Chapter 21: Burns

Introduction to Burn Injuries (1 of 2)

1. 1.25-2 million Americans treated for burns annually
2. 50,000 require ____________________________________
3. 3-5% considered life threatening
4. __________________ leading cause of death for children <12
5. Half of all tap-water burns occur to children < ____________

Introduction to Burn Injuries (2 of 2)

Greatest risk:
1. Very young & very old
2. ____________________________________
3. ____________________________________
4. Metal smelters
5. ____________________________________ workers

Reduction in Burn Injuries

1. Improved building codes
2. Safer ____________________________________ techniques
3. Sprinkler systems
4. Use of ___________________________ detectors
5. Educational campaigns aimed primarily at school children

Pathophysiology of Burns

Types of Burns:
1. ____________________________________ (from heat)
2. ____________________________________
3. ____________________________________
4. Radiation

Thermal Burns

1. Heat changes the ___________________________ structure of tissue
2. Extent of burn damage depends on:
   - ___________________________ of agent
   - Concentration of heat
   - ___________________________ of contact

Jackson's Theory of Thermal Wounds (1 of 3)

Explains the physical effects of high heat in 3 phases:
1. Zone of ___________________________
   - Most damaged area
   - Area in a burn ___________________________ the heat source that suffers
     the most damage as evidenced by clotted blood and thrombosed blood vessels

Jackson's Theory of Thermal Wounds (2 of 3)

1. Zone of ___________________________
   - Area surrounding zone of coagulation characterized by decreased blood flow.
2. Zone of ___________________________
   - Erythema (redness)
   - Peripheral area around burn that has an ___________________________
blood flow.

Jackson's Theory of Thermal Wounds (3 of 3)

The Body's Response to Burns
The human body responds to burns in 4 phases:
- ___________________________ Phase
- ___________________________ Shift Phase
- Hypermetabolic Phase
- ___________________________ Phase

Emergent Phase (Stage 1)
- ___________________________ reaction
- ___________________________ response
- ___________________________ release
- Tachycardia, Tachypnea, Mild Hypertension, Mild Anxiety

Fluid Shift Phase (Stage 2)
- Length 18-24 hours
- Begins after Emergent Phase
  - Reaches peak in 6-8 hours
- Damaged cells initiate inflammatory response:
  - ___________________________ blood flow to cells
  - Shift of fluid from intravascular to extravascular space
  - MASSIVE ___________________________
  - “Leaky ___________________________”

Hypermetabolic Phase (Stage 3)
- Last for days to ___________________________
- Large ___________________________ in the body's need for nutrients as it repairs itself

Resolution Phase (Stage 4)
- ___________________________ formation
- General rehabilitation and progression to normal

Electrical Burn Terminology
- ___________________________
  - Difference of electrical potential between two points
  - Different concentrations of electrons
- ___________________________
  - Strength of electrical current
  - ___________________________ (Ohms)
  - Opposition to electrical flow

Electrical Burns (1 of 4)
Ohm's Law:
- The ___________________________ is directly proportional to the voltage and inversely proportional to the resistance
- V=IR or I=V/R
  - V: Voltage
- R: Resistance
- I: Current

- Based on electron flow thru ________________________________
  - Emit more __________________________ the more current passed thru

17 **Electrical Burns (2 of 4)**

- ________________________________ Law:
  - The rate of heat production is directly proportional to the
    ________________________________ of the circuit and to the square of the current
  - \[ P = I^2 R \]
    - P: Power
    - R: Resistance
    - I: Current

- Skin is resistant to electrical flow
  - Greater the current the greater the flow thru the body and greater the release of

18 **Electrical Burns (3 of 4)**

- Greatest heat occurs at the points of ________________________________
  - Entrance and Exit wounds
  - Dry skin = ________________________________ resistance
    - Wet Skin = Less resistance

- Longer the contact, the greater the potential of injury
  - Increased damage inside body

- Smaller the point of contact, the more ________________________________ the energy, the greater the injury

19 **Electrical Burns (4 of 4)**

**Electrical Current Flow thru the Body:**

- **Tissue of Less Resistance**
  - Blood vessels
    - ________________________________

- **Tissue of Greater Resistance**
  - Muscle
    - ________________________________

- Results in
  - Serious vascular and nervous injury
  - Immobilization of ________________________________

20 **Examples of Electrical Burns**

21 **Chemical Burns**

Chemical destroys tissue

- ________________________________
  - Form a thick, insoluble mass where they contact tissue.

- ________________________________
  - Destroy cell membrane through liquefaction ________________________________
    - Deeper tissue penetration and deeper burns

22 **Chemical Burn to Face and Ear**

23 **Chemical Burn to Eye**
Radiation Injury

Radiation

- Sources of radiation energy:
  - _______________________________ Energy
  - Ultraviolet light
  - Visible Light
  - Heat
  - _______________________________

- Radioactive Substance
  - Emits ionizing _______________________________

Basic Physics of Radiation (1 of 2)

- Positively charged particles
  - _______________________________:
    - Equal in mass to protons
    - No electrical charge
  - _______________________________
    - Minute electrically charged particles
    - When emitted from radioactive substances are termed Beta Particles

Basic Physics of Radiation (1 of 2)

- Atoms with unstable nuclear composition
  - Ionizing Radiation
  - _______________________________
    - Time required for half the nuclei to lose activity through _______________________________

Types of Radiation

- _______________________________
  - _______________________________
  - _______________________________
  - Neutron

Alpha Radiation

- _______________________________ moving
  - Low-energy
  - Can travel only a few inches thru air
  - Stopped by clothing and _______________________________
  - Penetrate a few cell layers on skin
  - Minor external hazard
  - Very harmful if _______________________________

Beta Radiation

- _______________________________ than Alpha
  - Higher energy than alpha
  - Can travel 6-10 feet thru air
  - Stopped by _______________________________ , aluminum or similar materials
Less local damage than alpha
Harmful if inhaled or ____________________________________

Gamma Radiation (1 of 2)
Highly energized
Used in ____________________________________
Penetrate deeper than Alpha or Beta
- Through the entire body
EXTREMELY DANGEROUS
Penetrate thick ____________________________________
Exposure normally limited to nuclear blasts, those who work around nuclear reactors, and ____________________________________ personnel

Gamma Radiation (2 of 2)
Pass entirely thru clothing, and body
- Extensive ____________________________________ damage
Direct damage to skin and external tissues
Indirect Damage
- Cause internal tissue to emit Alpha and ____________________________________ particles
Requires ____________________________________ shielding

Neutron Radiation
Most ____________________________________ type of radiation
- ____________________________________ particles with no charge
- 3-10 times greater penetration than Gamma
Less ____________________________________ hazard when ingested than Alpha or Beta
Direct tissue damage
Only present in Nuclear Reactor Core and in nuclear bombs

Factors Affecting Exposure to Radiation
Duration of exposure
Distance from the source
Shielding from the source

Radiation

Measuring Radiation (1 of 2)
Measured with a ____________________________________ counter
Cumulative exposure is recorded by a ____________________________________
: basic unit of radiation
(Gy): 100 rads
0.2Gys can cause cataracts and bone marrow damage
Lethal dose to 50% (LD50) is about 4.5Gy

Measuring Radiation (2 of 2)
__________________________________ Counter

Radiation Injury Effects on Body (1 of 2)
Geiger counter needed to detect
- $R/hr$: Milliroentgens per hour
  - $1,000 \text{ mR} = 1\text{R}$
- Radiation absorbed dose of local tissue
- Roentgen equivalent in man
- Injury to irradiated part of organism
- $\text{RAD}=\text{REM}$ for all purposes

39 Radiation Injury Effects on Body (2 of 2)
- Alters body's cell ____________________________
- Cumulative damage over lifetime exposure
- Decreased ____________________________
- Acute
  - Effects in minutes to weeks
- Long-Term
  - Effects years or ____________________________ later

40 Radiation Injury Safety
- ____________________________ Accident
  - Exposed to radiation
  - Not contaminated by products
  - With proper decontamination, poses little danger to personnel
- ____________________________ Accident
  - Associated with fire at scene of radiation accident
  - Trained decontamination personnel

41 S/ S of Radiation Exposure
Depending on type and level of exposure:
- Nausea and ____________________________
  - 4 to 24 hours after exposure
- ____________________________ of skin
  - 2 to 6 hours after exposure
- As exposure nears lethal level:
  - Confusion, diarrhea, and physical ____________________________

42 Radiation Injury Management
- Park ____________________________
- Notify Radiation Response or Haz-Mat Response Team
- Look for radioactive ____________________________
- Measure radioactivity
- Decontaminate patients ____________________________ care by trained personnel
- Routine medical care (ABC's, etc)

43 Inhalation Injury

44 Toxic Inhalation
Synthetic resins and plastics
- Produce ____________________________ & Hydrogen Sulfide when burned
Chemical burns and systemic 
Onset can be immediate or 1 to 2 hours after inhalation
More frequent than 

**Carbon Monoxide Poisoning**
- Colorless, 
- Byproduct of incomplete 
- Suspect with faulty heating unit
- 200x greater affinity for hemoglobin than 
  - Hypoxemia & Hypercarbia (excessive pressure of carbon dioxide in the blood)

**CO Poisoning**
- Clinical assessment of hypoxia is very difficult in the prehospital setting.
  - Cyanosis typically occurs with O₂ sat. < %.
- May be falsely 
- Hypoxemia and hypercarbia may develop despite good pulse oximetry reading
- Measures saturation, NOT oxygenation

**Airway Thermal Burns (1 of 2)**
- Supraglottic structures absorb heat and prevent 
- Injury is common from superheated steam from moist
- Risk Factors
  - Standing in the burn environment
  - Screaming or yelling in the burn environment
  - in a closed burn environment

**Airway Thermal Burns (2 of 2)**
- Symptoms:
  - or “Crowing” inspiratory sounds
  - Singed facial and nasal 
  - Black 
  - Progressive respiratory obstruction and arrest due to

**Thermal Burns**
- Burn Depth
  - Partial-Thickness Burn
  - Full- Burn

**Superficial Burn**
- Degree Burn
- Involves only 
- skin
- Pain at burn site

**Partial Thickness Burn**
• __________ Degree Burn
• Involves epidermis & ____________________________________
• Intense pain
• White to red skin
• ____________________________________

54 Full Thickness Burn
• __________ Degree Burn
• All dermal layers/tissue may be involved
• Dry, ____________________________ skin (white, dark brown, or charred)
• Loss of ____________________________ (little pain)

55 Full Thickness Example

56 Body Surface Area
• Rule of Nines:
  - Expedient tool to measure extent of burn
  - Best used for ____________________________ surface areas
• Rule of Palms
  - Best used for burns < ___________ % BSA
  - Patient’s palm = ___________ % of TBS

57 Extent of Burns (Rule of 9’s)
• Used to determine percent of body surface that is burned (TBS)

<table>
<thead>
<tr>
<th>Area</th>
<th>Adult</th>
<th>Child</th>
<th>Infant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>9%</td>
<td>12%</td>
<td>18%</td>
</tr>
<tr>
<td>Arms</td>
<td>9%</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>Torso (front)</td>
<td>18%</td>
<td>18%</td>
<td>18%</td>
</tr>
<tr>
<td>Torso (back)</td>
<td>18%</td>
<td>18%</td>
<td>18%</td>
</tr>
<tr>
<td>Genitalia</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Legs</td>
<td>18%</td>
<td>16.5%</td>
<td>13.5%</td>
</tr>
</tbody>
</table>

58 Extent of Burns (Rule of 9’s)

59 Rule of Palms
• A burn equivalent to the size of the ____________________________ hand is equal to 1% body surface area (BSA).

60 Systemic Complications (1 of 2)
• ____________________________
  - Disruption of skin and its ability to thermoregulate
• ____________________________
  - Shift in proteins, fluids, and electrolytes to the burned tissue
  - General electrolyte imbalance
• ____________________________
  - Hard, leathery product of a full thickness burn
  - Dead and denatured skin

61 Systemic Complications (2 of 2)
• ____________________________
  - Greatest risk of burn is infection
• ____________________________ Failure
- Release of myoglobin

- **Special Factors**
  - Age & ________________________________
  - Physical ________________________________
    - Elderly, Infirm or Young

### Management of Burns

#### Size-up and Primary Assessment

- **Scene Size-up**
  - Fire Department?
    - ________________________________ and protective clothing

- **Primary Assessment**
  - ABC's MUST be intact
    - Consider ________________________________ or RSI EARLY!
  - Rapid ________________________________ of patient if scene is unstable

#### Rapid Trauma Assessment (Scan)

- Accurately ________________________________ extent of burn injury:
  - Rule of Nines or Rule of Palms
    - ________________________________ of burn
  - Area of body effected:
    - Any burn to the face, hands, feet, joints or genitalia is considered a serious burn
    - ________________________________ of patient affected

### General Signs & Symptoms

1. ________________________________

2. ________________________________

- Changes in skin condition at affected site
- Adventitious lung sounds
- Blisters
- ________________________________ of skin
- Hoarseness
- Dyshphagia (difficulty swallowing)

- Burned ________________________________

- Hemorrhage
- Other soft tissue injury
- Musculoskeletal injury
- ________________________________

- Chest pain

### Burn Severity

**Minor Burns:**
- Superficial < ________________% BSA
- Partial Thickness < ________________% BSA
- Full Thickness < ________________% BSA

**Moderate Burns:**
- Superficial > ________________% BSA
- Partial Thickness ________________-______________% BSA
- Full Thickness ________________-______________% BSA
Burn Severity

Critical Burns:
- Partial Thickness > ______________ % BSA
- Full Thickness > ______________ % BSA
- Inhalation Injury
- Any partial or full thickness burn involving ________________________________, feet, joints, face, or genitalia
- Any complicating medical diseases or ________________________________

Burns to the face, hands, feet, joints, genitalia, and circumferential burns are or special concern.

Burns to the Hand

Reassessment
- Non-critical: Reassess Q ______________ min
- Critical: Reassess Q ______________ min
- Pay special attention to:
  - ________________________________
  - Body Temperature
  - Loss of body ________________________________

Consideration of Burn Center
- Partial Thickness > ______________ % BSA
- Full Thickness > ______________ % BSA
- Significant burns to the face, hands, feet, or perineal area
- High ________________________________ electrical injuries
- Inhalation Injuries
- Chemical burns causing ________________________________ destruction
- Associated significant ________________________________

Management of Local and Minor Burns
- Stop the ________________________________ process
- Remove clothing
- Cool or Cold water immersion
- Consider ________________________________
  - ________________ sterile dressings

Management of Moderate to Severe Burns
- Stop the burning process
- Dry sterile dressings
- Maintain warmth
  - Prevent ________________________________
- Consider aggressive ________________________________ therapy for moderate to severe burns
- Burns over IV sites: place IV in ________________________________ thickness burn site.

IV Management of Thermal Burns

Parkland Burn Formula
4 mL × Pt wt (in kg) × % BSA = Amt of fluid given in the first 24 hours
• __________________________ is fluid of choice
• Pt should receive __________ of this amount in first 8 hrs.
• Remainder in __________ hrs
• Consider 1 hour dose
  - 0.5ml x Pt wt in kg x % BSA = Amt of fluid

76 Example (1 of 3)
• Your patient is a 45 year old male with 40% 2nd and 3rd degree burns. He weighs 176 pounds. Using a 10 drop set, how many drops per minute should this patient receive for the first 8 hours?
• What is the patient’s weight in kg?
• ____________
• What is the formula?
• ___________ X weight (___________) X % burned (___________) = ???

77 Example (2 of 3)
• ____________, what is this number?
• The amount given in first 24 hours
• How much should be given in first 8 hours?
• ____________
• Now what is the formula to get gtt/min?
• ____________________________ X ____________________________
  ____________________________ (in minutes)

78 Example (3 of 3)
• __________ X ___________________________
• ___________ gtt/min
• What if you have 2 lines?
• Add them together
  - Run one line at __________ gtt/min and the other tko, or
  - Run both at __________ gtt/min

79 Advanced Burn Life Support (ABLS) Fluid Replacement Formulas
Initial Fluid Resuscitation for burns > 20-25% TBA:
• Age 5yoa and less: LR @ ____________ cc/hr
• Ages 6-13: LR @ ____________ cc/hr
• Ages 14yoa and older: LR @ ____________ cc/hr

80 ABLS Fluid Replacement Formulas
Long term resuscitation formulas:
• Adults thermal and chemical burns
  - __________ ml LR X kg X % TBA burned
• Pediatrics (14 yoa and < 40kg)
  - __________ ml LR X kg X % TBA burned
• Adult High Voltage Electrical Injuries
  - __________ ml LR X kg X % TBA burned
• Pediatric High Voltage Electrical Injuries
  - Consult a burn center

81 Management of Thermal Burns
Moderate to Severe Burns:
● Caution for fluid ____________________________
  - Frequent auscultation of ____________________________ sounds
● Consider analgesic for pain
  - ____________________________
  - Fentanyl
● Prevent ____________________________

Management of Thermal Burns
Inhalation Injury:
● Remove to safe ____________________________
● Provide high-flow O2 by NRB
● Consider ____________________________ if swelling
● Consider ____________________________ oxygen therapy

Assessment of Electrical Burns
Safety:
● Turn off ____________________________
● Energized lines act as whips
● Establish a ____________________________ zone
Lightning Strikes:
● High voltage, high current, high energy
● Lasts fraction of a ____________________________
● No danger of electrical shock to ____________________________ from Pt

Management of Electrical Burns
Assess patient:
● Entrance & ____________________________ wounds
● Remove clothing, ____________________________ , and leather items
● Treat any visible injuries
● Pt has need for ____________________________ monitoring
  - Treat cardiac & respiratory arrest
● Aggressive airway, ventilation, and circulatory management.
● Consider Fluid bolus for serious burns: ____________ml/kg

Assessment of Chemical Burns

Scene Size-up
● Hazardous materials ____________________________
● Establish hot, warm and ____________________________ zones
● Prevent personnel exposure from ____________________________

Specific Chemicals
● ____________________________
● Dry Lime
● ____________________________
● Riot Control Agents

Phenol
● Industrial ____________________________
● ____________________________ dissolves Phenol
- Irrigate with copious amounts of ________________________________

89  **Dry Lime**
- Strong corrosive that reacts with ________________________________
- Brush off ________________________________ substance
- Irrigate with copious amounts of cool ________________________________

90  **Sodium**
- ________________________________ metal
- Reacts vigorously with water
- Releases extreme heat and ________________________________ gas and could possibly ignite
- Decontaminate: Brush off dry chemical
- Cover the wound with oil substance used to store the sodium

91  **Riot Control Agents (1 of 2)**
- Agents include CS, CN (Mace), Oleoresin, Capsicum OC
  (________________________ spray)
- Irritation of the ________________________________, mucous membranes, and respiratory tract.
- No ________________________________ damage

92  **Riot Control Agents (2 of 2)**
**General Signs & Symptoms:**
- ________________________________, gagging, and vomiting
- Eye pain, tearing, temporary ________________________________
**Management:**
- Irrigate eyes and mucus membranes with normal
  ________________________________ or water

93  **Assessment & Management of Radiation Burns**
- Notify Hazardous Materials Team
- Establish Safety Zones
  - Hot, Warm, & Cold
- Personnel positioned Upwind and ________________________________
- Use ________________________________ rescuers for recovery
- ________________________________ ALL rescuers, equipment and patients