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A comparison of large TBSA scald versus flame burns in young children

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Disclosures

I have no actual or potential conflict of interest in relation to this presentation.

Background - Definitions

- Burn mechanisms include thermal (flame, scald, cold), chemical, electrical, radiation, friction
- Flame burn = Injury to body tissue (including respiratory tract) caused by exposure to flame or its dense smoke
- Scald burn = Injury caused by exposure to hot liquids, commonly tap water or food/beverages
  - Most common burn injury in children < 5 years old
  - Common cause of non-accidental trauma
- % TBSA = Estimate of total percentage of body surface area involved
  - Superficial burn areas should not be included in estimate
  - Children most accurately assessed by Lund-Browder chart

Background - Definitions

- Superficial ("1st degree") = Injury confined to outer epidermal layer
  - Pain, erythema, no disruption of skin integrity

- Partial thickness ("2nd degree") = Destroys epidermis and part of dermis
  - Superficial: Blisters, bright red, mottled, wet, severe pain
  - Deep: Dark-red/yellow-white, slightly moist, minimally blanch, decreased sensation

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

Slide adapted from Dr. Pablo Aguayo, MD and Dr. Jenna Miller, MD

Background

- Severity related to higher %TBSA and percent full thickness
- Severe burns associated with:
  - Myocardial dysfunction
    - Well-documented following burn injury
    - Slowed relaxation, decreased diastolic compliance, impaired LV contractility in animal models[1]
  - Circulatory system damage
    - Duke et al found a statistically significantly greater incidence of hospital admission due to circulatory disease following burn injury over 33-year period[2]
  - Immune dysregulation
    - Catecholamines, cytokines, and glucocorticoids elevated up to 2-years post-injury[3]

1. Howard TS, et al. Burn-induced cardiac dysfunction increases length of stay in pediatric burn patients. 2013 Jul-Aug. doi: 10.1097/BCR.0b013e3182685e11.
2. Duke JM, et al. Long-term Effects of Pediatric Burns on the Circulatory System. 2015 Nov. doi: 10.1542/peds.2015-1945
3. O'Halloran E, et al. Non-severe burn injury leads to depletion of bone volume that can be ameliorated by inhibiting TNF-α. 2015 May. doi: 10.1016/j.burns.2014.09.004.

Background

- Scald injuries most common in children < 5
- As a general rule, patients who sustain flame burns are thought to undergo a more intense physiologic response
- Compared to scald burn injuries, flame injuries tend to be associated with
  - Higher %TBSA
  - Greater extent of full-thickness burn
  - Inhalation injury
  - More frequently admitted to ICU

Background

- PIQIC, Pediatric Injury Quality Improvement Collaborative
  - Consortium of five free standing children's hospitals with dedicated trauma and burn services
- Anecdotally we had seen more complications in younger burn victims, ages 0-3 years old, with scald injuries
- Despite general thought that flame burns present more severely, we sought to determine if differences existed in complications and mortality between differing age groups and mechanisms of injury

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Methods

- Multicenter, retrospective cohort study
- Over a 10-year period
- Inclusion criteria: all flame or scald injuries admitted to any of the 5 centers with TBSA greater than 15%
- Excluded if only inhalation injury

Methods

- Categorized by age into three groups:
  - $0 < age < 3$; $3 \leq age < 10$; $age \geq 10$
  - Group older than 10 excluded – only 3 scald patients
- Demographics, clinical features, complications
- Controlled for percent full thickness burn
- Defined abdominal catastrophe as bowel perforation, need for drain placement, or exploratory laparotomy
- Defined comorbidities as: ventilator present at anytime; prematurity <36 weeks; congenital heart disease (CHD) with single ventricle; CHD without single ventricle; and not reported as previously healthy, but condition not listed

Methods

- Utilized the American Burn Association data dictionary to define complications in collection tool
- Categorical variables reported as counts and percentages
  - P-values by Fisher's Exact Test
- Continuous variables reported with median and inter-quartile ranges
  - P-values using Wilcoxon Rank Sum test

Results

- 162 pediatric patients
  - 95 patients with scald burns
  - 67 patients with flame burns
- No significant differences in demographics

- Most burns in 0–3-year-old group due to scald
- Most burns in 3-10-year-old group due to flame

	SCALD BURNS			FLAME BURNS		
	0-3 years (N=73)	3-10 years (N=22)	P-value	0-3 years (N=15)	3-10 years (N=52)	P-value
Gender Male	43 (58%)	12 (54%)	0.81	13 (87%)	35 (67%)	0.20
Race/Ethnicity			0.72			0.78
White, Non-Hispanic	28 (38%)	7(32%)		7 (47%)	27 (50%)	
Black, Non-Hispanic	33 (45%)	10 (43%)		6 (40%)	18 (35%)	
Hispanic	8 (11%)	3 (14%)		0 (0%)	3 (6%)	
Other/Unknown	4 (6%)	2 (9%)		2 (13%)	4 (8%)	
Documented Prior Comorbidity	6 (8%)	3 (14%)	0.43	2 (13%)	4 (8%)	0.61

Table 1: Summary of demographics and clinical features by burn mechanism and age

Results – Scalds

- Only 28% full thickness
- 3-10 year-olds had significantly higher TBSA and longer Hospital LOS
- 0-3 year-old group had longer PICU LOS and mechanical ventilator (MV) days
- 0-3 year-old group had a trend towards higher incidence of sepsis, nosocomial infection, abdominal catastrophe

	SCALD BURNS		
	0-3 years (N=73)	3-10 years (N=22)	P-value
Percent Full Thickness	0 [0-3]	0 [0-4]	0.08
Percent TBSA	21 [18-30]	24 [21-36]	<0.001
Mortality	0 (0%)	2 (9%)	0.05
Sepsis	10 (14%)	3 (14%)	0.99
Nosocomial Infection	19 (26%)	5 (23%)	0.99
Abdominal Catastrophe	5 (7%)	0 (0%)	0.59
Hospital LOS	19 [12-40]	21 [17-40]	<0.001
PICU LOS	3 [2-16]	3 [2-9]	<0.001
Mechanical Ventilator Days	13 [1-137]	5 [2-138]	<0.001

Table 2a: Summary of clinical features of scald burns, by age

Results – Flames

- 0-3 year-old group had few mortalities and cases of sepsis, with no abdominal catastrophes
- 0-3 year-old group had shorter hospital LOS, PICU LOS, and MV days
- 3-10 year-olds had higher percentages of TBSA and percent full thickness
- 67% full thickness vs. 28% in scalds

	FLAME BURNS		
	0-3 years (N=15)	3-10 years (N=52)	P-value
Percent Full Thickness	15 [0-21]	20 [0-39]	<0.001
Percent TBSA	26 [19-41]	32 [23-44]	<0.001
Mortality	2 (13%)	10 (19%)	0.72
Sepsis	2 (13%)	10 (19%)	0.72
Nosocomial Infection	3 (20%)	11 (23%)	0.99
Abdominal Catastrophe	0 (0%)	3 (6%)	0.99
Hospital LOS	18 [3-46]	35 [10-52]	<0.001
PICU LOS	9 [1-14]	7 [2-18]	<0.001
Mechanical Ventilator Days	6 [0-32]	9 [1-72]	<0.001

Table 2b: Summary of clinical features of flame burns, by age

Models - Scald and Flame

- **Mortality**
  - Odds of mortality significantly increased for higher TBSA in both burn mechanisms
    - Increasing TBSA by 1% associated with 3% increase in odds of mortality
  - The effect of burn mechanism on mortality depends on age
  - Flame: a one-year increase in age was not related to significant reduction in mortality odds *(p=0.29)*
  - Scald: Reduced odds of mortality compared to flame *(p=0.02)*
    - For every additional year of age, odds of mortality increased by 42%

Models - Scald and Flame

- **Nosocomial Infections**
  - Every additional year of age resulted in 18% reduced odds
  - At least one prior comorbidity associated with 4x odds of nosocomial infection
    - *Overall low numbers of comorbidities and wide confidence interval – interpret with caution*
  - No statistically significant associations %TBSA and nosocomial infection

Models - Scald and Flame

- **Hospital LOS**
  - No significant associations

- **PICU LOS and MV Days**
  - Higher %TBSA related to longer PICU stays and more days on MV
  - For every 1% increase in %TBSA, PICU LOS increased by 1% *(p=0.02)*
  - For every 1% increase in %TBSA, MV Days increased by 2.5% *(p<0.01)*

Models - Scald and Flame

- **Abdominal Catastrophe**
  - Model showed a significant protective effect of full-thickness burns
  - Increasing percent full thickness burns was associated with a 5% reduction in odds of bowel catastrophe
  - No statistically significant difference between burn mechanisms

Conclusions

- Age could be considered protective for scald burns
  - Compared to 3-10 year-old scalds, 0-3-year-old patients with scalds have statistically significant longer PICU course and mechanical ventilation, and trends toward increased incidence of sepsis, nosocomial infection, abdominal catastrophe
- Increasing percent full thickness had a protective effect on odds of abdominal catastrophe, regardless of mechanism

Conclusions

- Odds of mortality higher in flame injuries
  - Higher TBSA and % full-thickness

- **No significant difference in odds of developing sepsis, nosocomial infections, or abdominal catastrophe between burn types**
  - **Despite lack of full thickness burns and lower TBSA, patients with scald burns did not do any better!**

Discussion

- Why is this the case?
  - Myocardial dysfunction, endothelial/vascular damage, immune dysregulation
  - Much of the previous literature does not examine differences by age or burn mechanism
  - Differences in timing of initiating enteral feeds and advancing to full nutrition
- Modern cohort of pediatric burn patients from multiple centers
- Age and burn mechanism are important factors

Future Directions

- Evaluate whether suspected non-accidental trauma plays a role in complication rates
  - Delayed presentation, severity of injury
- Include time to excision and association with sepsis and nosocomial infection
- Trend markers of inflammation, cardiac output, cytokines, echocardiogram findings at set timepoints
- Examine timing of feeding and escalation to full feeds by burn severity
- Closer monitoring of abdomen during resuscitation phase

Thank you to the PIQIC team

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