



Emergency Medicine and Trauma Care Research Center

BURN AND MANAGEMENT OF DIFFERENT TYPES OF BURNS

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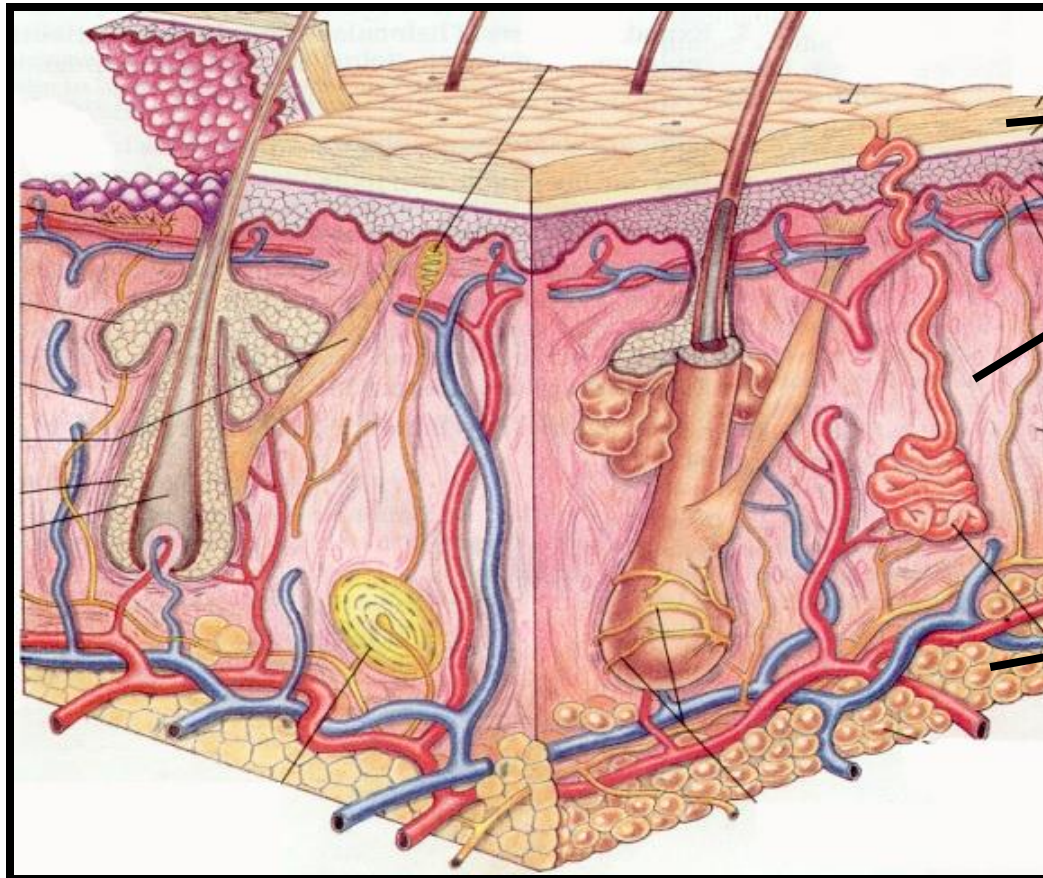
Head of department

OVERVIEW

- **Burn Pathophysiology**
- Initial Assessment & Management
- Airway Management & Inhalation Injury
- Shock & Fluid Resuscitation
- Burn Wound Management
- Electrical Injuries
- Chemical Burns
- Pediatric Burns
- Other Topics



SKIN ANATOMY



Epidermis

Dermis

Hypodermis



FUNCTION OF NORMAL SKIN

- Protection from infection & injury
- Prevention of loss of body fluid
- Regulation of body temperature
- Sensory contact with environment

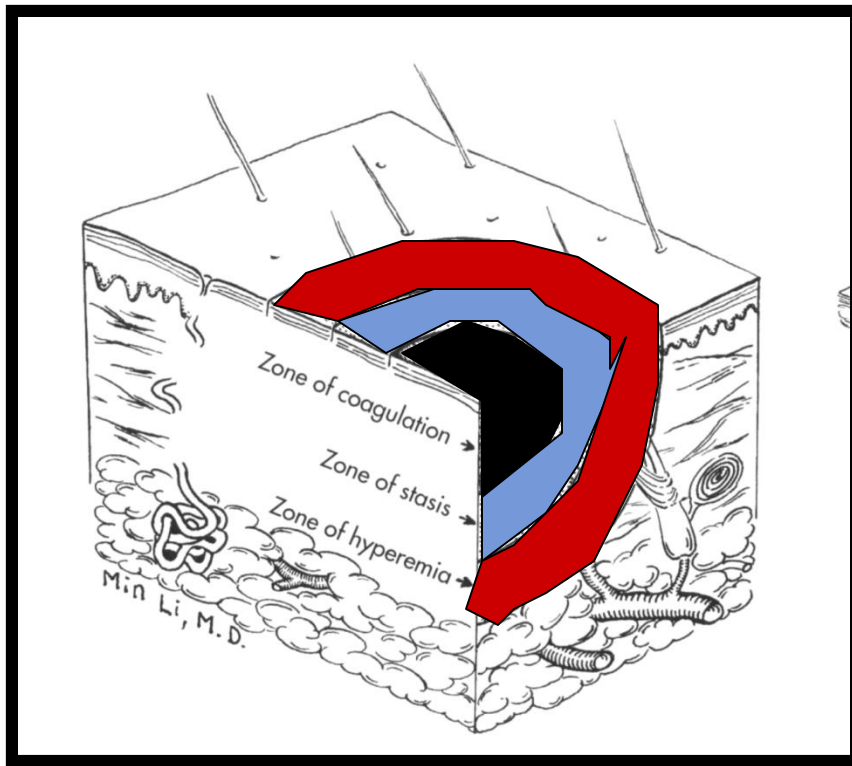


WHAT IS A BURN?

- An injury to tissue from:
 - Exposure to flames or hot liquids
 - Contact with hot objects
 - Exposure to caustic chemicals or radiation
 - Contact with an electrical current



PATHOPHYSIOLOGY OF BURN INJURY



- Zone of Coagulation:
 - Irreversible damage
- Zone of Stasis:
 - Impairment of blood flow
 - Recovery variable
- Zone of Hyperemia:
 - Prominent vasodilation
 - Usually recovers



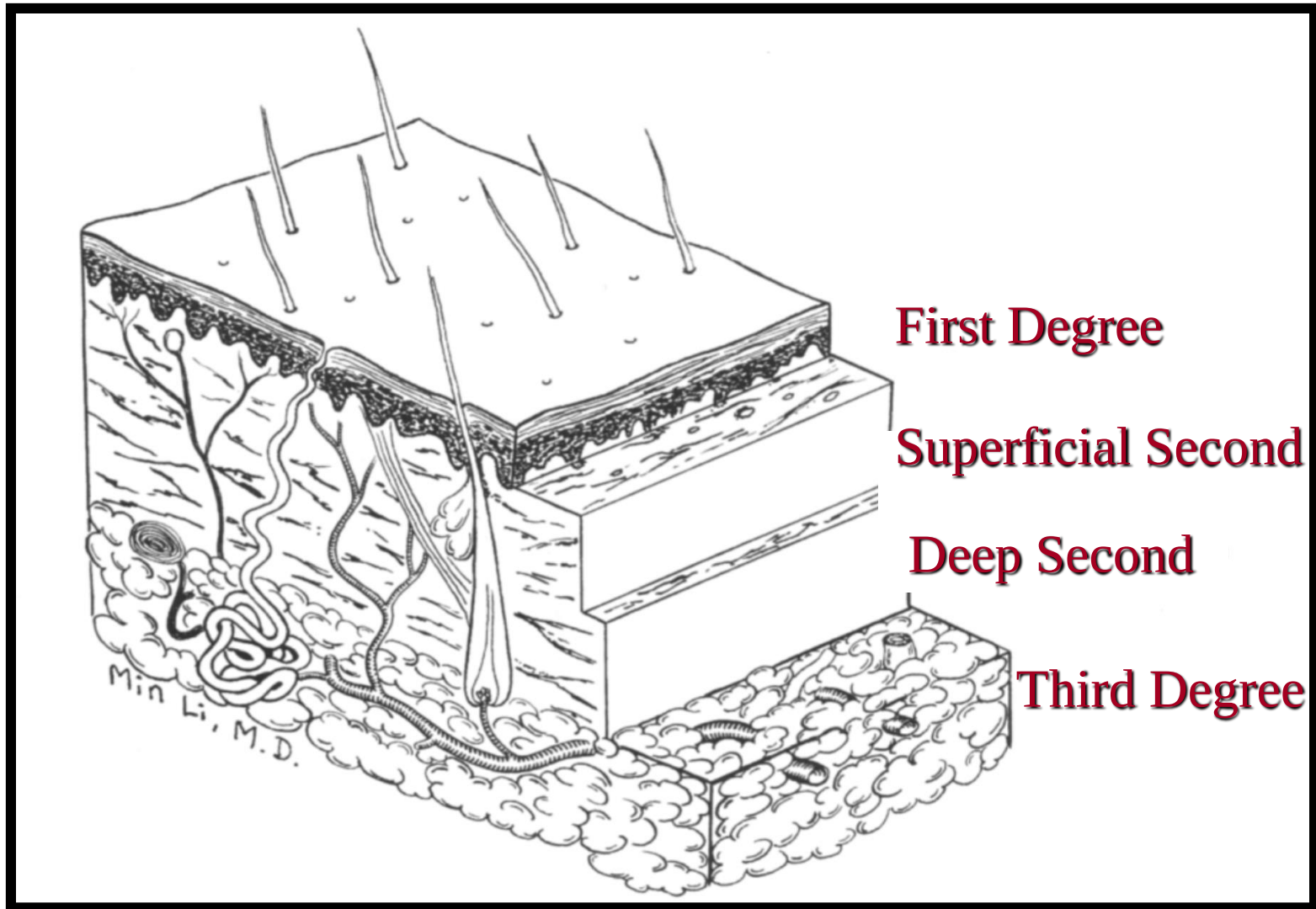
SEVERITY OF A BURN

Depends on:

- Depth of burn
- Extent of burn
- Location of injury
- Patient's age
- Presence of associated injury or diseases



DEPTH OF A BURN



DEPTH OF A BURN

○ First Degree

- Epidermis only
- Erythematous
- Hypersensitive
- Classic sunburn
- Heals without scar



DEPTH OF A BURN

○ Second Degree

- Epidermis + part of dermis

○ Superficial

○ Deep

- Blisters
- Edematous and red
- Very painful
- Scarring variable



DEPTH OF A BURN

○ Third Degree

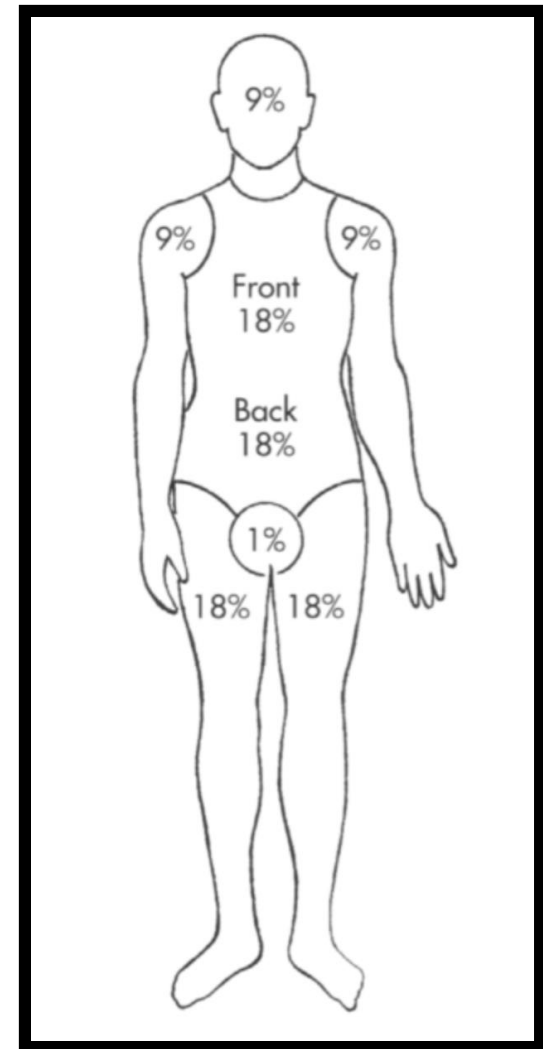
- Full thickness burn
- Can involve underlying muscle, tendon, bone
- Waxy white, leathery brown or charred black
- Painless
- Heals with scar



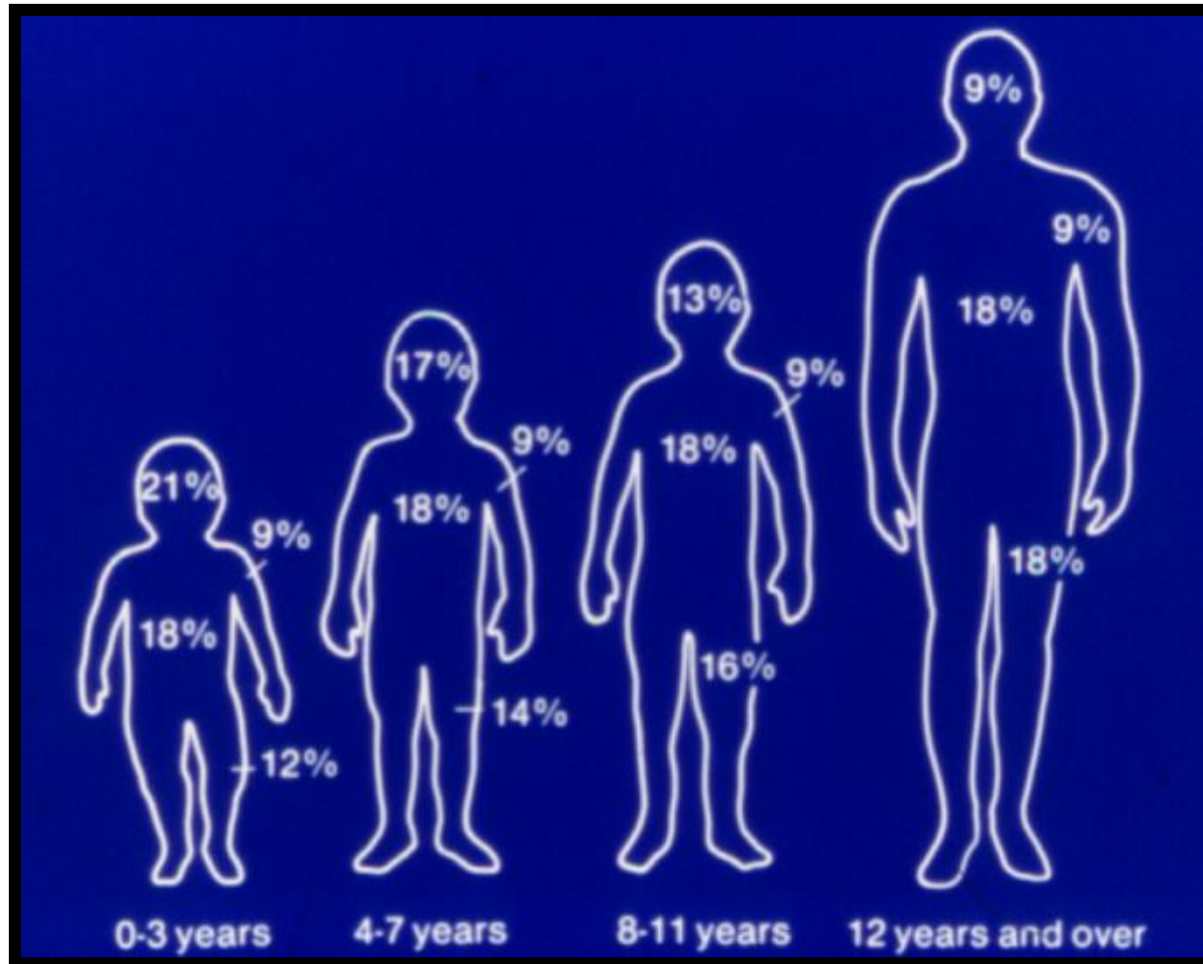
EXTENT OF A BURN

○ “Rule of Nines”

- Most universal guide for initial estimate
- Deviates in children due to larger head surface area



“ROBYN’S RULE OF 4S”



ABA BURN REFERRAL CRITERIA

- 2nd & 3rd degree burns of greater than 10% BSA in patients under 10 or over 50 yrs old
- 2nd & 3rd degree burns of greater than 20% BSA in other age groups
- 2nd & 3rd degree burns with functional or cosmetic implications
- 3rd degree burn of greater than 5% BSA



ABA BURN REFERRAL CRITERIA

- Significant electrical burn
- Chemical injury with functional or cosmetic impairment
- Inhalation injury
- Circumferential burn of chest or extremity
- Burn injury with pre-existing medical disorder
- Any burn with concomitant trauma



PRIMARY SURVEY

- **A** – Airway
- **B** – Breathing
- **C** – Circulation / C-spine / Cardiac status
- **D** – Disability / Neurologic Deficit
- **E** – Exposure and Examination
- **F** – Fluid Resuscitation



SECONDARY SURVEY

- Complete head-to-toe examination
- Obtain as much information as possible regarding injury:
 - **A** – Allergies
 - **M** – Medications
 - **P** – Past medical history
 - **L** – Last meal or drink
 - **E** – Events preceding injury



MANAGEMENT PRINCIPLES

- Stop the Burning Process
- Universal Precautions
- Airway Management
- Circulatory Management
- Insertion of a Nasogastric Tube
- Insertion of a Foley Catheter



MANAGEMENT PRINCIPLES

- Relieve Pain
- Assess Extremity Pulses Regularly
- Assess for Ventilatory Limitation
- Provide Emotional Support
- Suicide Management



INHALATION INJURY

- Important determinant of morbidity & mortality
- Manifests within the first 5 days after injury
- Present in 20-50% of pts admitted to burn centers
- Present in 60-70% of pts who die in burn centers



INDICATORS OF INHALATION INJURY

- Burned in closed space
 - Facial or intra-oral burns
 - Singed nasal hairs
 - Soot in mouth, nostrils, larynx
 - Hoarseness or stridor
 - Respiratory distress
 - Signs of hypoxemia
- 

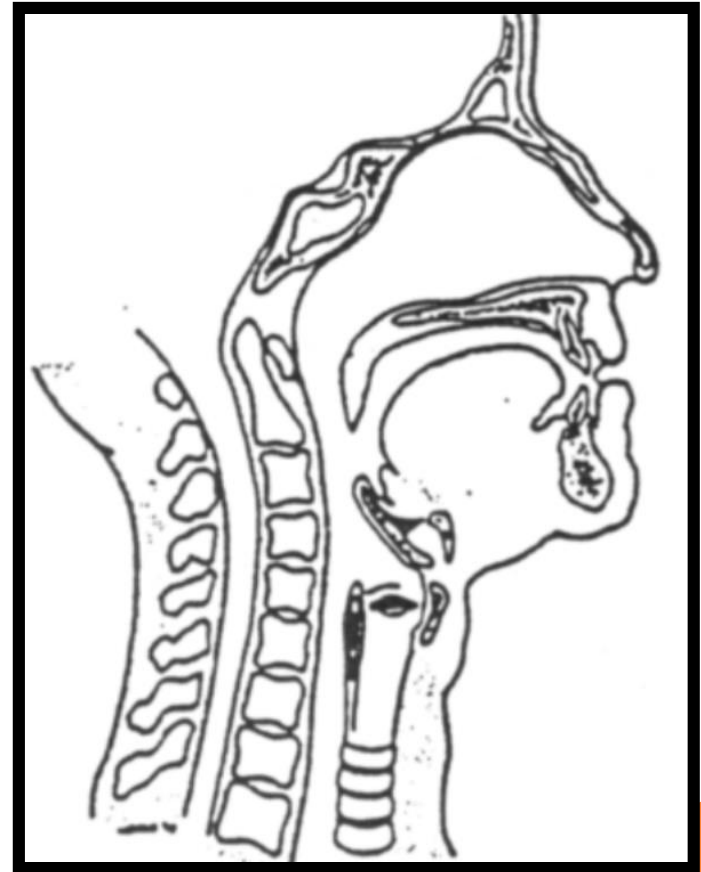
HISTORY OF EVENT

- Is there a history of unconsciousness?
- Were there noxious chemicals involved?
- Did injury occur in closed space?



TYPES OF INHALATION INJURY

- Carbon Monoxide Poisoning
- Inhalation Injury Above the Glottis
- Inhalation Below the Glottis



CARBON MONOXIDE POISONING

- Colorless, odorless gas
- Binds to hemoglobin 200 times more than oxygen
- Most immediate threat to life in survivors with severe inhalation injury
- Toxicity related directly to percentage of hemoglobin it saturates



CARBON MONOXIDE POISONING

Signs & Symptoms of Carbon Monoxide Toxicity

<u>Carboxyhemoglobin (%)</u>	<u>Signs/Symptoms</u>
0-10	None
10-30	Headache
30-50	Headache, nausea, dizziness, tachycardia
50-60	CNS dysfunction, coma
60+	Death

SIGNS OF CO POISONING

- Cherry red coloration
- Normal or pale skin with lip coloration
- Hypoxic with no apparent cyanosis
- PaO₂ is unaffected
- **Essential to determine carboxyhemoglobin levels !**



CO POISONING: TREATMENT

- 100% oxygen until carboxyhemoglobin levels less than 15
 - Increases rate of CO diffusion from 4 hours to 45 minutes
- Hyperbaric oxygen is of unproven value
 - May be useful in isolated CO intoxication but complicates wound care



INHALATION INJURY ABOVE THE GLOTTIS

- Most common inhalation injury
- Results from heat dissipation into tissues
- Commonly leads to obstruction
- Edema lasts for 2-4 days
- Dx by visualization of upper airways



INHALATION INJURY ABOVE THE GLOTTIS: TREATMENT

Intubate!!!



INHALATION INJURY BELOW THE GLOTTIS

- Chemical pneumonitis caused by toxic products of combustion
 - Ammonia, chlorine, hydrogen chloride, phosgene, aldehydes, sulfur & nitrogen oxides
 - Related to amount and type of volatile substances inhaled
- Onset of symptoms is unpredictable
 - Close monitoring for first 24 hours



INHALATION INJURY BELOW THE GLOTTIS: TREATMENT

Prior to transfer to burn center

- Intubation
 - to clear secretions
 - relieve dyspnea
 - deliver PEEP
 - Improve oxygenation
- Steroids not indicated
- Prophylactic antibiotics unjustified
- Circumferential chest burns:
escharotomies



INHALATION INJURY IN THE PEDIATRIC PATIENT

- Small airways: rapid onset of obstruction
 - Well secured, appropriately sized, uncuffed tube
- Rib cage is not ossified
 - More pliable
 - Pt exhausts rapidly due to decrease in compliance with circumferential chest burns
 - Escharotomies performed with first evidence of ventilatory impairment



SHOCK & FLUID RESUSCITATION

Goal:

- To maintain vital organ function while avoiding the complications of inadequate or excessive therapy

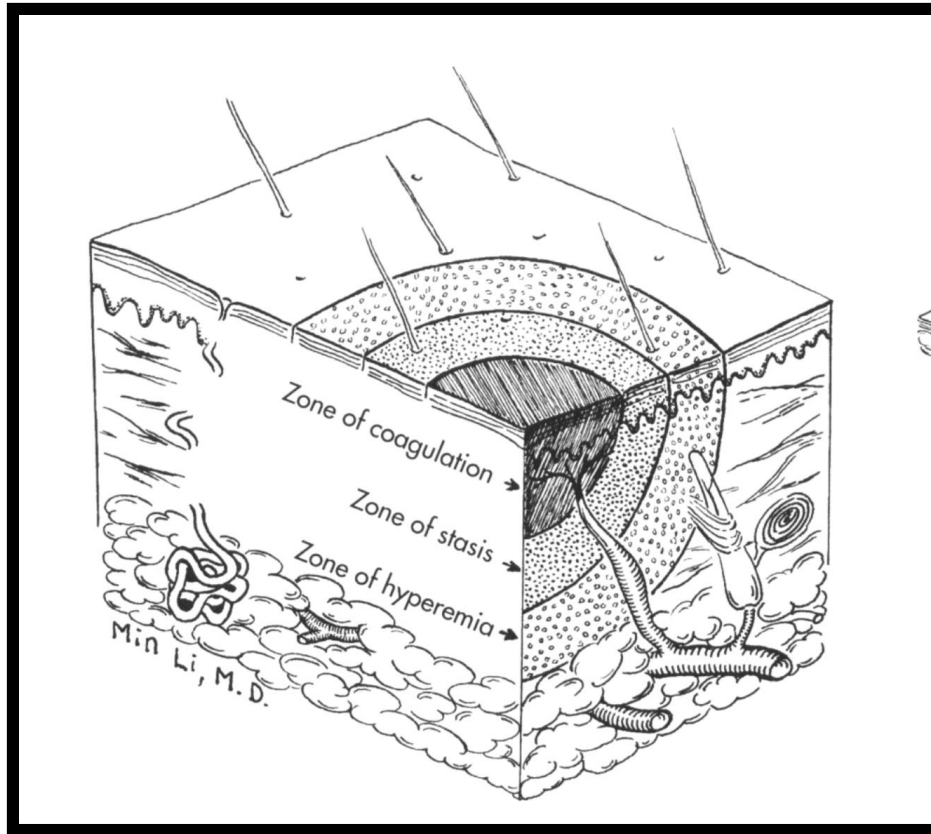


SYSTEMIC EFFECTS OF BURN INJURY

- Magnitude & duration of response proportional to extent of surface burned
- Hypovolemia
 - Decreased perfusion & oxygen delivery
- Initial increase in PVR & decrease in CO
 - Neurogenic & humoral effects
- Corrected with adequate fluid resuscitation
 - Prevent shock & organ failure



CELLULAR RESPONSE TO BURN INJURY



- Severity dependant on temperature exposed and duration of exposure
- “Zone of Stasis”: recovery of injured cells dependant on prompt resuscitation



RESUSCITATION FLUID NEEDS

- Related to:
 - extent of burn (rule of nines)
 - body size (pre-injury weight estimate)
- Delivered through large bore peripheral IV
 - Attempt to avoid overlying burned skin
 - Can use venous cut down or central line



RESUSCITATION FLUID NEEDS: FIRST 24 HOURS

○ **Parkland Formula:**

- Adults: $2-4 \text{ ml RL} \times \text{Kg body weight} \times \% \text{ burn}$
- Children: $3-4 \text{ ml RL} \times \text{Kg body weight} \times \% \text{ burn}$
- First half of volume over first 8 hours, second half over following 16 hours
 - Hypovolemia, decreased CO
 - Increased capillary permeability
 - **Crystalloid fluid is keystone**, colloid not useful



RESUSCITATION FLUID NEEDS: SECOND 24 HOURS

- Capillary permeability gradually returns to normal
- Colloid fluids started to minimize volume
 - Only necessary in patients with large burns (greater than 30% TBSA)
 - $0.5 \text{ ml of } 5\% \text{ albumin} \times \text{Kg body weight} \times \% \text{ burn}$



MONITORING OF RESUSCITATION

- Actual volume infused will vary from calculates according to physiologic monitoring
- Optimal regimen:
 - minimizes volume & salt loading
 - prevents acute renal failure
 - low incidence of pulmonary & cerebral edema



MONITORING OF RESUSCITATION

- Urinary output is a reliable guide to end organ perfusion
 - **Adults: 30-50 ml per hour**
 - **Children (less than 30 Kg): 1 ml/Kg per hour**
- Infusion rate should be increased or decreased by $\frac{1}{3}$ if u/o falls or exceeds limits by more than $\frac{1}{3}$ for 2-3 hours



MANAGEMENT OF MYOGLOBINURIA & HEMOGLOBINURIA

- High voltage electrical injury and mechanical trauma
- Maintain urine output of 75-100 ml per hour
- Add 12.5 gm of Mannitol to each liter of fluid
 - Urine output not sustained
 - Urine pigment does not clear
- Sodium bicarbonate 1 amp (50 meq) per liter of fluid
 - Heme pigments more soluble in alkaline urine



MONITORING RESUSCITATION

- Blood pressure:
 - Can be misleading due to progressive edema & vasoconstriction
- Heart Rate:
 - Tachycardia commonly observed
- Hemaglobin & hematocrit:
 - Not a reliable guide
 - Transfusion not to be used for resuscitation
- Baseline serum chemistries & arterial blood gases
 - Baseline to be obtained in burns of >30% BSA



MONITORING RESUSCITATION

- CXR: daily for first 5-7 days
 - Normal study in first 24 hours does not r/o inhalation injury
- ECG:
 - All electrical injuries
 - Pre-existing cardiovascular disease



FLUID RESUSCITATION IN THE PEDIATRIC PATIENT

- Require greater amounts of fluid
 - Greater surface area per unit body mass
- More sensitive to fluid overload
 - Lesser intravascular volume per unit surface area burned



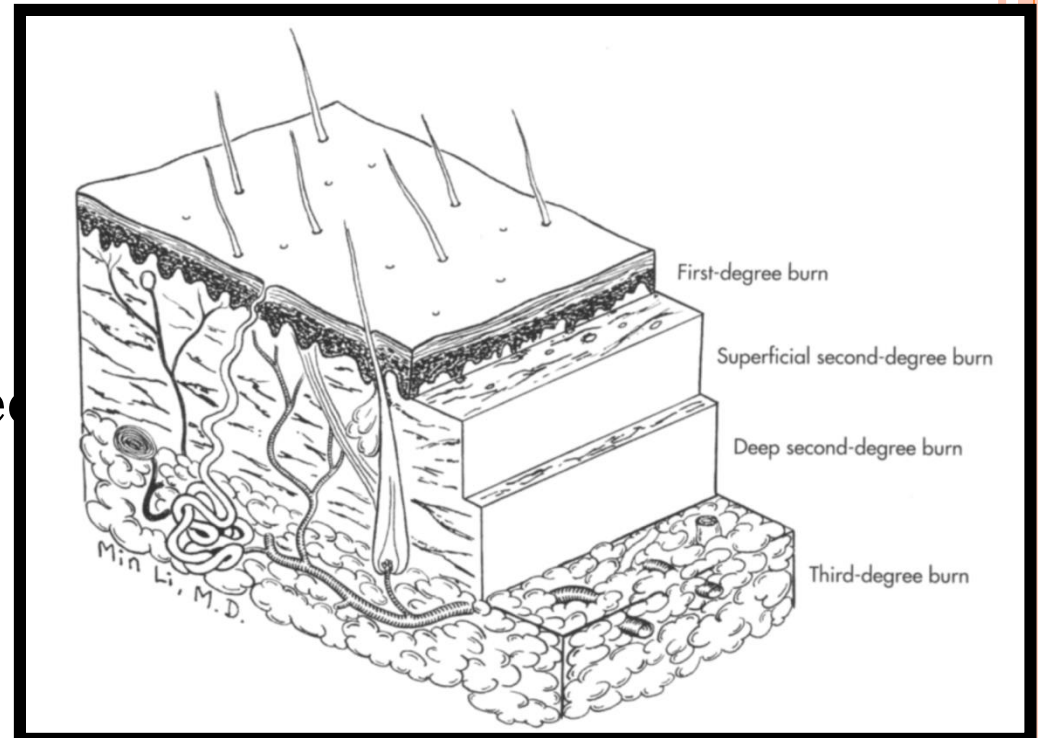
DEPTH OF BURN

○ Partial Thickness

- First degree
- Superficial second degree
- Deep second degree

○ Full Thickness

- Third degree



TAR BURNS

- Contact burns
- Bitumen is non-toxic
- Immediate cooling of molten with cold H₂O
- Removal of tar not an emergency
- Cover with petroleum based product & dressed to emulsify tar



Please Pass the Mayo!

ELECTRICAL INJURY

- Occurs when electricity is converted to heat as it travels through tissue
- Divided into:
 - High voltage – greater than 1000 V
 - Low voltage – less than 1000
- Hands & wrists are common entrance wounds
- Feet are common exit wounds



ELECTRICAL INJURY

- Extremely difficult to evaluate clinically
- Greatest tissue damage occurs under and adjacent to contact points
- Superficial tissues cool more rapidly than the deeper tissue
 - Accounts for non-viable tissue beneath viable, more superficial muscle



TYPES OF TISSUE INJURY

- **Cutaneous Burn with no underlying tissue damage**
 - No passage of current through patient
- **Cutaneous Burn plus deep tissue damage**
 - Involving fat, fascia, muscle and/or bone
- **Muscle damage associated with myoglobin release**
 - Urine may be light red to “port wine” color
 - Risk of kidney damage



LIGHTNING INJURY

- Direct current of >100 000 000 volts and up to 200 000 amps
- Injury results from:
 - Direct strike
 - Side flash
 - Flow of current between person & nearby object
- Often travels on surface of body
 - Burns typically superficial
 - “splashed on” spidery pattern



MANAGEMENT OF ELECTRICAL INJURY

- ABC's
- Assess Injury
 - History
 - LOC, cardiac arrhythmia, other trauma
 - Physical Exam
 - neuro exam, long bone #, dislocations, cervical spine
- Maintain Patency of Airway
- Cardiac Monitoring:
 - Standard 12 lead ECG on admission
 - Continuous cardiac monitoring for first 24 hours



MANAGEMENT OF ELECTRICAL INJURY: FLUID RESUSCITATION

- Administer Ringer's Lactate in amounts estimated with Parkland Formula
 - Will underestimate required volume due to underlying tissue damage
 - Increase fluids as per urine output
- Examine urine for pigment
 - Maintain urine output 75-100 ml/hr until clear
 - Add 1 amp (50 meq) per liter of RL to alkalize urine
 - Mannitol 12.5 mg/liter to maintain urine output



MANAGEMENT OF ELECTRICAL INJURY: PERIPHERAL CIRCULATION

- Hourly monitoring of skin color, sensation, capillary refill and peripheral pulses
- Remove all rings, watches, jewelry
- Surgical correction of vascular compromise
 - Decompression by escharotomy or fasciotomy
 - Upper limb-volar & dorsal incisions with protection of ulnar nerve
 - Lower limb-medial & lateral incisions



ELECTRICAL BURNS IN THE PEDIATRIC PATIENT

- Low voltage accidents most common
 - Generally household (faulty insulation, frayed cords, insertion of metal object into wall socket)
 - Cutaneous injury, no muscle damage
- Oral commisure injury
 - Look worse than they are
 - No initial debridement



CHEMICAL BURNS: CLASSIFICATION

○ Alkalis

- Hydroxides, carbonates and caustic sodas of sodium, ammonium, lithium, barium & calcium
- Oven & drain cleaners, fertilizers, industrial cleaners

○ Acids

- HCl, oxalic, muriatic & sulfuric acids
- Common in household & swimming pool cleaners

○ Organic Compounds

- Phenols, creosote, petroleum products
- Contact chemical burns & systemic effects



CHEMICAL BURNS

- Factors That Determine Severity:
 - Agent
 - Concentration
 - Volume
 - Duration of contact (delay in treatment)



TREATMENT OF CHEMICAL BURNS

- Wear gloves and protective clothing
- Remove saturated clothing
- Brush skin if agent is a powder
- **Irrigate, irrigate, irrigate!**
 - Copious amounts of water
 - Continued until pain or burning has decreased
- Neutralization of agent contraindicated
 - Generation of heat may lead to further injury



PEDIATRIC BURNS

- Scald burns most common burn in < 3 years
- Flame burns most common in children > 3 years
- Always consider child abuse



PEDIATRIC BURNS: PATHOPHYSIOLOGY

- Greater surface area per pound of body weight
 - Greater fluid needs
 - Greater evaporative water loss
 - Greater heat loss
- Disproportionately thin skin
 - Burns may be deeper than initially assessed
 - Requires less exposure time to result in burn



PEDIATRIC BURNS: AIRWAY

- Intubation performed by someone experienced
- Larynx more cephalad
 - More acute angulation of the glottis
- Cuffed tube always used
- Cricothyroidotomy is never indicated
- Large bore needle placed through cricothyroid membrane may be used in emergency cases



PEDIATRIC BURNS: CIRCULATORY STATUS

- Burn > 10% BSA should be hospitalized
- IV Ringer's Lactate is administered as per formula
 - Must also add maintenance fluid (4-2-1 rule)
- NG tube
- Urinary catheter to monitor urine output:
 - <30 Kg: 1ml/Kg per hour
 - >30 Kg: 30-50 ml per hour
- If hypoglycemic, add 5% glucose to RL solution



PEDIATRIC PATIENT: WOUND CARE

- Stop burning process
- Remove all clothing
- Topical antibiotics not indicated before transfer
- Conserve heat with thermal blankets
- Escharotomy
 - Chest: ventilatory impairment
 - Limb: vascular compromise



THE END!



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