Special Topics: Thermal Burns & Smoke Inhalation

MEDICAL RESPONDER AND RECEIVER SEMINAR: EXPLOSION AND BLAST INJURIES

Pathophysiology of the Burn Wound

- The burn wound is the source of virtually all ill effects seen in the burn patient.
- Removal of the burn wound results in much improved patient outcome.

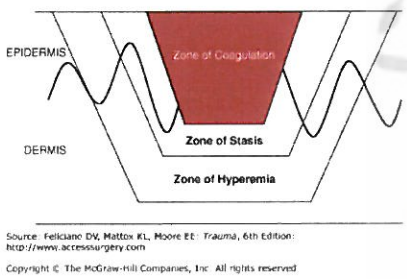
Cellular and Tissue Effects

- Damage to the cells and tissue is a function of temperature and time.
- Sustained temperatures between 40C and 44C cause various enzymes to malfunction.
- Higher temperatures cause protein breakdown.

Cellular and Tissue Effects

- Zone of coagulation
  - Protein coagulation and cell necrosis
- Zone of stasis
  - Cell initially viable, but blood flow compromised
- Zone of hyperemia
  - Minimal cellular injury, but increased blood flow and vasodilatation

Zones of Injury



Source: Feliciano DV, Mattox KL, Moore EE: *Trauma*, 6th Edition: http://www.accesssurgery.com

Systemic Effects

- Consumption of clotting factors and platelets
- Suppression of cellular immunity
- Myocardial depression
- Pulmonary dysfunction
- Hypermetabolism
- Fat and skeletal muscle catabolism
- Renal dysfunction

Primary Survey

- Airway:
  - Can deteriorate abruptly and rapidly
  - Airway obstruction due to progressive edema
- Breathing
  - Circumferential full thickness burns
  - Lung injury can affect oxygenation
- Circulation
  - BP, Pulse, circumferential burns and third-spacing
- Disability
  - Neurologic status may be affected due to multiple causes
- Exposure
  - Pay attention to hypothermia-induced stress

Inhalation Injury

- Upper airway burns
  - Tracheobronchial injury
- Lower airway burns
  - Lungs
- Toxic compounds
  - Carbon monoxide
  - Cyanide

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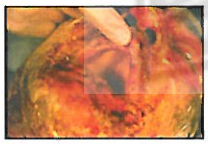
Smoke Inhalation

- Smoke particles
  - Clinical manifestations:
    - Stridor, cough, shortness of breath
    - Carbonaceous sputum, soot in airway, singed nasal vibrissae, facial burns
  - Can lead to rapid airway compromise
  - Surgical airway may be needed if oral intubation is not successful



Carbon Monoxide-Mechanism

- Binds hemoglobin to form carboxyhemoglobin that is unable to carry oxygen
- May inhibit to a certain degree cytochrone oxidase

Carbon Monoxide-Clinical

- Most common presentation:
  - Flu-like illness
- CNS
- CV

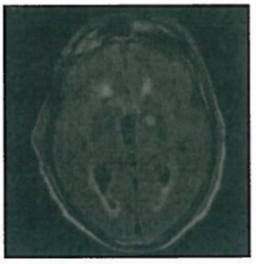
Carbon Monoxide-Labs

- Carboxyhemoglobin level (Arterial or Venous)
- Creatine kinase
- EKG, CXR

Carbon Monoxide

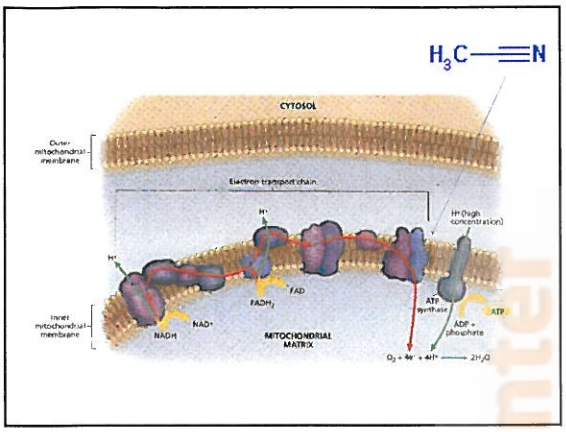
- 100% Oxygen therapy
- Hyperbaric oxygen therapy

Long-term Effects



Hydrogen Cyanide-Mechanism

- Inhibits cytrochrome oxidase
- Cells are unable to use oxygen
- Anerobic metabolism prevails
- Lactate accumulates



Hyrdrogen Cyanide-Clinical

- Clinical:
  - CNS
  - CV
  - Bitter almond: only 60% of population can detect it.
  - Cherry red skin, fundoscopic exam

Hydrogen Cyanide-Labs

- Lactic acidosis with a lactate > 7 mmol/l
- Elevated venous O2 saturation
  - >90%
- Low O2 extraction when comparing a Venous PO2 with and Arterial PO2

Cyanide Antidote Kit

- AKA the Lilly kit
- Contains:
  - Amyl nitrite pearls
  - Sodium nitrite
  - Sodium thiosulfate

Hydroxocobalamin

- 5 g IV over 15 minutes
- May repeat dose if no response and patient is critically ill

Adverse Effects of Hydroxocobalamin

Secondary Survey

- History
- Circumstances
- Cause

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Secondary Survey

- Duration of contact with flame
- Method used to extinguish the fire
- Substances placed on the burns during pre-hospital/bystander wound care

Secondary Survey

- Setting
  - Indoors versus outdoors
- Associated trauma
  - Blast injuries
- Associated smoke inhalation

Past Medical History

- Comorbid conditions
  - Diabetes, renal failure, cardiovascular disease
  - Immunocompromised state
  - Previous disabilities and special needs

AMPLE

- Allergies
- Medications
- Last meal
- Tetanus status

Depth of Burn

- First degree
- Second degree or partial thickness
  - Superficial and deep
- Third degree or full thickness
- Fourth degree

Burn Depth Estimation

- First degree: painful erythematous like a sunburn
- Partial thickness or second degree: painful, blisters, erythematous
- Full thickness or third degree: insensate, pale, without viable hair follicles, cadaveric/leathery consistency to palpation

First Degree Burn

Second Degree Burn

Egg Explosion from Microwave

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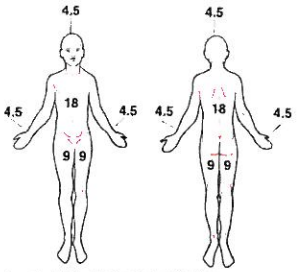
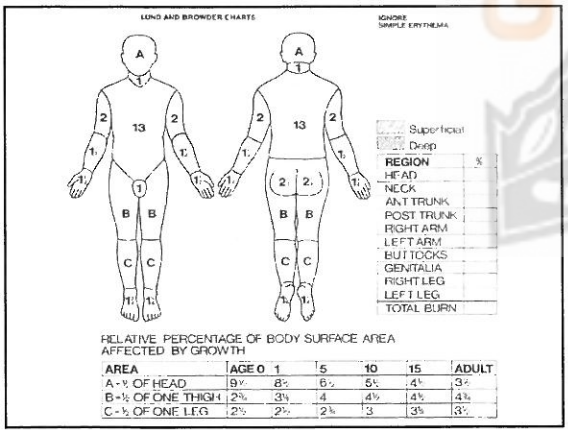
Third Degree Burn

Burn Surface Area Estimation

- The patient's hand including fingers is approximately 1% of Total BSA

Rule of 9





RELATIVE PERCENTAGE OF BODY SURFACE AREA AFFECTED BY GROWTH

AREA	AGE 0	1	5	10	15	ADULT
A - ½ OF HEAD	9½	8½	6½	5½	4½	3½
B - ½ OF ONE THIGH	2¾	3¼	4	4½	4¾	4¾
C - ½ OF ONE LEG	2½	2½	2¾	3	3¼	3½

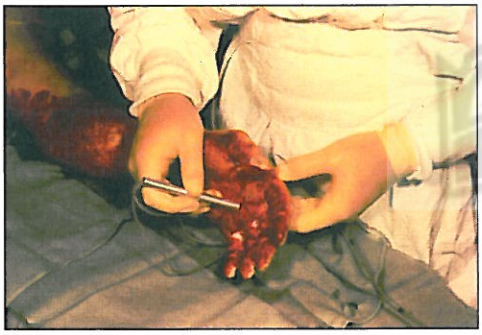
The Berkow Chart

Table 50-3 Berkow Chart for Estimation of Burn Size in Children

AREA	1 YR	1–4 YRS	5–9 YRS	10–14 YRS	15 YRS
Head	19	17	13	11	9
Neck	2	2	2	2	2
Ant. trunk	13	13	13	13	13
Post. trunk	13	13	13	13	13
Buttock	2.5	2.5	2.5	2.5	2.5
Genitalia	1	1	1	1	1
Upper arm	4	4	4	4	4
Lower arm	3	3	3	3	3
Hand	2.5	2.5	2.5	2.5	2.5
Thigh	5.5	6.5	8	8.5	9
Leg	5	5	5.5	6	6.5
Foot	3.5	3.5	3.5	3.5	3.5

Assessment for Perfusion/Ventilation

- Circumferential full thickness burns
  - Extremity perfusion may be compromised
  - Ventilation may be compromised



Special Consideration-Pediatrics

- Larger surface area of head
- More susceptible to hypothermia
- Moral support to patient and parents

Fluid Resuscitation

- Fluid is determined by the severity of injury
  - Amount of 2nd and 3rd degree burn
- Lactated ringers
- Initial fluid determined by parkland formula
  - 2-4cc/kg/%TBSA
  - ½ over the first 8 hours
- DO NOT BOLUS
- Titrate fluid to urine output
  - 30-50cc/hour

Fluid Resuscitation

FORMULA	CRYSTALLOID	COLLOID VOLUME	FREE WATER
Parkland	4 ml/kg/%TBSA burn	None	NONE
Brooke	1.5 ml/kg/%TBSA burn	0.5 mL/kg/% TBSA burn	2 L
Galveston (Pediatric)	5000 mL/m^2 burned + 1500 mL/m^2 total	None	None

Adapted from Feliciano

Maintenance Fluids

- Note that maintenance fluids need to be added in children to the Parkland formula.
- When using the Galveston formula, maintenance fluids are already included.

Wound Care

- If the patient is to be transferred, cover the burns with sterile, dry, towels or sheets
- Do not soak the burns or wrap with wet towels, this may induce hypothermia and worsen outcome.

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Debridement

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Job Well Done!

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Cleansing Solution

- Antispectic scrub
  - Chlorhexidine versus Povidone-Iodine

Ointments

- Silver preparations (e.g., silver sulfadiazine)
  - 5 mm layer every 24 hours
    - Sulfa allergy
    - Staining of skin
- Silver nitrate (0.5%)
  - Can be used in sulfa allergy
  - less burn eschar penetration

Ointments

- Acticoat® silver based dressing
  - No need for dressing change
  - Need for frequent application of silver nitrate
- Mafenide Acetate (Sulfamylon®)
  - Sulfonamide. Excellent antibiotic coverage
  - Cartilage

Ointments

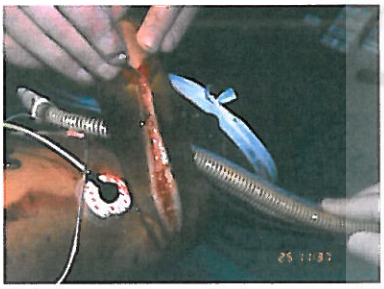
- Neosporin®, Polysporin® and Bacitracin® are the most commonly used.
- Neosporin activity is due to the combination of three different types of antibiotics with different spectra:
  - Bacitracin (gram-positive activity)
  - Neomycin (gram-negative activity)
  - Polymyxin B (gram-negative activity)

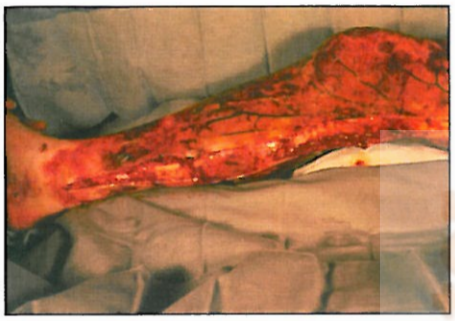
Escharotomy- Indications

- Used to treat full thickness (third-degree) circumferential burns.
- Underlying tissues become constricted due to the eschar's loss of elasticity, leading to impaired circulation distal to the wound.
- The ability to ventilate a patient may be impaired by a circumferential chest burn.

Escharotomy- Description

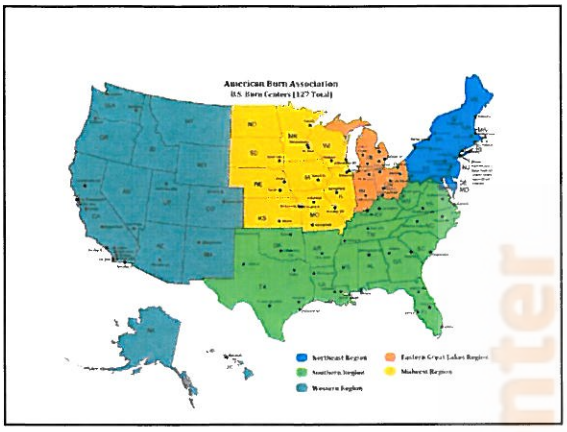
- H shaped incision





Transfer to Burn Center

- Partial thickness burns >10% TBSA.
- Burns involving the face, hands, feet, genitalia, perineum, or major joints.
- Third degree burns in any age group.
- Electrical burns, including lightning.
- Chemical burns.
- **Inhalation injury.**
- Burns in patients with pre-existing medical problems.
- **Combination of burns and trauma.**



Questions or Comments?