Management of Burns

Eric McCoy PA-C
Kathy Johnston RN, BSN
Trauma/Burn Service
UPMC Mercy

A Long Tradition of Caring

- Comprehensive burn care from initial treatment through rehabilitation
- Region’s only Level I Regional Resource Trauma and Comprehensive Burn Center
- 24-hour in-house attending surgeon
- Adult ABA Verification

Dedication to Our Pediatric Patients

- Enchanted Forest pediatric play area
- Newly appointed dedicated Child Life Specialist
- “Learn Not to Burn” Prevention Program
Clinical Connections
April 16, 2014

**Vecta Mobile Sensory Unit**
- Multisensory stimulation used to distract pediatric patients during treatment
- Optic cable lights, bubble column, projected imagery and aroma therapy

**Anatomy of the Skin**
- Skin is the largest organ in the body.
- The skin consists of three layers:
  - Epidermis
    - Consists of five layers (stratum)
    - Tough non-vascular protective barrier
  - Dermis
    - Consists of two layers
    - Nerve endings, blood vessels, hair follicles, sebaceous and sweat glands & sensory fibers
  - Subcutaneous Tissue
    - Adipose tissue, major blood vessels and nerves

**Functions of the Skin**
- Maintenance of Body Temperature
- Production of Vitamin D
- A Barrier
  - Prevents evaporative water loss
  - Protection for microorganisms
  - Protection from environment
    - Sensations of touch, pressure and pain
- Cosmetic Appearance
Incidence of Burn Injuries

- Overall a decreased incidence in the number of burn injuries as well as hospitalizations and deaths.
- Yet, annually in the United States:
  - Approximately 1 million people require medical attention from burn injuries.
  - 700,000 ER visits; of which 45,000 people are hospitalized
  - Deaths from burn / smoke inhalation injuries account for 4,500 deaths.
- Most burn injuries occur in the home
  - 75% are victims of their own actions
  - Populations at highest risk: pediatric and elderly

Special Populations

- **Pediatric Clients**
  - Thinner skin; prone to more severe injury
  - Greater body surface area / to weight ratio
    - Greater evaporative fluid losses → hypovolemia
    - Rapid heat losses → hypothermia
  - Reduce metabolic reserves; prone to hypoglycemia
  - Small airways → more difficult to secure
  - Immature immunological response → sepsis
  - Consider possibility of abuse / neglect

Abuse & Burn Injuries

- **Abuse & Burn Injuries**
  - Can occur in any age group; children highest incidence
  - Burn injuries accounts for 10% of all child abuse cases
- **Suspect Abuse When:**
  - Burn distribution inconsistent with reported incident
  - Delay in seeking medical attention
  - History of family instability
  - Inability to cope with stress in time of crisis
- **Laws Related to Suspicion of Abuse**
  - Must report suspected abuse cases!!
Causes of Burn Injuries

- Thermal
  - Contact
    - Direct contact with hot object (i.e. pan or iron)
    - Anything that sticks to skin (i.e. tar, grease or foods)
  - Scalding
    - Direct contact with hot liquid / vapors (moist heat)
    - i.e. cooking, bathing or car radiator overheating
    - Single most common injury in the pediatric client
  - Flame
    - Direct contact with flame (dry heat)
    - i.e. structural fires / clothing catching on fire

- Electrical
  - Contact with an electrical current
    - i.e. open wiring or being struck by lightning
    - Pediatrics: chewing on electrical cord or placing object in outlet
    - Require some different management

- Chemical
  - Strong acids or alkaloids
    - i.e. household cleaning products
  - Management specific to chemical involved
Causes of Burn Injuries

- Radiation
  - Prolonged exposure to ultraviolet rays of the sun
  - Other sources: occupational or medical therapies

- Cold Injuries
  - Frostbite
    - Don’t forget all burns not from heat!!
      - Injury due to freezing & refreezing of intracellular fluid
      - Ice crystals puncture the cells and destroy tissue
      - Can result in amputation

Causes of Burn Injuries

- Inhalation Injuries
  - Suspect inhalation injury when:
    - Burn occurred within a closed space
    - Burns to face or neck
    - Singed nasal hair or eyebrows
    - Hoarseness, voice changes, wheezing or stridor
    - Sooty sputum
    - Brassy cough or drooling
    - Labored breathing or tachypnea
    - Erythema and blistering of oral or pharyngeal mucosa
  - Often requires intubation & mechanical ventilation

Causes of Burn Injuries

- Inhalation Injuries Cont..
  - Carbon Monoxide Poisoning
    - Most common inhalation injury
      - May occur with or without cutaneous burns
      - Hemoglobin’s affinity for carbon monoxide is 200x greater than that for oxygen; result ~ hypoxia
    - Diagnosis:
      - Serum COHb levels & ABG’s
      - Pulse Ox: false readings !!
    - Management: 100% O2
      - Face mask or mechanical ventilation
Classification of Burn Injuries

- Depth of Burn Injury
  - Superficial-Thickness
  - Partial Thickness
    - Superficial
    - Deep
  - Full Thickness
  - Deep-Full Thickness

- Size of Burn Injury
  - Total body surface area (TBSA) burned

Clinical Management of Burns

- Daily Hydrotherapy in the burn center by trained burn unit nurse in collaborating with techs, PA's and MD's.
- All burn dressings changed by burn nurse or technician.
- Goal of wound care is to promote healing and prevent infection.
- Teaching.

Principle of Wound Care

- Remove nonviable tissue
- Minimize risk of infection
- Promote epithelialization
- Decrease drying of wound bed
Superficial-Thickness Burns

- Involves the epidermis
  - Wound Appearance:
    - Red to pink
    - Mild edema
    - Dry and no blistering
    - Pain / hypersensitivity to touch
    - i.e. Classic sunburn
    - Desquamation (peeling of dead skin) occurs 2-3 days post-burn
  - Wound Healing:
    - In 3 to 5 days (spontaneous)
    - No scarring / other complications

Partial-Thickness Burns

- Superficial, partial-thickness
- Involves upper 1/3 of dermis
  - Wound Appearance:
    - Red to pink
    - Wet and weeping wounds
    - Thin-walled, fluid-filled blisters
    - Mild to moderate edema
    -Extremely painful
  - Wound Healing:
    - In 2 weeks (spontaneous)
    - Minimal scarring; minor pigment discoloration may occur
Topical antimicrobials are used to control bacteria growth and decrease likelihood of wound infection.

Signs of infection:
- Foul smell
- Green drainage
- Elevated temperature
- Erythema of skin and tissues surrounding wound

Common Topical Agents:
- Silvadene
- Sulfamylon cream
- Triple antibiotic ointment
- Santyl / Polysporin
- Mepilex Ag
- Medihoney

Deep Partial-Thickness Burns
Deep Partial-Thickness Burns

- Involves larger portion of dermis (not complete)
  - Wound Appearance:
    - Mottled: Red, pink, or white area
    - Moist
    - No blisters
    - Moderate edema
    - Painful; usually less severe
  - Wound Healing:
    - May heal spontaneously 2-6 weeks
    - Hypertrophic scarring / formation of contractures
  - Wound Management:
    - Treatment of choice: surgical excision & skin grafting
Full-Thickness Burns

- Involves the entire epidermis and dermis
  - Wound Appearance:
    - Dry, leathery and rigid
    - + Eschar (hard and in-elastic)
    - Red, white, yellow, brown or black
    - Severe edema
    - Painless & insensitive to palpation
  - Wound Healing:
    - No spontaneous healing; weeks to months with graft
  - Wound Management:
    - Surgical excision & skin grafting
Deep partial thickness to full thickness injury may cause increasing tissue pressure due to capillary leak, inelasticity and inflammatory response resulting in Compartment Syndrome.

- Signs and Symptoms are the 5 P’s:
  - Pain
  - Pallor
  - Pulselessness
  - Paresthesia’s
  - Paralysis

Surgical intervention such as escharotomy or fasciotomy are required to restore circulation to effected area.

### Complications

#### Deep Full-Thickness Burns

- Extends beyond the skin to include muscle, tendons & possibly bone.
  - Wound Appearance:
    - Black (dry, dull and charred)
    - Eschar tissue: hard, in-elastic
    - No edema
    - Painless & insensitive to palpation
  - Wound Healing:
    - No spontaneous healing; weeks to months with graft
  - Wound Management:
    - Surgical excision & skin grafting
    - Frequently requires amputation if extremity involved
Classification of Burn Injuries

- Size of a Burn Injury
  - Total Body Surface Area (TBSA) Burned
    - Palmar Method
      - A quick method to evaluate scattered or localized burns
      - Client’s palm = 1% TBSA
    - Rule of Nines
      - A quick method to evaluate the extent of burns
      - Major body surface areas divided into multiples of nine
        - Modified version for children and infants
    - Lund-Browder Method
      - Most Accurate; based on age (growth)
      - Can be used for the adult, children & infants
Classification of Burn Injuries

Severity of Burn Injuries

- Treatment of burns is directly related to the severity of injury!
- Severity is determined by:
  - Depth of burn injury
  - Total body surface (TBSA) burned
  - Location of burn
    - All burns of the face, hands, feet, face or perineum are considered severe!!
  - Client’s Age
  - Presence of other preexisting medical conditions or trauma

Critical Care Criteria

- Greater than 20% TBSA thermal burns
- Inhalation Injury
- Electrical Injury
- Fluid balance
- Temperature regulation
- Comorbid Conditions
  - extremes of age
  - pre-existing medical conditions
  - malnutrition
  - immunocompromised
Pain Management

- Critically ill patients requiring mechanical ventilation
  - Fentanyl (narcotic opiate) continuous IV drip for pain control
  - Propofol (hypnotic/amnestic) continuous IV drip for sedation
  - Medications are ordered to be titrated for a riker sedation scale as ordered by the physician.

Pain Management, cont.

- Acute Interventional Pain Service Consult (AIPPS)
  - Local blocks
  - Ketamine infusions IV
  - Selected Opiates
  - Neurontin

Managing Pain for Dressings

- Pediatric Patients receive Conscious Sedation by pediatric-certified anesthesia personnel in the hydrotherapy and are recovered in their rooms by staff nurse.
- Adult patients receive pre-medication, usually PO opiates prior to dressing changes, with additional narcotic boluses during procedures as directed by physicians.
- Dedicated Physicians Assistant available at all times during dressing changes to evaluate wounds and pain control.
Pain Conclusion

- Pain control is a huge issue for burn patients from initial injury through-out rehabilitation.
- Transition is made as healing occurs from AIPPS to the Chronic Pain Service as needed.

Prognosis

- Patient outcome dependent largely on depth and extent of injury.
- Also influenced by such indicators as:
  - Age
  - Location of wounds
  - Mechanism of injury

Phases of Burn Care

- Resuscitation
- Acute
- Rehabilitation
Current Status of Burn Resuscitation

• Initial management follows the guidelines established by ATLS course of the American College of Surgeons
• ABC’s of critical burns have several complicating variables

Airway

• Initial evaluation by history, symptoms and physical findings
• Intubation required
  • Unconscious patients
  • Obvious respiratory distress
  • Hemodynamic instability

Airway

• “Hard” signs and symptoms
  • Dyspnea
  • Chest tightness
  • Tachypnea
  • Stridor
  • Use of accessory muscles
  • Swelling of the tongue and oropharynx
  • Immediate intubation!!
Inhalational Injuries

- Inhalational injuries complicate nearly one third of all major burns
- Doubles the mortality of cutaneous burns
- Three distinct components
  - Carbon monoxide poisoning
  - Upper airway thermal burns
  - Lower airway chemical injuries

Airway

- Suspect inhalational injury
  - Fires in closed spaces
  - Facial burns
  - Singeing of facial hairs
  - Oropharyngeal carbon deposits
  - Carbonaceous sputum

HOUSEFIRE SMOKE

<table>
<thead>
<tr>
<th>GAS</th>
<th>SOURCE</th>
<th>EFFECT</th>
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</thead>
<tbody>
<tr>
<td>Carbon Monoxide</td>
<td>Organic Matter</td>
<td>Tissue Hypoxia</td>
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<tr>
<td>Carbon Dioxide</td>
<td>Organic Matter</td>
<td>Narcosis</td>
</tr>
<tr>
<td>Hydrogen Chloride</td>
<td>Plastics (PVC)</td>
<td>Mucosal irritation</td>
</tr>
<tr>
<td>Hydrogen Cyanide</td>
<td>Polyurethane</td>
<td>Respiratory Failure</td>
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<tr>
<td>Benzene</td>
<td>Petroleum plastics</td>
<td>Mucosal irritation</td>
</tr>
<tr>
<td>Aldehydes</td>
<td>Wood, cotton, paper</td>
<td>Severe mucosal and lung damage</td>
</tr>
</tbody>
</table>
Carbon Monoxide

- Produced by the combustion of organic material
- Systemic poison
  - Inhibits transport and mitochondrial use of oxygen
- Pulse oximeter gives spuriously high reading for O2 saturation
- COHgb assessment must be made by ABG

Carbon Monoxide Poisoning

- 0% - 5% = Normal value
- 15% - 20% = Headache, confusion
- 20% - 40% = Visual changes, nausea
- 40% - 60% = Hallucinations, combativeness, coma
- > 60% = Mortality rate > 50%

Carbon Monoxide Poisoning

- Treatment
  - 1/2 life on room air = 240 minutes
  - 1/2 life at 100% FIO2 = 30-40 min (tight-fitting non-rebreather face mask or ET tube)
  - HBO (O2 at 3 atm.) will shorten 1/2 life even further...Several randomized, controlled trials have failed to show significant benefit over 100% O2 (Tibbles, Perrota, Ann. Em. Med. 1994)
Upper Airway Thermal Injuries

- Occur due to hot air or chemical toxins
- Dx by direct laryngoscopy
  - Swelling, sloughing, carbonaceous sputum below vocal cords
- Indication for prophylactic intubation
- Manifest within 48 hrs of injury
- Maximal swelling 12 – 24 hrs

Lower Airway Thermal Injuries

- Injury to tracheobronchial tree and lung parenchyma
- Due to combustion products in smoke and inhaled steam
  - Atelectasis
  - Decreased ciliary action
  - Pooling of secretions
  - Bronchorrhea
  - Bronchospasm
## Timeline of Inhalational Injuries

- **0-36 hours**
  - Carbon monoxide poisoning
  - Upper airway obstruction
  - Bronchospasm
- **24-72 hours**
  - Pulmonary edema
  - Atelectasis
  - Tracheobronchiitis
- **3-10 days post injury**
  - Bronchopneumonia/ARDS

## Diagnosis of Inhalational Injuries

- High index of suspicion
- History/physical exam
- Chest x-ray and CT not helpful
- Fiberoptic bronchoscopy
  - May use local anesthesia only
  - Place appropriate sized endotracheal tube over scope

## Treatment of Inhalational Injuries

- Treatment begins at scene
- Secure airway
- 100% oxygen until COHgb <10%
- Carboxyhemoglobin and ABG obtained
- Consider checking cyanide level with hypoxia/acidosis
- Meticulous pulmonary hygiene
  - Frequent airway suctioning
  - Chest physiotherapy
  - Early mobilization
  - Percussive and vibratory techniques
Breathing

- Always recognize associated trauma!!
  - Tension pneumothorax, pulmonary contusion, head/spinal injuries
- Circumferential third degree burns to the chest
  - Restricts chest wall expansion
  - Decreases lung compliance
  - Increased airway pressures
  - Escharotomy!!

Circulation

- Two large bore IV’s
- Access through unburned skin preferred
- Avoid in limbs distal to areas of circumferential burns
  - Tourniquet effect
  - Cutdowns associated with high infection rates
  - Interosseous preferred
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**Circulation**

- Goal is restoration of adequate tissue perfusion and cardiovascular function with the least amount of administered fluid
  - Optimal survival
  - Fewest adverse events
- Calculations based on weight and burn size
- Include only areas of partial and full thickness dermal injury
- Burn size initially based on "rule of nines"

**Rule of Nines**

- 9%
  - Head
  - Each upper extremity
- 18%
  - Each leg
  - Anterior trunk
  - Posterior trunk
- Underestimates head size in children

**Fluid Resuscitation**

- Oral resuscitation
  - Children with less than 10-15% TBSA
- Requires close monitoring
  - Nausea and vomiting
  - Gastric ileus
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**Adult Burn Resuscitation Formulas**

- Crystalloid fluid resuscitation based on Parkland or modified Brooke formula
  - LR most popular
- 4cc x kg x % TBSA
- Half of fluid requirements given over first eight hours, half over the next 16 hours

**Fluid Resuscitation in Pediatric Burn Patient**

- Children require more fluid
  - Greater ratio of surface area to volume
- Hypoglycemia
  - Limited glycogen stores
  - 5% dextrose maintenance fluid
    - <2 years old

**Monitoring Resuscitation**

- Gross tissue edema has no direct correlation to adequacy of intravascular volume
- Urinary output is prime indicator of adequate tissue perfusion
  - Adults: 0.5 to 1 ml/kg/hr
  - Children: 1 to 1.5 ml/kg/hr
  - Infants: 1.5 ml/kg/hr
Fluid Resuscitation

- Factors associated with increased requirements
  - Delayed resuscitation
  - Scald burn injuries
  - Inhalational injuries
  - High-voltage electrical injuries
  - Hyperglycemia
  - Alcohol intoxication
  - Patients on chronic diuretic therapy
  - Associated trauma

Fluid Resuscitation

- Rhabdomyolysis
  - Suspect with deep burns, electrical burns, compartment syndromes
  - Results in myoglobinuria and acute tubular necrosis
  - Maintain urine output >100cc/hr
  - Consider alkalinization and mannitol

Fluid Resuscitation

- No single perfect formula
- Adverse consequences
  - Poor tissue perfusion
  - Abdominal compartment syndrome
  - Extremity compartment syndrome
  - Pulmonary edema
  - Pleural effusion
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Wound Management

- Thermal injury disrupts protective barrier function of skin
- Dressings protect against environmental flora and evaporative heat loss
- Superficial wounds
  - Promote re-epithelialization
- Partial-thickness, full-thickness
  - Protect against microbial colonization

Wound Management

- Topical antimicrobials
  - Eschar devitalized and avascular – systemic antibiotics do not reach
  - Topicals delay wound colonization and infection
  - Promote spontaneous wound healing
  - Early excision and grafting still key
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Topicals

- Importance of excision not recognized until 1970’s
- Required for deep partial-thickness and full-thickness burns
- Necrotic tissue is nidus for development of infection and burn wound sepsis
- Improves survival, reduces infection rate, shortens hospital stay, decreases scarring

Burn Excision and Grafting

- Excision may begin as early as post-burn day 3
- Extensive burns - serial operations placed several days apart
- Temporarily cover with biologic dressing, xenograft, cadaveric allograft until autograft available
Grafting

- Selection of depth
  - Full-thickness: entire thickness of dermis
  - Partial-thickness: partial thickness of dermis (0.08 to 0.20 in.)
- Thicker grafts contract less
- Burn size may require re-cropping

Grafting

- Applied as sheet (unmeshed) or meshed grafts
  - Meshing minimizes hematoma/seroma formation
  - Sheet more aesthetic

Autograft: Sheet  Autograft: Meshed
Donor Site: Wound Considerations

- The donor site is often the most painful aspect for the post-operative client.
  - We have created a brand new wound !!
  - Variety of products are used for donor sites.
    - Most are left place for 24 hours and then left open to air.
    - Donor sites usually heal in 7-10 days
Advances in Wound Closure: Biological Dressings

- Biological dressings
  - Cadaver allograft
  - Porcine xenograft
  - Amniotic membranes

Advances in Wound Closure: Skin Substitutes

- Dermal replacement material
  - Integra™
    - Bi-laminar composite with bovine collagen neodermis, silicone neoepidermis
  - AlloDerm™
    - Acellular allogenic dermal matrix
- Cultured epithelial autografts
- Stem cell culture technology
- Negative Pressure Wound Therapy

Advances in Wound Closure
Rehabilitation Phase

- Begins day one and may last several years
  - Nursing, OT and PT are major providers
  - Meticulous asepsis continues to be important
- Major areas of focus:
  - Support of adequate wound healing
    - Prevention of hypertrophic scarring & contractures
  - Psychosocial Support
    - Client and family
  - Promotion of maximal functional independence

Hypertrophic Scar Formation

- Excessive scar formation, which rises above the level of the skin
- Management: Pressure Garments
  - Elasticized garments that are custom fitted
  - Maintains constant pressure on the wound
    - Result: smoother skin & minimized scar appearance
  - Client Considerations:
    - Must be worn 23 hours a day
    - Need to be worn for up to 1-2 years
    - Are very hot and tight!!

Contracture Formation

- Shrinkage and shortening of burned tissue
- Results in disfigurement
  - Especially if burn injury involves joints
- Management is opposing force:
  - Splints, proper positioning and ROM
    - Must begin at day one!!
    - Multidisciplinary approach is essential!!
Psychosocial Considerations

- Alterations in Body Image
  - Loss of Self-Esteem
    - Returning to community, work or school
    - Sexuality
- Supports Services
  - Psychologist, social work & vocational counselors
  - Local or national burn injury support organizations
- Nursing Considerations
  - Encourage client & family to express feelings
  - Assist in developing positive coping strategies

Psychosocial Considerations

- LISTEN AND PROVIDE REALISTIC SUPPORT !!
  - Be honest about possible scarring
  - Remember people come to terms with the change in their appearance at their own pace.
  - Provide reassurance that skin grafts always look worse before they look better.
  - Remember how a client looks at discharge is not how they will look in 2 years.

“The Skin Cell Gun”

- Research collaborative with McGowan Institute of Regenerative Medicine
- Experimental study using human burn victims
Burn Center Criteria

- Partial thickness burns > 10% TBSA
- Face, hands, feet, genitalia, perineum, major joints
- Full thickness burns; any age or size
- Electrical burns
- Chemical burns
- Inhalation injury

- Pre-existing medical disorders
- Concomitant trauma, particularly if burn injury poses greatest risk
- Children
- Special social, emotional, or long-term rehabilitative intervention