The ABC’s of Pediatric Burns

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• Graphic photographs of burns

Objectives

1. Recognize that children require a specialized approach and resources
2. Recognize that pediatric trauma and burn injury is a significant public health issue
3. Discuss pediatric burn management
4. Why specialized burn management matters
Are Children Just Little Adults?

The Myth

“Our pediatric colleagues are wrong...children are small adults...you just have to run the IV slower…”

-Attributed to Norman E. McSwain Jr, MD FACS

William E. Ladd, MD

- 1906 – Graduates from Harvard (MD)
  - Trained in gynecology
  - Practices general surgery
- 1910 – Begins volunteering at (Boston) Children’s Hospital
  - “The Children’s was my very first and most permanent love.”
  - Increasingly devotes more time to the study of pediatric diseases
- 1911 & 1913 – Publishes experiences with intussusception in Boston Surgical Journal
  - Demonstrates reduction in mortality to 45% (would later ↓mortality to <5%)
Issues with Surgery in Children ©1910

- Dismal survival
  - Appendicitis = 4th leading cause of death in kids <12 yrs
  - Colostomy = 90% (or higher) mortality
  - Intussusception, pyloric stenosis – near 100% mortality
- IV fluid therapy is poorly understood
- Few available medicines (no antibiotics)
  - Anesthesia issues in children (none or too much)
- Adult surgical instruments
- Challenges with diagnosis (i.e. rare conditions)
- Few surgeons willing to operate on children

The First Rule of Pediatric Surgery

“…a child was not just a diminutive man or woman…the adult may safely be treated as a child, but the converse can lead to disaster…”

- Dr. W.E. Ladd
  Boston Surgical Society Address

“Nonsense! Anyone who can work on a bunny rabbit can operate on a child!”

- Dr. Edward Churchill*
  (*attributed)

Summary #1

- Children have unique:
  - Physiology and anatomical considerations
  - Developmental and psychological considerations
- Children deserve specialized, age, and developmentally appropriate care
- Trauma care is in Pediatric Surgeon’s DNA
- Children are not little adults!
Why Care About Pediatric Trauma & Burns?

Childhood Injuries

- Each year:
  - ~225,000 hospitalizations
  - ~9,000,000 ED visits
  - ~11,000,000 office visits
- Pediatric injuries cost $87 billion annually in medical and societal costs
  - Death, hospitalizations, ED visits, etc.

Pediatric Trauma

- 1 child every hour dies from an injury
  - 1 in 5 child deaths is due to injury
- Every 4 seconds – a child is treated in an ED for injury
- >9000* US children died of injury in 2009
  - Most are preventable

\textbf{Remains the \#1 cause of childhood death}

* Ages 0-19

Causes of Death: Ages 1 – 14 years

Source: National Center for Injury Prevention and Control
Causes of Death: Ages 1 – 5 years

![Graph showing causes of death for ages 1-5 in 2009](source)

Pediatric Burns – By Numbers

- ~100,000 children ≤ 14 years old were treated for burns in hospital emergency rooms in 2007.
  - 20% were < 4 years old
- >70% of pediatric burn injuries → fire/flame, scald
  - Scald burns=most common cause of burn injury in children ≤ 5 years old
  - Majority are from hot foods and liquids
- Burns in children are responsible for nearly 2,500 deaths per year
- Up to 25% of burn admissions → child abuse-related
  - Mostly infants and toddlers

Burn-related Injury Rates (1990-2006)

![Graph showing burn-related injury rates](source)
Rates of Burn Injuries by Type for Children <6 Years of Age

Inpatient Burn Care Costs

  - Mean of 1.9 hospitalizations over 3-4 years
  - Mean total cost of hospitalization per patient: $83,535
  - Median total cost of hospitalization per patient: $16,331
If Children Are Different, Then How Do We Approach the Burn?

Approaching the Burn

- Stop the burn process
- Primary Survey
  - ACS ATLS & ABA ABLS Protocols (ABC’s)
  - Priorities remain the same as adult
    - Special considerations for anatomy, physiology, and developmental stage
- Initial Resuscitation
- Secondary Survey
- Initial Debridement and Wound Care
- Skin Coverage &/or grafting

Stop the Burn
Primary Survey (ABC’s)

- **Airway**
  - Pediatric airway considerations
  - Inhalation injury ± airway edema
- **Breathing**
  - Ventilation
- **Circulation**
  - Shock, vascular compromise
  - IV access
- **Disability/Neuro**
- **Environment/Exposure**
  - Prevent hypothermia

Pediatric Airways

- Narrow, funnel-shaped
  - Usually anterior
  - Smaller children prone to bronchospasm
- Emergent intubation *rarely* indicated for burn injuries
  - STOP & Think
  - Back up plan
  - “Don’t take away a child’s airway unless you have to”

Inhalation injury

- Breathing super heated air ± smoke
- Burns to the airway
- Debris in distal airway (‘soot’)
- Carbon Monoxide (indoor burn) + other gases
- Bronchoscopy and washouts
  - Bronchodilators
  - Aerosolized heparin
Time to Rethink Intubation?

Preventing Unnecessary Intubations: A 5-Year Regional Burn Center Experience Using Flexible Fiberoptic Laryngoscopy for Airway Evaluation in Patients With Suspected Inhalation or Airway Injury

- Retrospective study n=51 patients (2013 – 2017)
- 50/51 patients (98%) managed without intubation
  - Use of flexible fiberoptic laryngoscopy

Initial Resuscitation

- IV access
  - 2 large bore IV’s
  - Early interosseous access
  - Avoid burned extremity
- IV Fluids
  - Maintenance for <15% TBSA
  - Fluid boluses (20 ml/kg)
    - ≥15% TBSA
    - Delay in treatment
    - Significant fluid demands
    - Consider Foley for >15% TBSA
    - Pain medication!

Resuscitation

- Resuscitation Formulas
  - Traditional = Parkland
    - >15% TBSA
    - 4ml/kg/%TBSA
    - e.g. 60kg * 45% burns * 4ml/kg/%TBSA = 10,800 mL
    - ½ in first 8h; remainder over 16h
  - Judicious IV fluid resuscitation is key!
    - Prevent fluid overload (edema)
- Transition or transfer to definitive care
- Nutrition
  - Early enteral access & feeds
Fluid Resuscitation Matters

• Authors noted significant differences in TBSA estimates and fluid resuscitation calculations
  – TBSA often overestimated
  – ~60% of referred children received significantly more fluid than necessary

Secondary Survey

• Systematic head-to-toe
• Formal evaluation of burn extent
  – Total Body Surface Area percentage (TBSA%)
  – “Rule of 9’s”
  – Lund & Browder Chart
  – Using patient’s palm of hand (smaller children)
• Labs, Imaging, etc.

TBSA % - “Rule of Nines”
Lund-Browder Chart TBSA%

Accuracy Estimation of TBSA

Initial estimate = 15% TBSA

Final estimate = 6% TBSA

Burn Depth
Superficial (1st Degree)

Superficial Partial-thickness (2nd Degree)

Deep Partial-thickness (2nd Degree)
Full Thickness (3rd Degree)

- Cleansing & debridement
- Topical antimicrobial agents
- Dressings
  - Compresses
  - Biosynthetics
  - Biologics
- Appropriate analgesia
  - First experience is critical

4th Degree (bone & tendon)

Initial Debridement & Wound Care

- Cleansing & debridement
- Topical antimicrobial agents
- Dressings
  - Compresses
  - Biosynthetics
  - Biologics
- Appropriate analgesia
  - First experience is critical
Antibiotic Ointment vs. Silver Sulfadiazine

Delay Healing Associated with Silver Sulfadiazine Use for Partial Thickness Scald Burns in Children

- Use of antibiotic ointment was superior to silver sulfadiazine in regards to time to healing
  - Associated with less pain
  - Silver sulfadiazine has specific uses in children

Excision & Grafting

- Follows fluid resuscitation
- Excision
  - Sharp / Hydrosurgery – to healthy bleeding tissue
  - Conservative excision in children
Grafting

• Allograft
• Xenograft
• Autograft
  – Split thickness
  – Full thickness
  – Sheet graft
• Cultured Epithelial Autograft (CEA)
  – Compassionate use only (FDA)
  – “Experimental”
• Use a conservative approach

Summary #2

• Pediatric trauma remains the #1 cause of death in children
  – Most trauma deaths are preventable
  – Burns remain a significant cause of death
• While the assessment priorities do not change, must consider:
  – Special anatomical considerations
  – Age-specific physiology
  – Developmental age & needs
• Accurate assessment of size & depth of burn wound is essential
• Early but conservative excision
• “Phone a friend” – transfer to centers of expertise

TABLE 10-7
Criteria for Referral to a Burn Center

1. Partial thickness burns >10% total body surface area (TBSA)
2. Burns to involve the face, hands, feet, genitalia, perineum, or major joints
3. Third-degree burns in any 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, delay recovery, or affect mortality
8. Any patient with burns and concurrent 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 remedial risk, the patient’s condition may be stabilized initially in a burn center before transfer to a trauma center. Physician surgeons will be necessary in such situations and should be in concert with the center’s critical care unit and trauma surgeons.
9. Burn victims on hospital with not qualified personnel or equipment for the care of children
10. Burn injury in patients who will require special social, emotional, or rehabilitative care immediately

What Makes the UF Pediatric Burn Program Different?

Answer: The Team

UF Pediatric Burn Care Overview

- Provide comprehensive burn care to pediatric patients and families with a multidisciplinary team
  - 24/7 Pediatric Surgical coverage
  - Care for burn wounds up to 50% TBSA
  - Specialized resources for children
    - 24/7 PICU with CCM and sedation
    - Pediatric Anesthesia & Pediatric Specialist Surgeons (Hand, Plastic, Ortho)
    - Pediatric PT & OT
    - Social Work & Child Life Specialist
    - Specialized Burn Nurses
    - Child Psychiatry & Pain management
  - Use cutting edge technology
    - Cultured Epithelial Autograft
    - PTSD screening
    - Virtual Reality
  - Research and Quality Improvement Initiatives
  - Work closely with law enforcement, Child Protective Services and DCF to protect children that have suffered intentional burn injuries
UF Pediatric Burn Care

- Average 188 pts/year
  - High volume center
- Performed 506 IP dressing changes FY-18
  - 450 Floor
  - 56 PICU w/sedation
- 528 Outpatients appointments
  - Weekly clinic w/open access
- Outpatients evaluated by:
  - Pediatric ARNP & Surgeon
  - Pediatric Burn RN
  - Pediatric OT
  - Child Life/Social Work
- Burn Clinic provides the ability to follow long term outcomes and function

Previous Pediatric Burn Care - Silos

Current = Patient Centered Care
**The Team in Action**

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**Patient T**

- 14 yo male, unrestrained backseat passenger in single vehicle crash
  - Patient came into contact with high voltage live wire during escape
  - No LOC / other significant injuries
  - Initially estimated burn ~25% TSBA
    - Following Burn ICU debridement =45% TSBA
    - Burns to:
      - Bilateral UE
      - Torso / groins / genitals
      - Bilateral LE (with circumferential burns to LLE
      - Full thickness burns (3rd & 4th degree [foot])

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**The ABC’s of Pediatric Burns**

**Coding Fiesta 2019**

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October 26, 2019
Hospital Course (briefly)

- 4 month hospitalization
- Rehab ~2 weeks
- Underwent 10 operations
  - Debridement & allografting
  - Left below knee amputation (BKA)
  - Additional debridement & grafting
  - Cultured Epithelial Autograft (CEA) placement
    - 48 sheets (2880cm² or ~9 ft²)
    - Final operation (EUA, staple removal)
Burn Survivor

Tallahassee Democrat.

High school graduate's story is one of 'triumph over tragedy'

Final Summary

• UF Health Shands Children's Hospital provides comprehensive burn care to children and families
• High volume centers improve outcomes
• The “Team” matters
• Children require and deserve specialized attention and treatment

And Finally...

• Trauma & Burn care is the chance to save a life...
• Pediatric Trauma & Burn care is the chance to save a lifetime
The ABC’s of Pediatric Burns

Questions

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