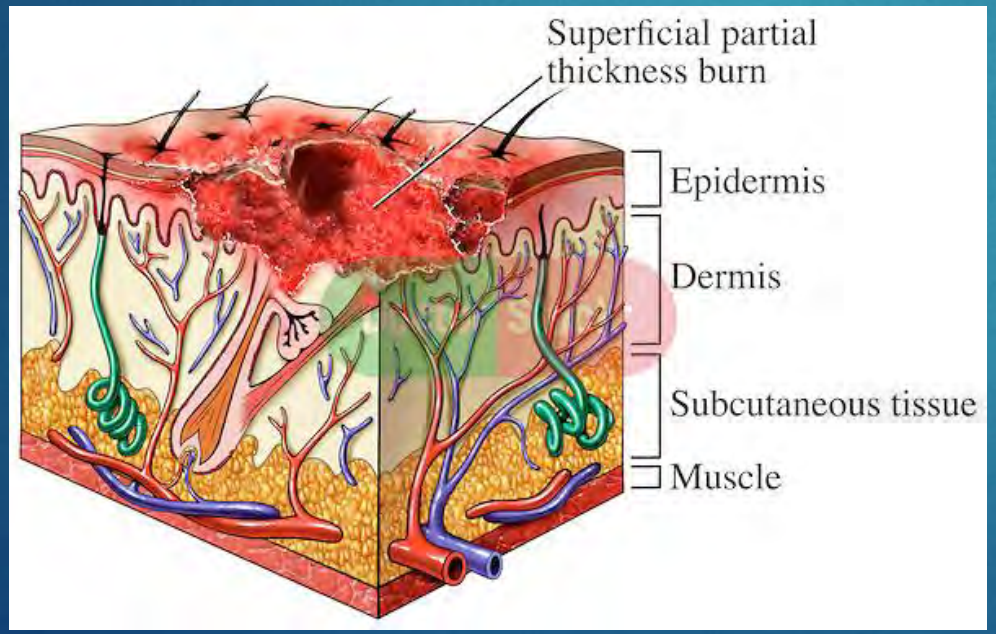
Depth of Burns

- Superficial burns (1st degree);
- Injury confined to outer epidermal layer of skin
- No disruption of skin integrity; pain, erythema



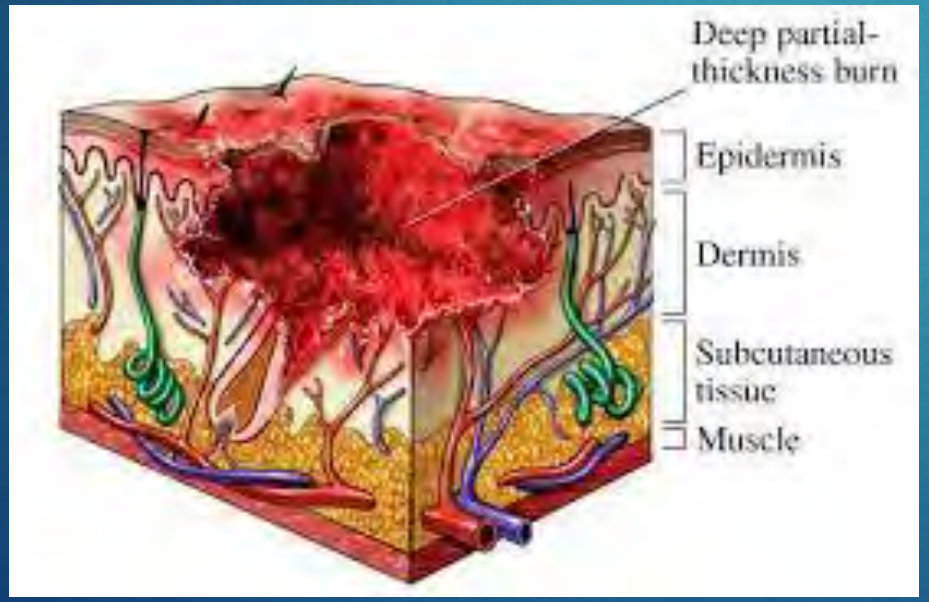
Depth of Burns

- Partial thickness burns (2nd degree);
- Destroys epidermis and part of dermis
- Blisters, bright red, mottled, wet, severe pain



Depth of Burns

- Deep, partial thickness burns (2nd degree);
- Complete destruction of epidermis, severe dermal
- Few dermal appendages; Dark-red/yellow-white, slightly moist, minimally blanch, decreased sensation

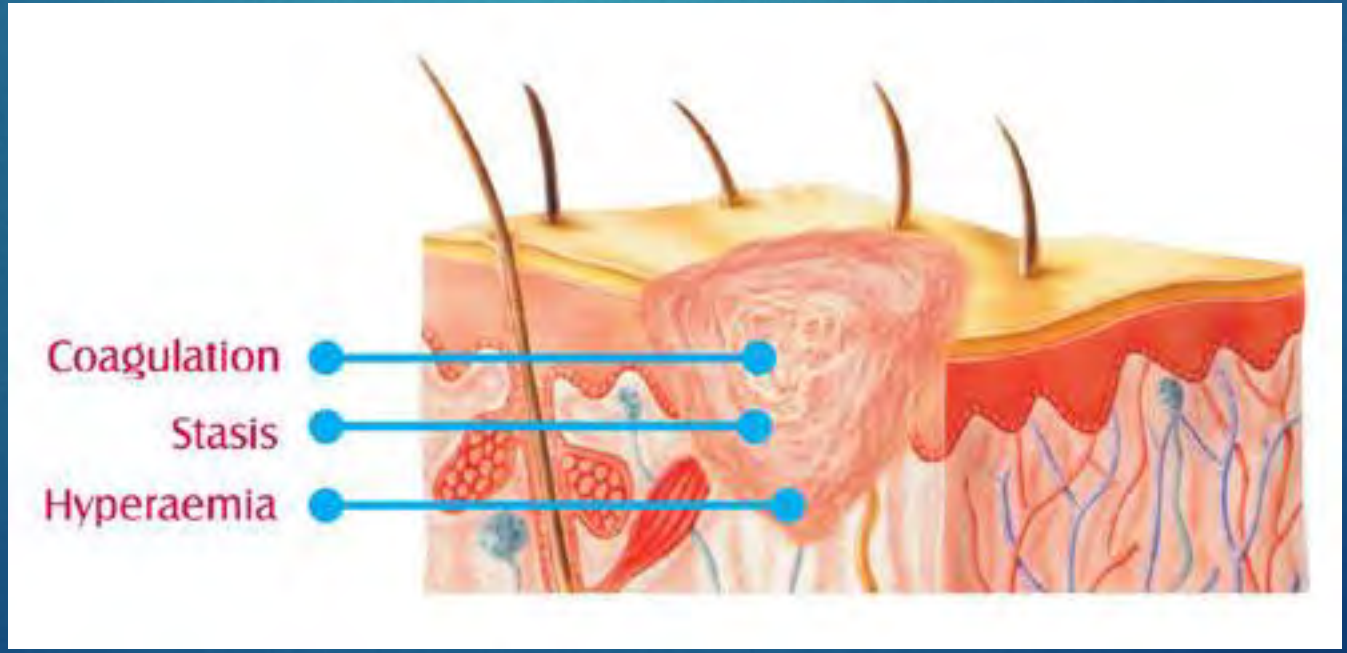


Depth of Burns

- Full thickness burns(3rd degree);
- Injury to epidermis, dermis and subcut tissue
- Charred or white, dry, leathery, insensate, thrombosed blood vessels

Depth of Burns

- Mechanism causing injury is through coagulation necrosis
- 3 concentric zones of thermal injury: coagulation, stasis, and hyperemia



Why is it important to measure TBSA?

Because EVERYTHING depends on it!!!

Errors of size estimation before burn center transfer are frequent

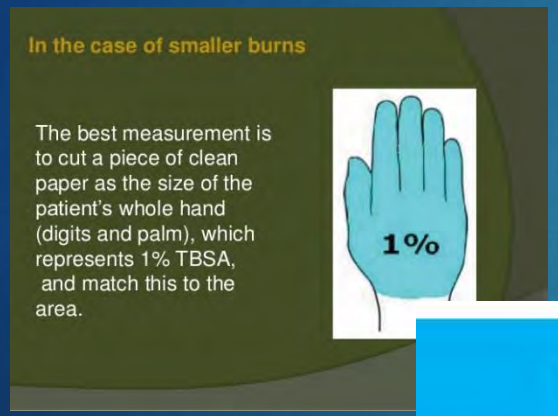
Absolute errors 1.3%-16%, mean 6.28%

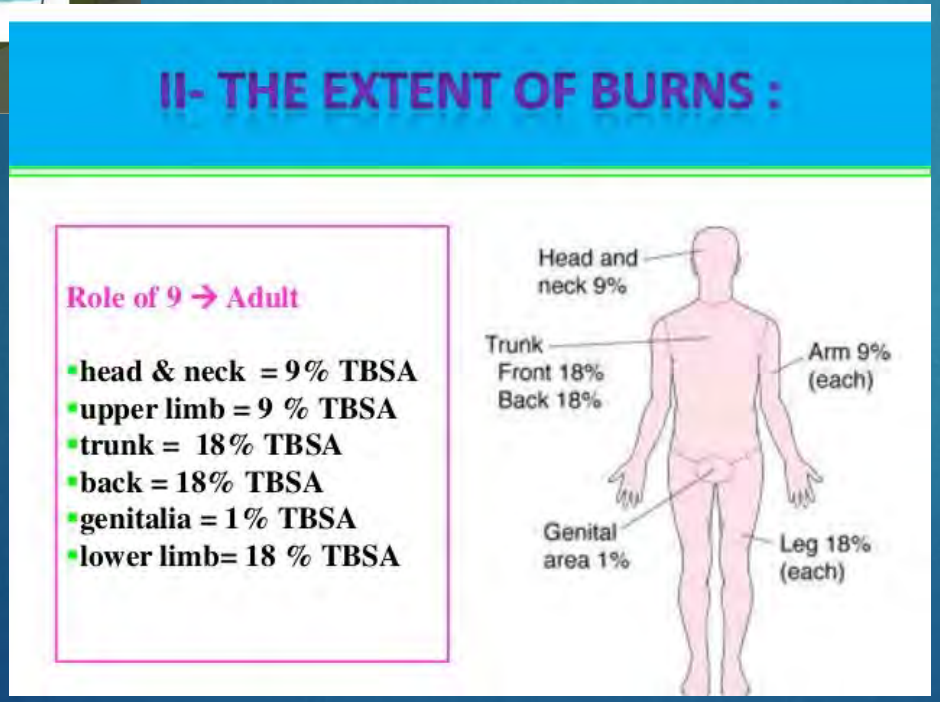
Overestimation more common

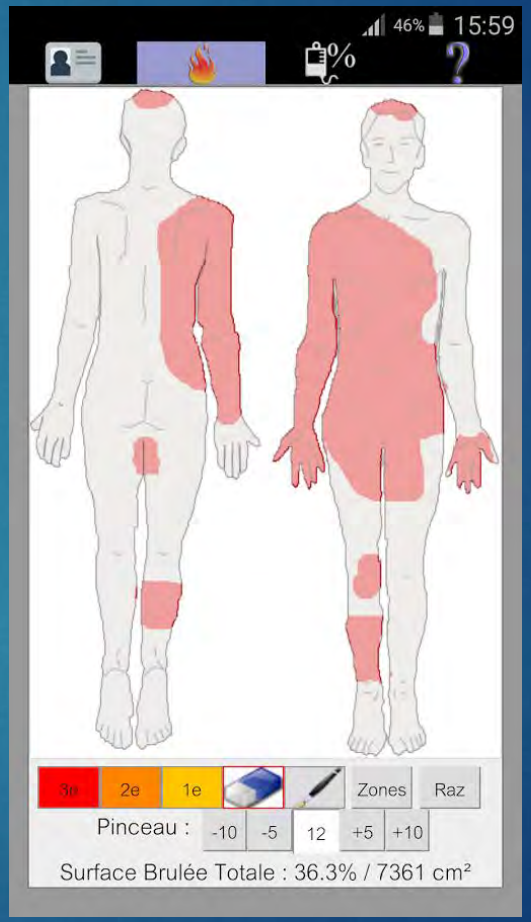
Relative error: 75%-3500%

12%-60% have no estimation

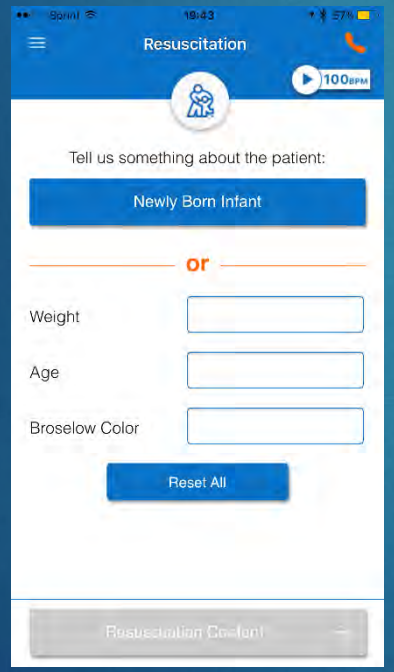
How do you assess size of the burn?

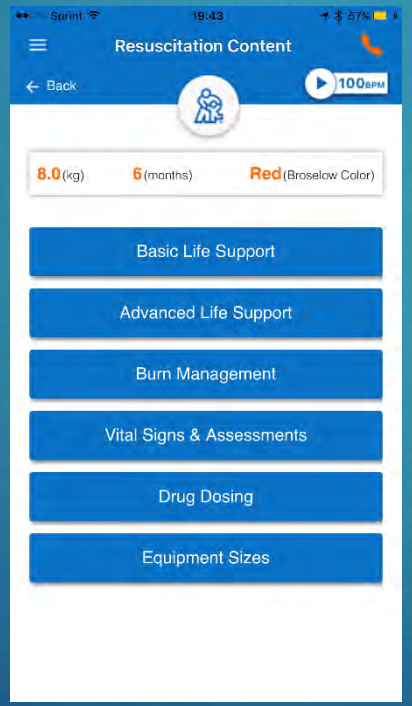


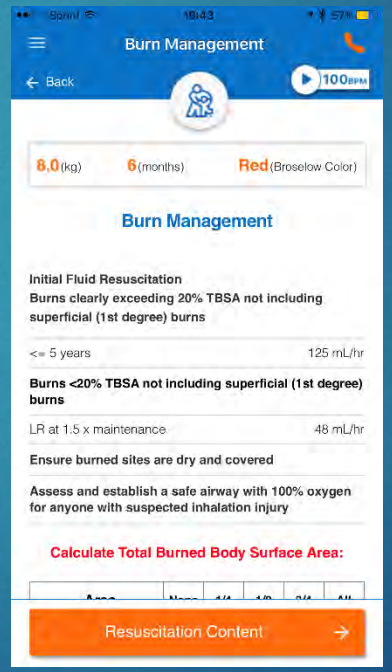


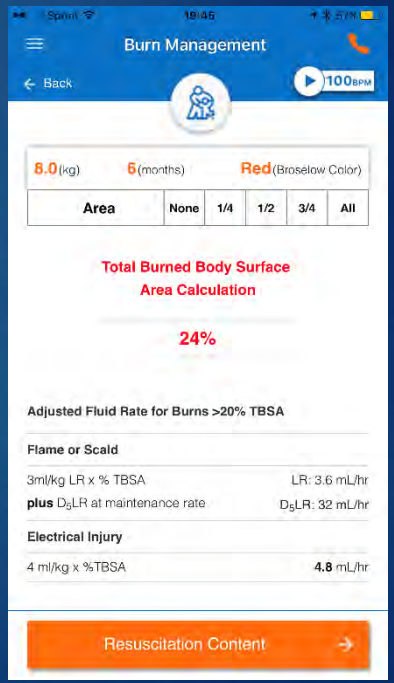


Coming Soon:
CMH Pediatric Resuscitation App



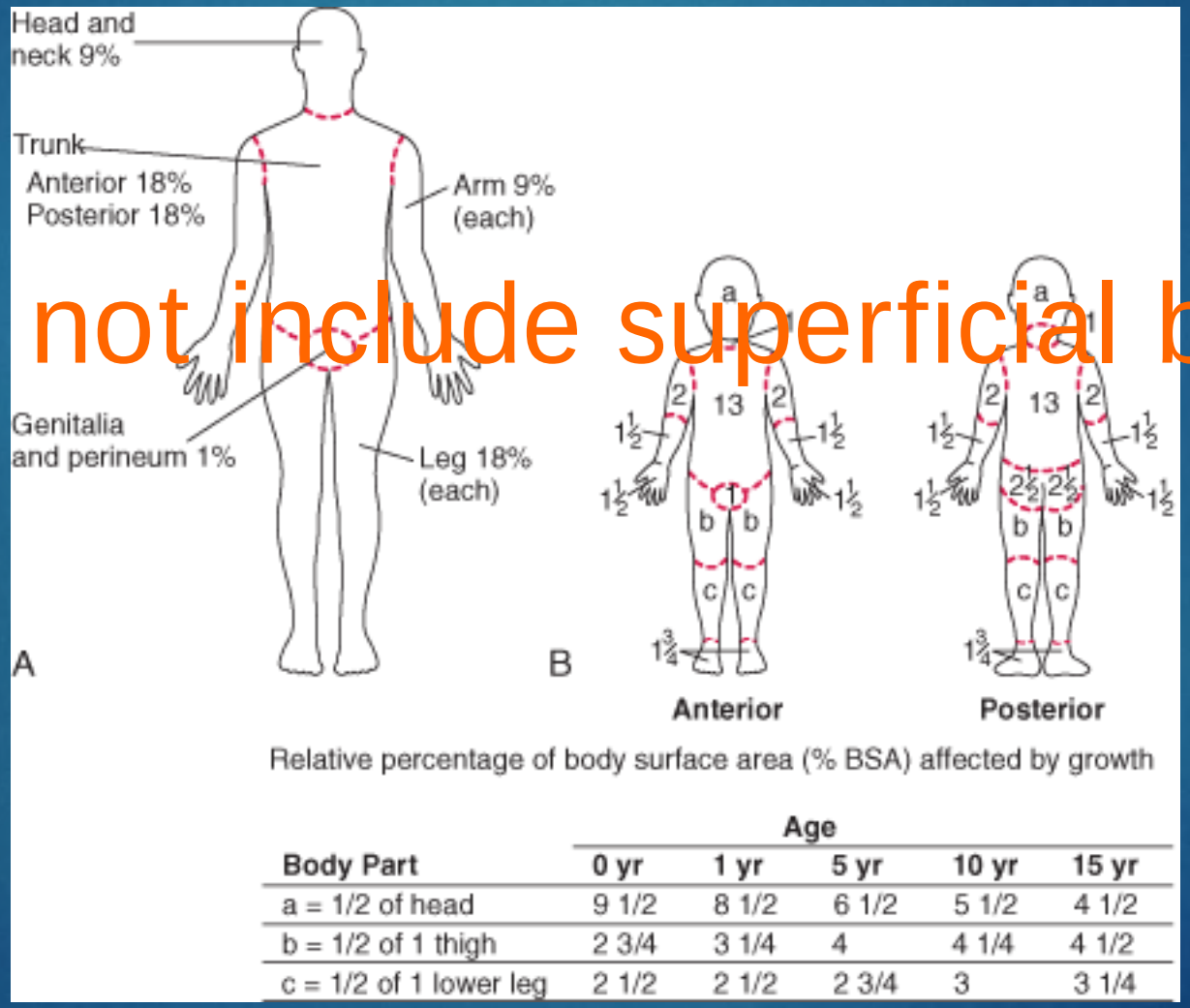






Assessing Extent of Burn

Lund-Browder Chart



Do not include superficial burns

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

Tools you will need

Courtesy of the
American Burn Association
Advanced Burn Life Support (ABLS)
Learn more about the ABA and ABLS at **www.ameriburn.org**

Burn Center Referral Criteria

A burn center may treat adults, children, or both.

Burn injuries that should be referred to a burn center include:

1. Partial thickness burns greater than 10% total body surface area (TBSA).
2. Burns that involve the face, hands, feet, genitalia, perineum, or major joints.
3. Third degree burns in any age group.
4. Electrical burns, including lightning injury.
5. Chemical burns.
6. Inhalation injury.
7. Burn injury in patients with preexisting medical disorders that could complicate management, prolong recovery, or affect mortality.
8. Any patient with burns and concomitant trauma (such as fractures) in which the burn injury poses the greatest risk of morbidity or mortality. In such cases, if the trauma poses the greater immediate risk, the patient may be initially stabilized in a trauma center before being transferred to a burn unit. Physician judgment will be necessary in such situations and should be in concert with the regional medical control plan and triage protocols.
9. Burned children in hospitals without qualified personnel or equipment for the care of children.
10. Burn injury in patients who will require special social, emotional, or rehabilitative intervention.

Excerpted from Guidelines for the Operation of Burn Centers (pp. 79-86), Resources for Optimal Care of the Injured Patient 2006, Committee on Trauma, American College of Surgeons

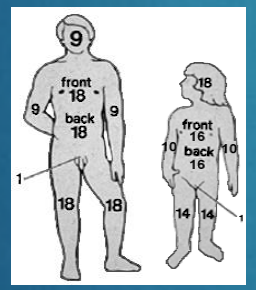
Severity Determination

First Degree (*Partial Thickness*)
Superficial, red, sometimes painful.

Second Degree (*Partial Thickness*)
Skin may be red, blistered, swollen. Very painful.

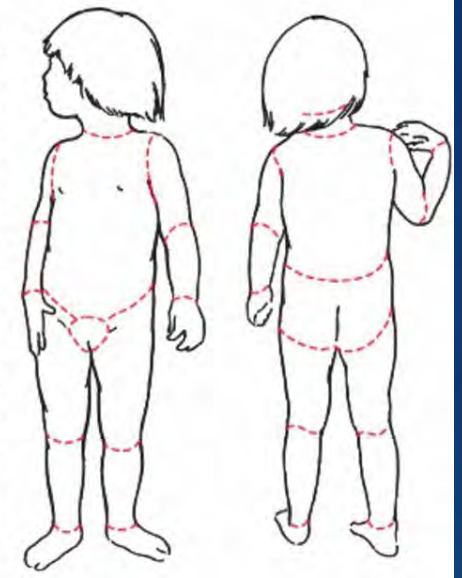
Third Degree (*Full Thickness*)
Whitish, charred or translucent, no pin prick sensation in burned area.

Percentage Total Body Surface Area (TBSA)



Burn Estimate: Age Versus Area

	Birth-1 yr	1-4 yr	5-9 yr	10-14 yr	15 yr	2°	3°	Total
Head	19	17	13	11	9			
Neck	2	2	2	2	2			
Anterior trunk	13	13	13	13	13			
Posterior trunk	13	13	13	13	13			
Right buttock	2½	2½	2½	2½	2½			
Left buttock	2½	2½	2½	2½	2½			
Genitalia	1	1	1	1	1			
Right upper arm	4	4	4	4	4			
Left upper arm	4	4	4	4	4			
Right lower arm	3	3	3	3	3			
Left lower arm	3	3	3	3	3			
Right hand	2½	2½	2½	2½	2½			
Left hand	2½	2½	2½	2½	2½			
Right thigh	5½	6½	8	8½	9			
Left thigh	5½	6½	8	8½	9			
Right leg	5	5	5½	6	6½			
Left leg	5	5	5½	6	6½			
Right foot	3½	3½	3½	3½	3½			
Left foot	3½	3½	3½	3½	3½			
					Total			



How deep?

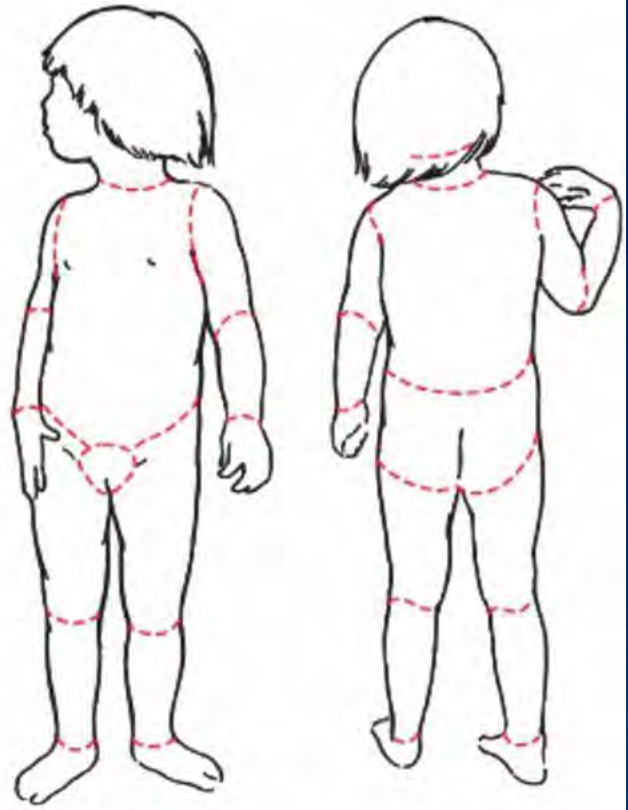
Wet Blisters Tender Blanches

Superficial, partial thickness

TBSA?

Burn Estimate: Age Versus Area

	Birth-1 yr	1-4 yr	5-9 yr	10-14 yr	15 yr	2°	3°	Total
Head	19	17	13	11	9			
Neck	2	2	2	2	2			
Anterior trunk	13	13	13	13	13			
Posterior trunk	13	13	13	13	13			
Right buttock	2½	2½	2½	2½	2½			
Left buttock	2½	2½	2½	2½	2½			
Genitalia	1	1	1	1	1			
Right upper arm	4	4	4	4	4			
Left upper arm	4	4	4	4	4			
Right lower arm	3	3	3	3	3			
Left lower arm	3	3	3	3	3			
Right hand	2½	2½	2½	2½	2½			
Left hand	2½	2½	2½	2½	2½			
Right thigh	5½	6½	8	8½	9			
Left thigh	5½	6½	8	8½	9			
Right leg	5	5	5½	6	6½			
Left leg	5	5	5½	6	6½			
Right foot	3½	3½	3½	3½	3½			
Left foot	3½	3½	3½	3½	3½			
					Total			



TBSA?

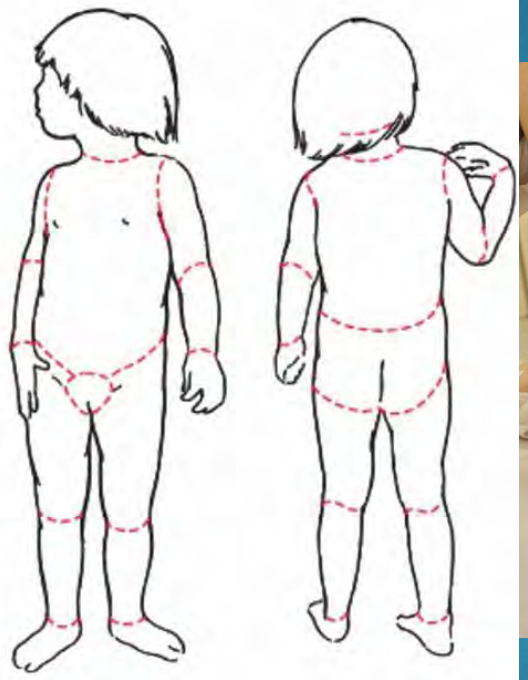
Anterior Trunk: 13% TBSA

TBSA?

1.	13/4=	3.25%
2.	3.25/2=	1.5%
TBSA		4.75%

Burn Estimate: Age Versus Area

	Birth-1 yr	1-4 yr	5-9 yr	10-14 yr	15 yr	2°	3°	Total
Head	19	17	13	11	9			
Neck	2	2	2	2	2			
Anterior trunk	13	13	13	13	13			
Posterior trunk	13	13	13	13	13			
Right buttock	2½	2½	2½	2½	2½			
Left buttock	2½	2½	2½	2½	2½			
Genitalia	1	1	1	1	1			
Right upper arm	4	4	4	4	4			
Left upper arm	4	4	4	4	4			
Right lower arm	3	3	3	3	3			
Left lower arm	3	3	3	3	3			
Right hand	2½	2½	2½	2½	2½			
Left hand	2½	2½	2½	2½	2½			
Right thigh	5	6½	8	8½	9			
Left thigh	5½	6½	8	8½	9			
Right leg	5	5	5½	6	6½			
Left leg	5	5	5½	6	6½			
Right foot	3½	3½	3½	3½	3½			
Left foot	3½	3½	3½	3½	3½			
					Total			



TBSA?

TBSA Left Thigh: 6.5%

What is TBSA?

TBSA: Anterior torso 4.75% + left thigh 6.5%= 11.25%

How deep?

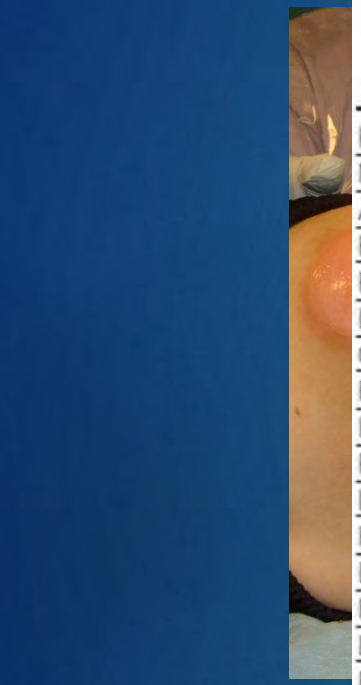
Wet Blisters Blanches Partial thickness

How deep?

Less wet Central part non-blanching

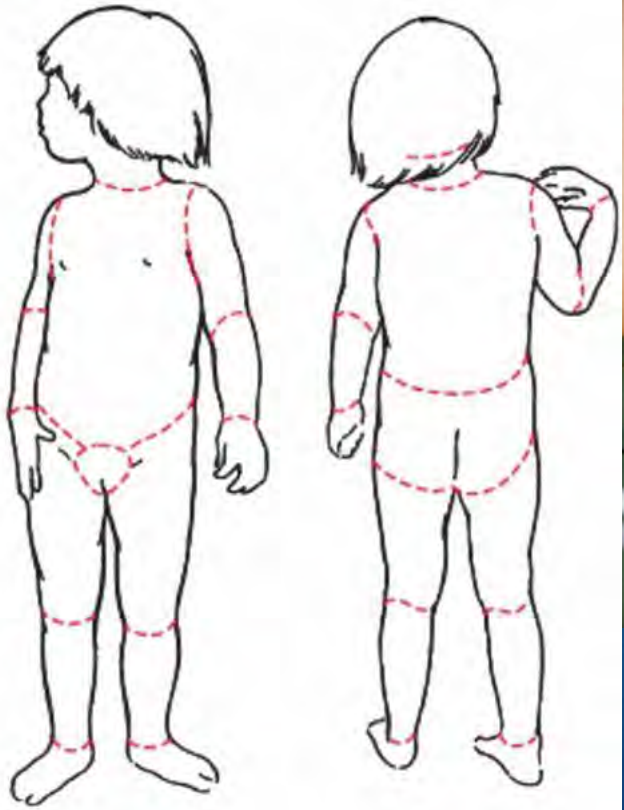
Insensate in center, sensate on periphery

TBSA?



Burn Estimate: Age Versus Area

	Birth-1 yr	1-4 yr	5-9 yr	10-14 yr	15 yr	2°	3°	Total
Head	19	17	13	11	9			
Neck	2	2	2	2	2			
Anterior trunk	13	13	13	13	13			
Posterior trunk	13	13	13	13	13			
Right buttock	2½	2½	2½	2½	2½			
Left buttock	2½	2½	2½	2½	2½			
Genitalia	1	1	1	1	1			
Right upper arm	4	4	4	4	4			
Left upper arm	4	4	4	4	4			
Right lower arm	3	3	3	3	3			
Left lower arm	3	3	3	3	3			
Right hand	2½	2½	2½	2½	2½			
Left hand	2½	2½	2½	2½	2½			
Right thigh	5½	6½	8	8½	9			
Left thigh	5½	6½	8	8½	9			
Right leg	5	5	5½	6	6½			
Left leg	5	5	5½	6	6½			
Right foot	3½	3½	3½	3½	3½			
Left foot	3½	3½	3½	3½	3½			
					Total			



TBSA?

TBSA?

1. Define anatomic limits: Posterior torso: 13%TBSA

TBSA?

13/2= 6.5% TBSA Guesstimate 2% no burn (hand)

TBSA: 6.5% - 2% = 4.5% sup and deep

How deep: Mixed partial and deep

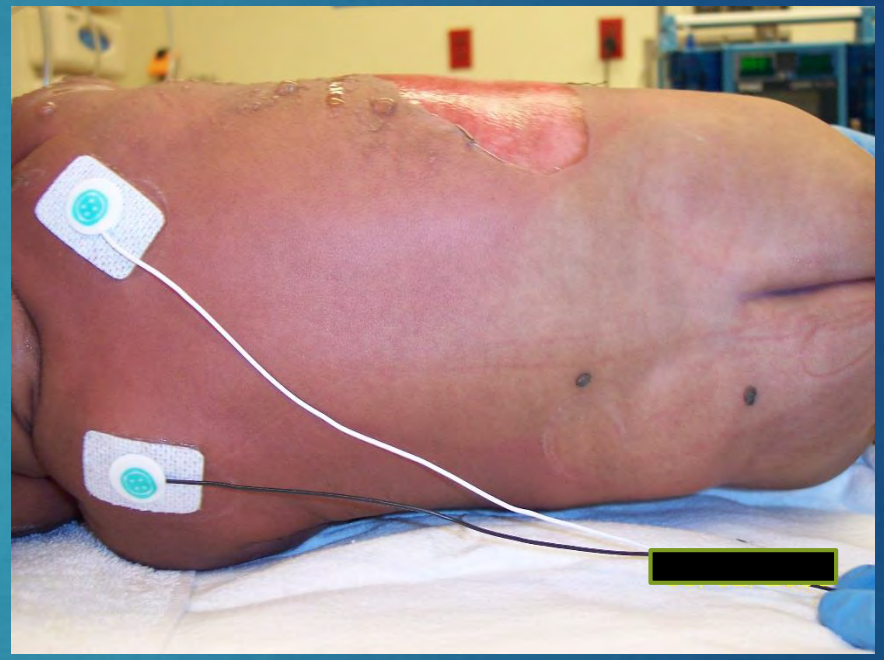
TBSA= 4.5%

How deep now?

Majority deep, some superficial and deep partial thickness

How deep?

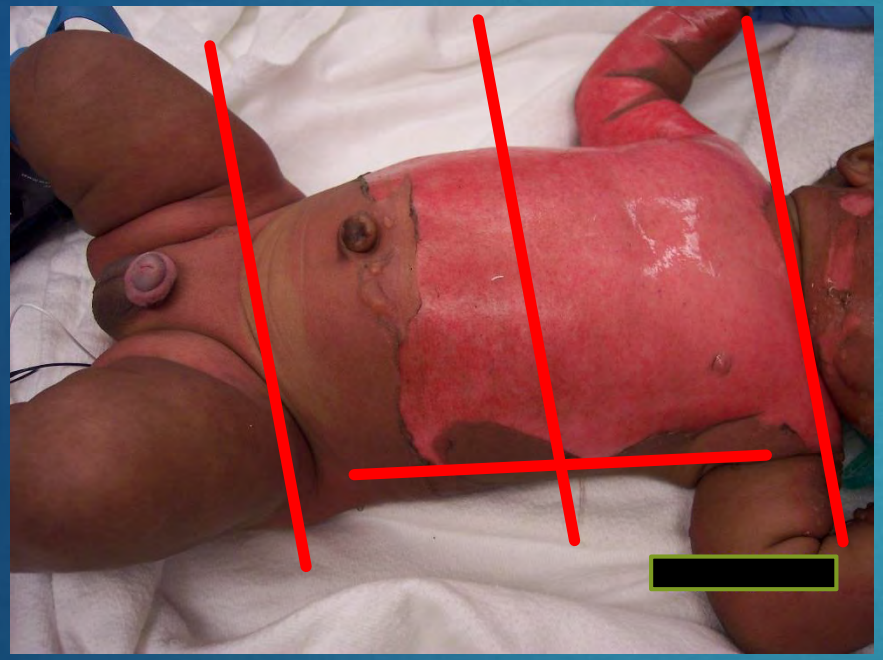
How deep?

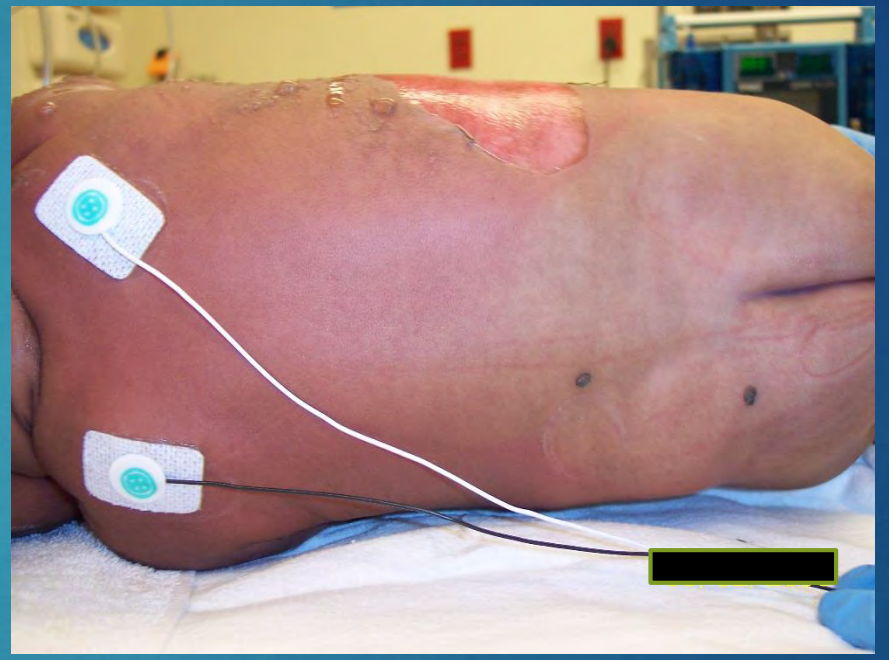


Wet Bright red Painful Blisters

Partial thickness Superficial or Deep?

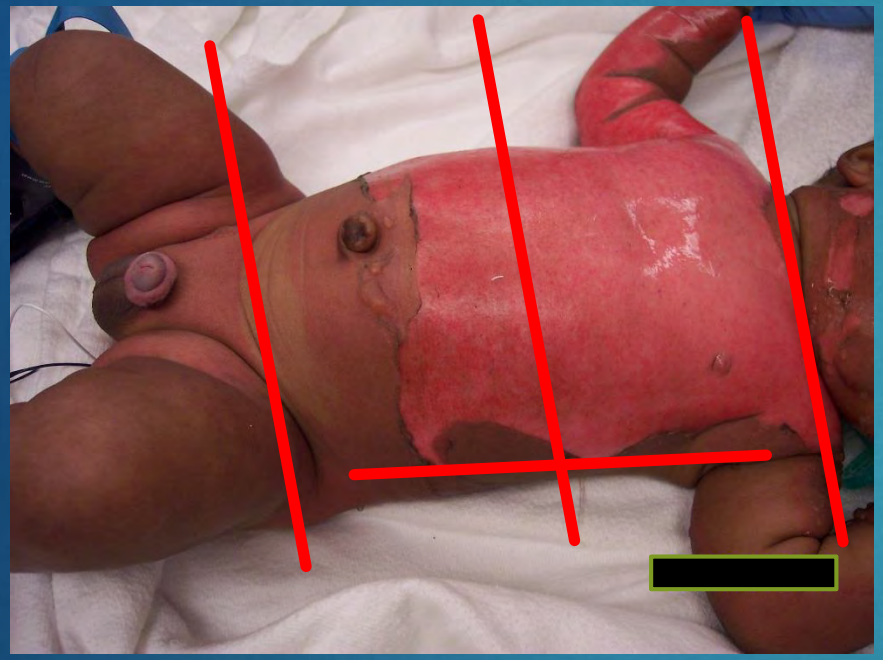
TBSA

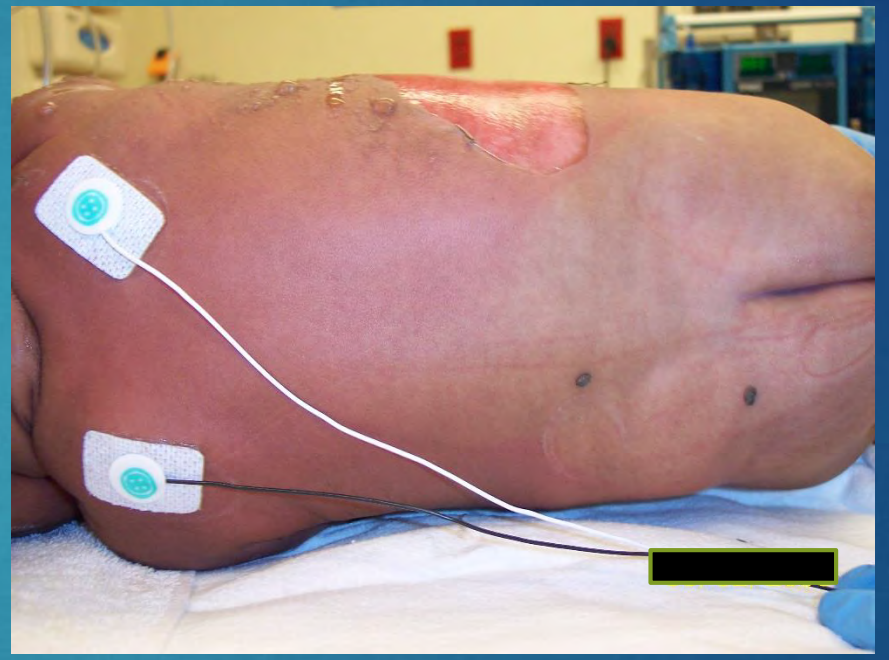




1. Define anatomic limits: Anterior torso: 13%TBSA

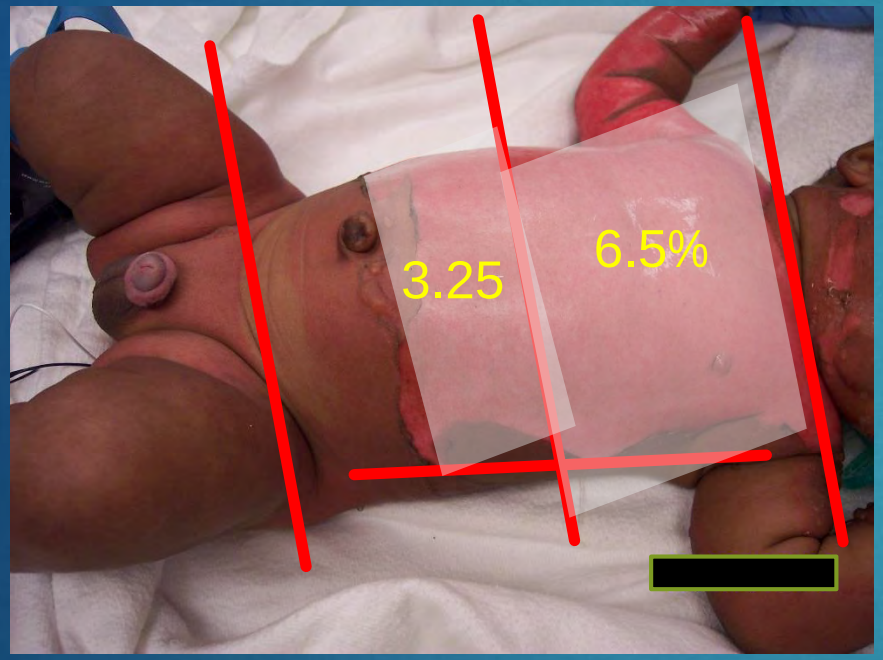
TBSA

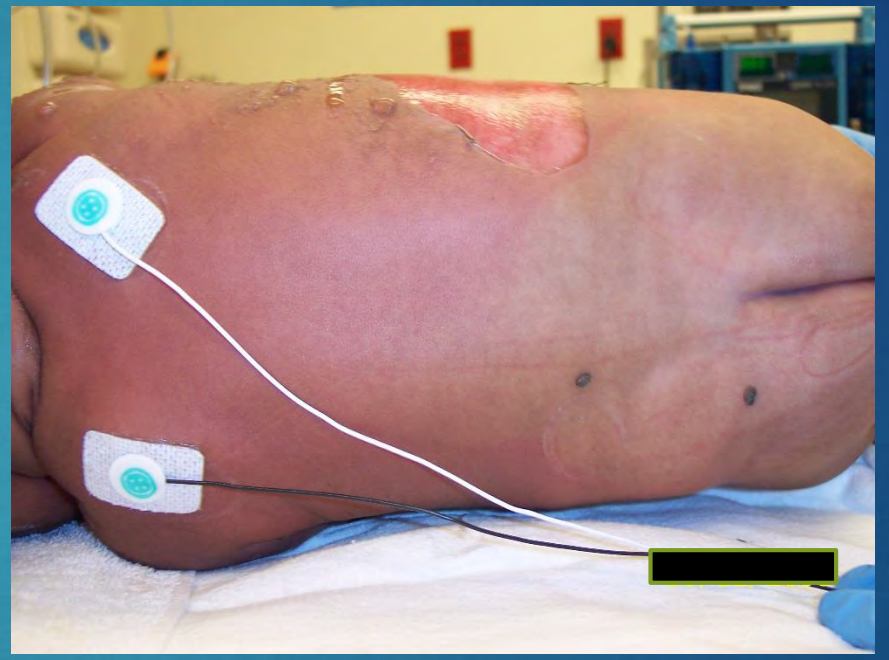




1. Define anatomic limits: Anterior torso: 13%TBSA
1. Define anatomic limits: Right arm: 7%TBSA

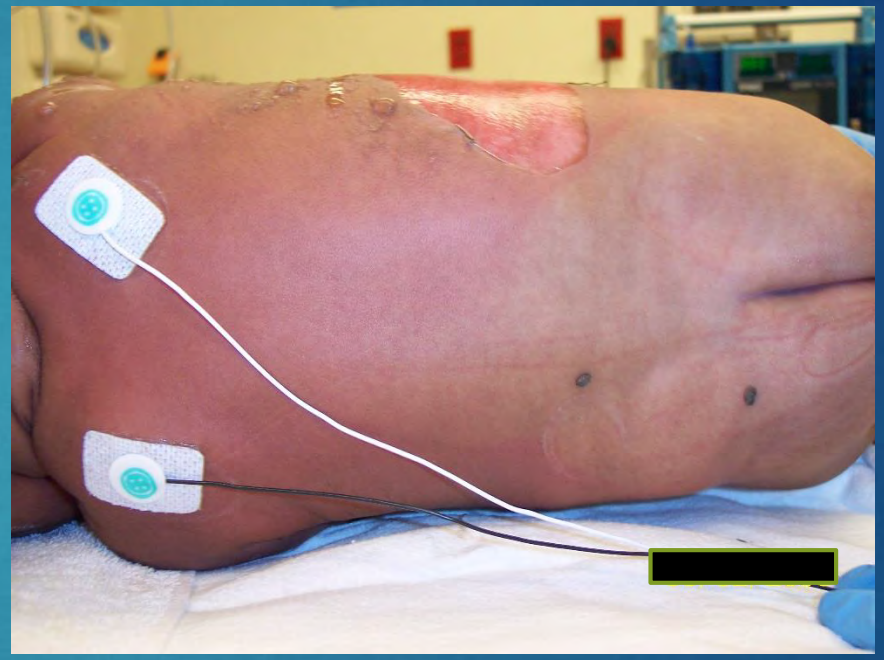
TBSA-Anterior torso





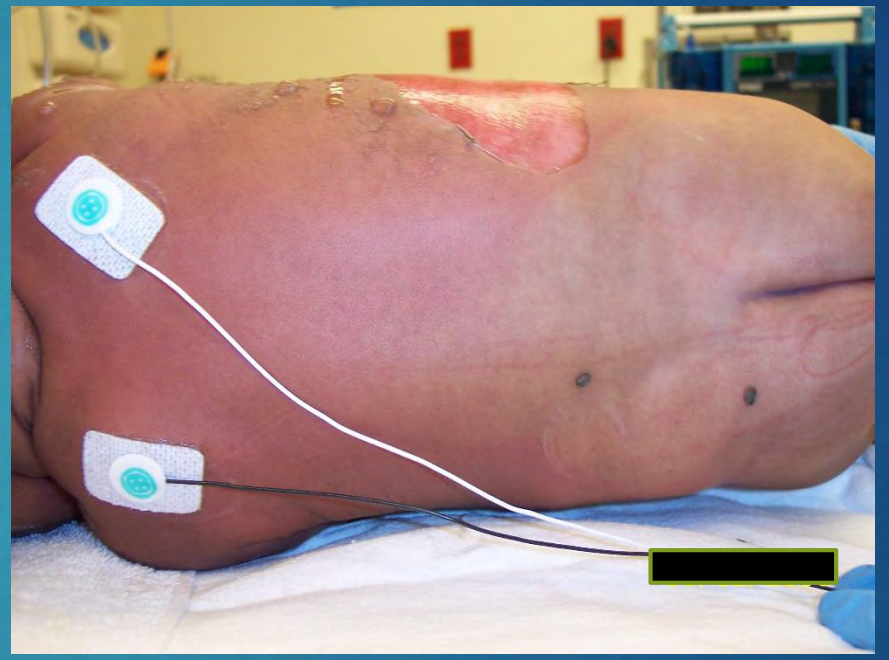
Anterior torso: 13/2 = 6.5% 9.75%

TBSA Right arm



1. Define anatomic limits: R upper arm: 4%
2. Define anatomic limits: R lower arm: 3%

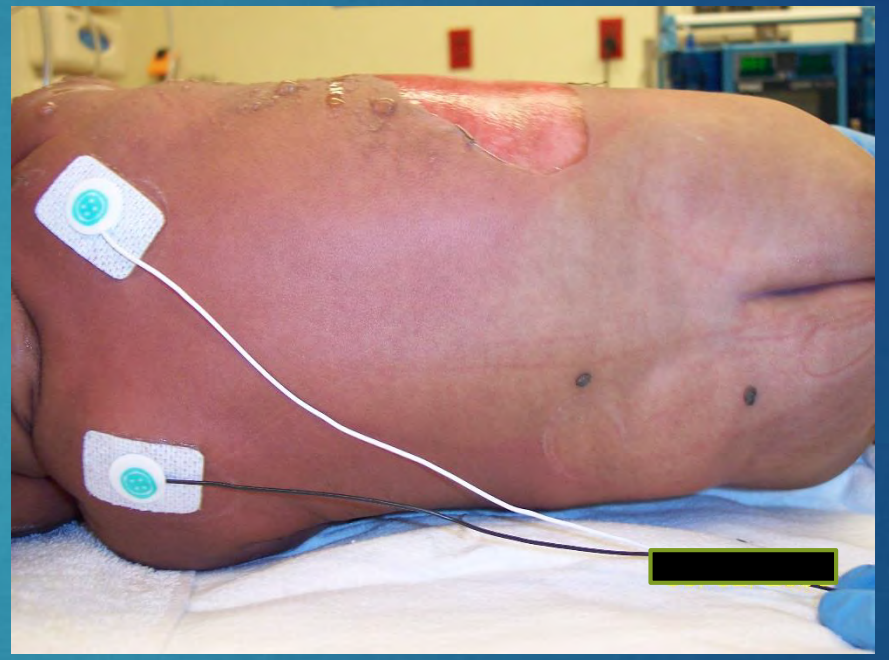
TBSA Right arm



Right arm total: 7% TBSA

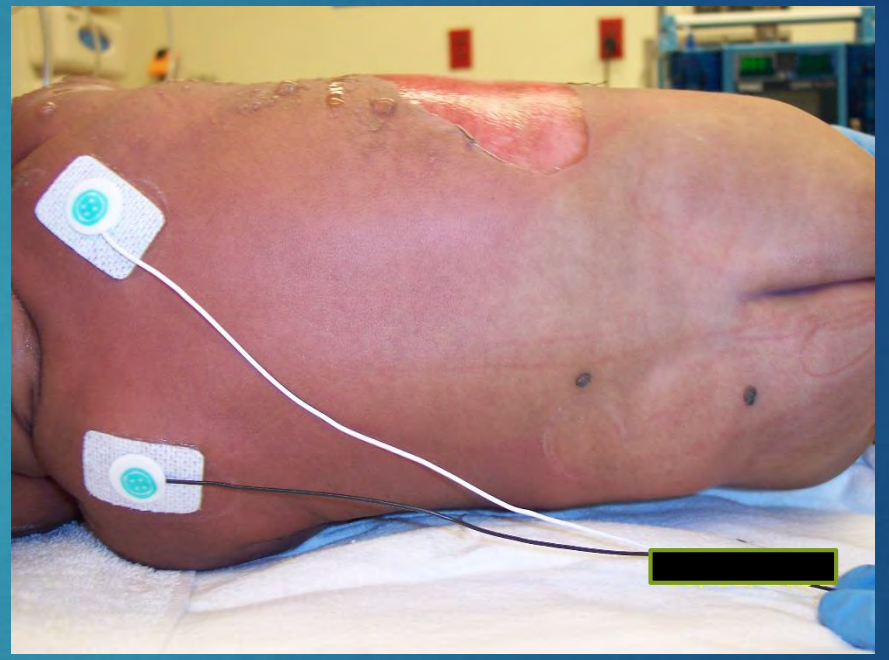
Half of right arm: 3.5% TBSA

TBSA Right arm



1. Anterior torso: 9.75% + right arm 3.5% = 13.25%

Report



"I have a 4 month old male who sustained 13% TBSA superficial, partial thickness burns to his anterior torso and right arm from hot water"

How deep?

Children's Mercy Burn Unit

(816) 234-3520

Pediatric Fluid Resuscitation

Pediatric Burns-Circulation

- Looked at predicted vs administered fluids
- Over-resuscitation was prevalent due to overestimation of burn
- <20% TBSA, too much while >20% TBSA too little
- Over resuscitated even after correction for overestimation of TBSA
- Titration based on UOP was a major problem

Pediatric Burns-Circulation

- 5 years old and younger: 125ml/hour LR
- 6-14 years old: 250 ml/hour LR
- 3ml/kg/TBSA
- For children <10kg, use D5 LR
- For children <30kg add D5LR maintenance fluid

Antibiotics, Wound Care and Temperature

What you need to know for the operating room:
Debridement vs Excision

Burn related child abuse

Intentional harm or threat of harm to a child by someone acting in the role of caregiver

The Children's Mercy Hospitals and Clinics

Cases of NAT	27	9%
Males	18	67%
Age (yrs)	2.4	
TBSA	10.1%	
Previous CPS	37%	
Avg LOS (days)	10.7	
Intentional	78%	
Scald	67%	

Take note of the details

Scald burns

- The burn occurs where the hot liquid touches the skin
- Water follows the law of gravity
  - In a spill, water flows towards the ground
  - In a container, it forms a flat horizontal line

Falling objects don't cause these burns

Can you guess what happened?

Can you guess what happened?

Accident?

What else do you see?

He turned on the hot water by accident...

Common temperatures

- 102-104 Spa/Jacuzzi
- 120 F Recommended water heater setting
- 175-180 F Holding temperature fast food coffee
- 212 F Boiling water
- 300-500F Grease frying

What is critical to do?


Just for Kids


AMBULANCE
E9fun.com

Transport Recommendations

Pre Hospital and ER stabilization

- Confirm TBSA involved
- Room temperature 31ºC (87.8ºF)
  - Increased core body temp common within hours of burn injury, up to 39ºC
- Ensure vaccination status
  - Age appropriate Tetanus booster or vaccine
  - Tetanus immunoglobulin for unimmunized
    - *Must be given at site far away from Tetanus vaccine*
- NG/OG tube placement
- Foley catheter
- Pain control
  - Morphine, Fentanyl, dexmedetomidine

Transport Stability

- Burn Wound Care
  - Ensure burned sites are dry and covered with at least a clean sheet
  - Avoid wet dressings
  - Avoid any ointments or burn treatments

Transport Stability

- Start fluid resuscitation, avoid fluid boluses if possible
  - We recommend using 10ml/kg for fluid bolus, if clinically indicated

- Use ABA transport recommendations for IVF until patient arrives to CMH or other burn center
  - ≤5years- LR at 125ml/hr
  - 6-14years- LR at 250ml/hr
  - 15+years- LR at 500ml/hr

References

1. American Burn Association. Burn incidence and treatment. http://www.ameriburn.org/resources_factsheet.php.
2. Jeschke MG. Burns in children: standard and new treatments. The Lancet 2014;383:1168-78.
3. American Burn Association. Ameriburnorg. 2016. Available at: http://www.ameriburn.org/NBR.php.
4. Jamshidi R. Initial assessment and management of thermal burn injuries in children. Pediatrics in Review. 2013;34:395:-403
5. Cancio LC. Initial assessment and fluid resuscitation of burn patients. Surg Clin N Am 2014;94:741-54.
6. Pham TN. American burn association practice guidelines burn shock resuscitation. J Burn Care and Research. 2008;29:257-266
7. Baxter Cr. Fluid Volume and Electrolytes Changes in the Early Post Burn Period. Clin Plast Surg 1974.; 1: 693-703
8. Cancio LC, Chavez S, Alvarado-Ortega M, et al: Predicting increased fluid requirements during the resuscitation of thermally injured patients. J Trauma 2004, 56:404-413.
9. Demling RH. The Burn edema process: Current Concepts. J Burn Care Rehab 2005: 26:207-27.
10. Park, SH. Early albumin use improves mortality in difficult to resuscitate burn patients. J trauma Acute Care Surg. 2012, Vol 73, number 5.
11. Roberta J. Navickis. Albumin in Burn Shock Resuscitation: A Meta-Analysis of Controlled Clinical Studies. American Burn Association. 2014
12. University of Michigan Guidelines for Pediatric Burn Resuscitation.
13. Herndon, DN. Total Burn Care. Fourth Edition. 2012
14. Greenhalgh, DG. Burn Resuscitation. J or Burn Care and Research. July/August 2007