# Burn and Management of different types of Burns

*Prof. Dr. Alireza Ala*

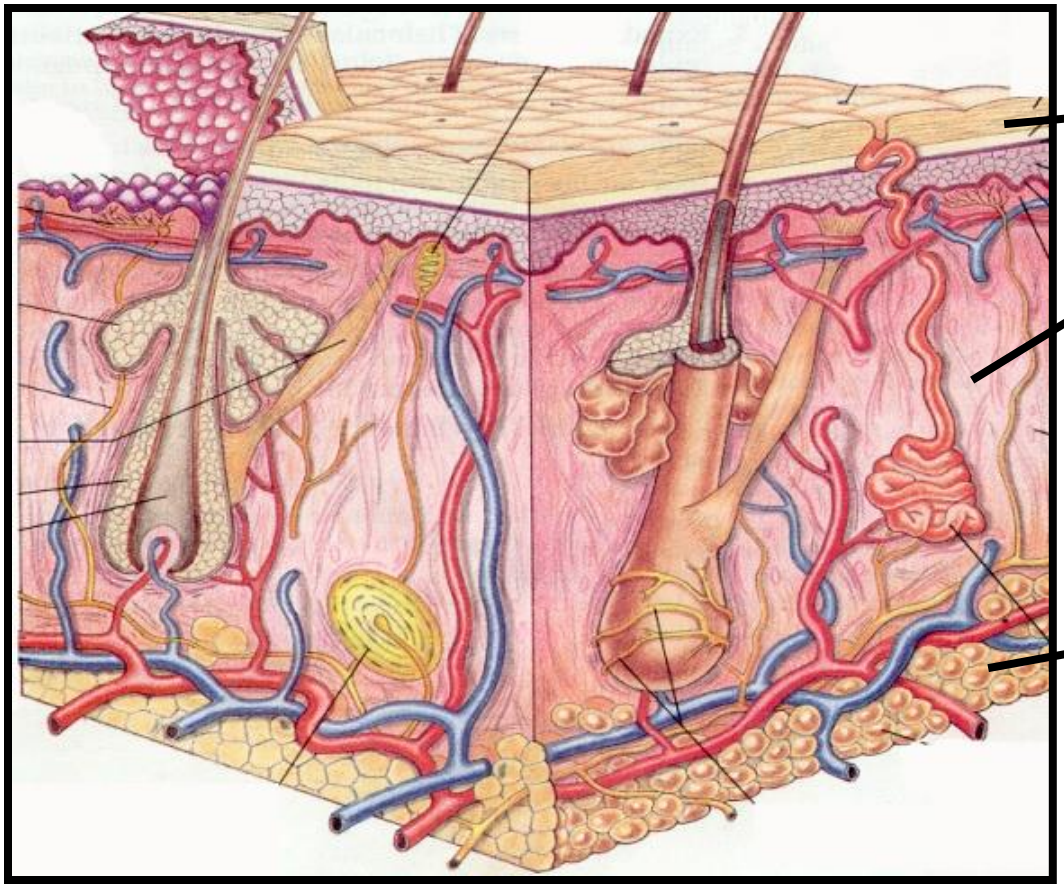
*Emergency medicine specialist*

*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



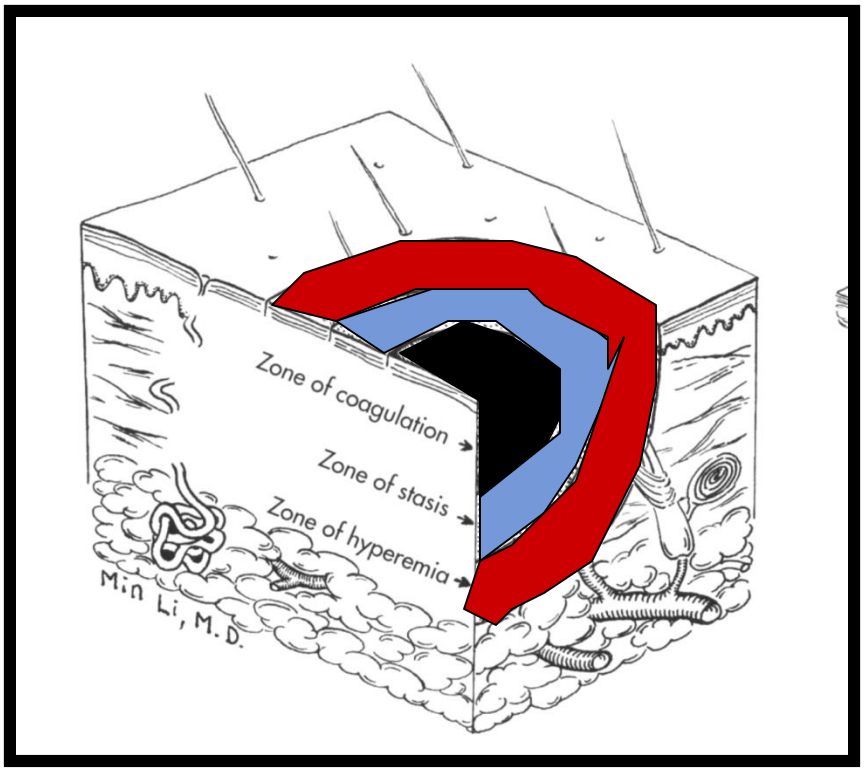
# Function of Normal Skin

- 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



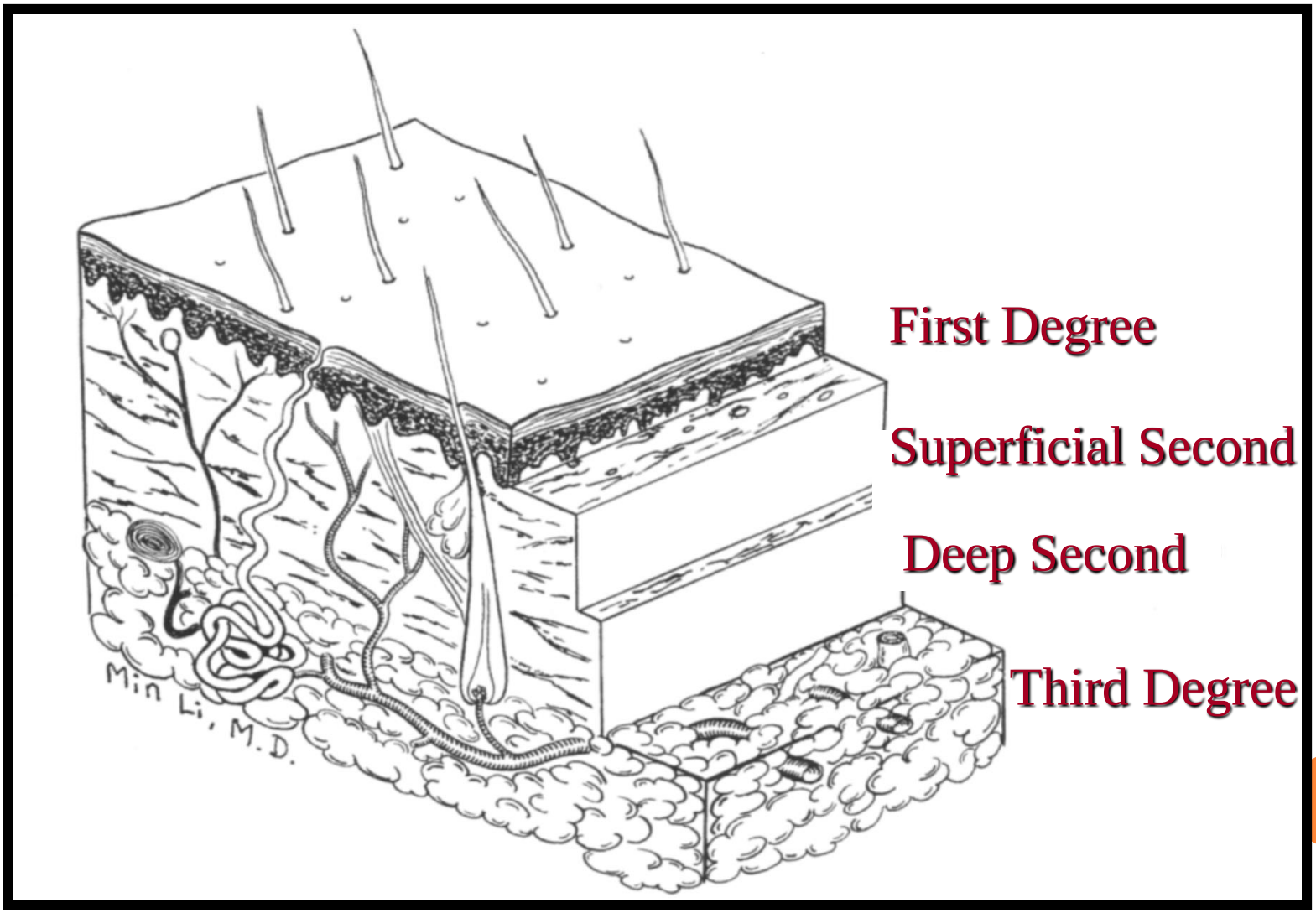

- Zone of Coagulation:
  - Irreversible damage
- Zone of Stasis:
  - Impairment of blood flow
  - Recovery variable
- Zone of Hyperemia:
  - Prominent vasodilation
  - Usually recovers

# 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

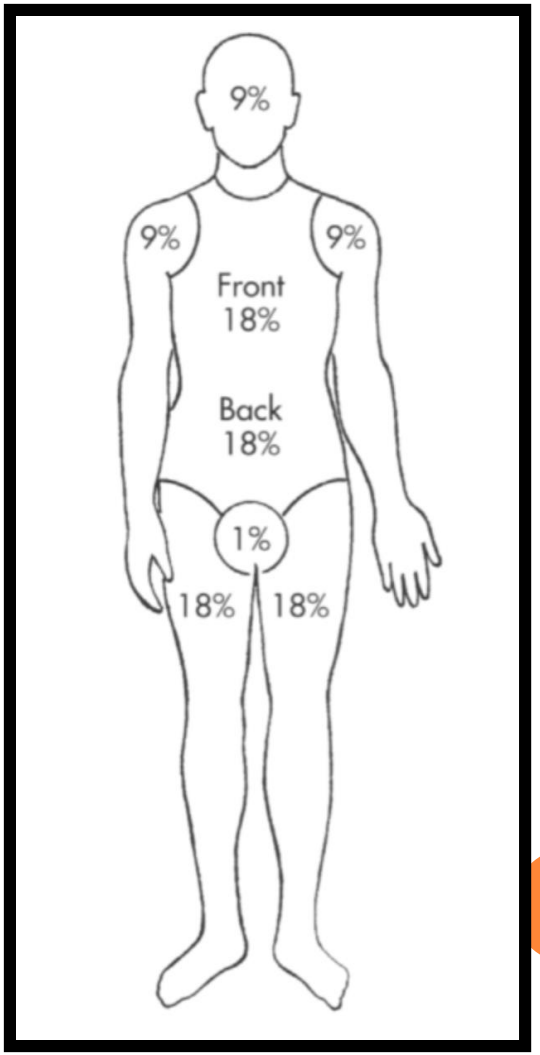
- **Second Degree**
  - Epidermis + part of dermis
    - Superficial
    - Deep
  - Blisters
  - Edematous and red
  - Very painful
  - Scaring variable

# Depth of a Burn

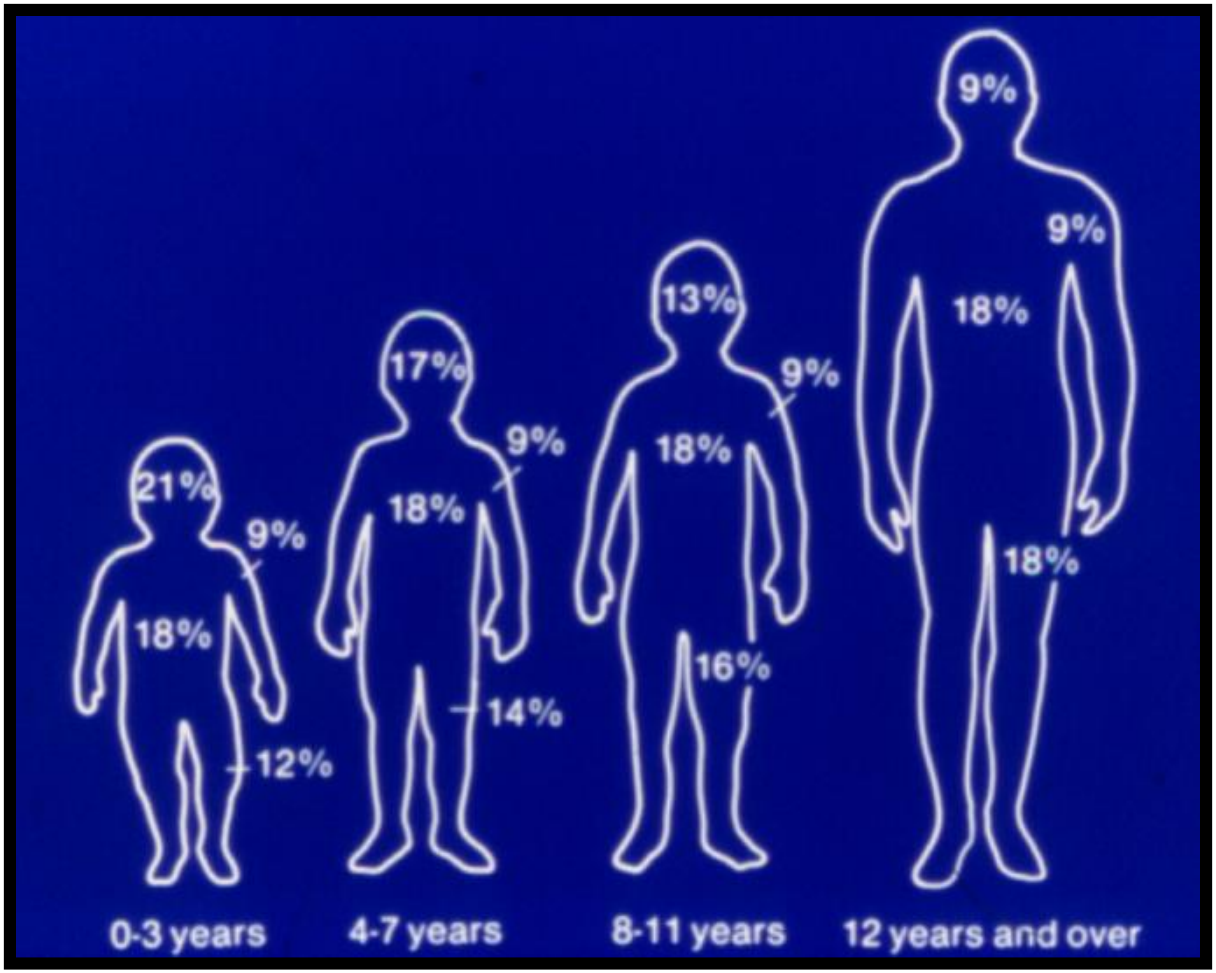
- **Third Degree**
  - Full thickness burn
  - Can involve underlying muscle, tendon, bone
  - Waxy white, leathery brown or charred black
  - Painless
  - Heals with scar

# 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 then 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** – **A**llergies
  - **M** –**M**edications
  - **P** – **P**ast medical history
  - **L** – **L**ast meal or drink
  - **E** – **E**vents 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

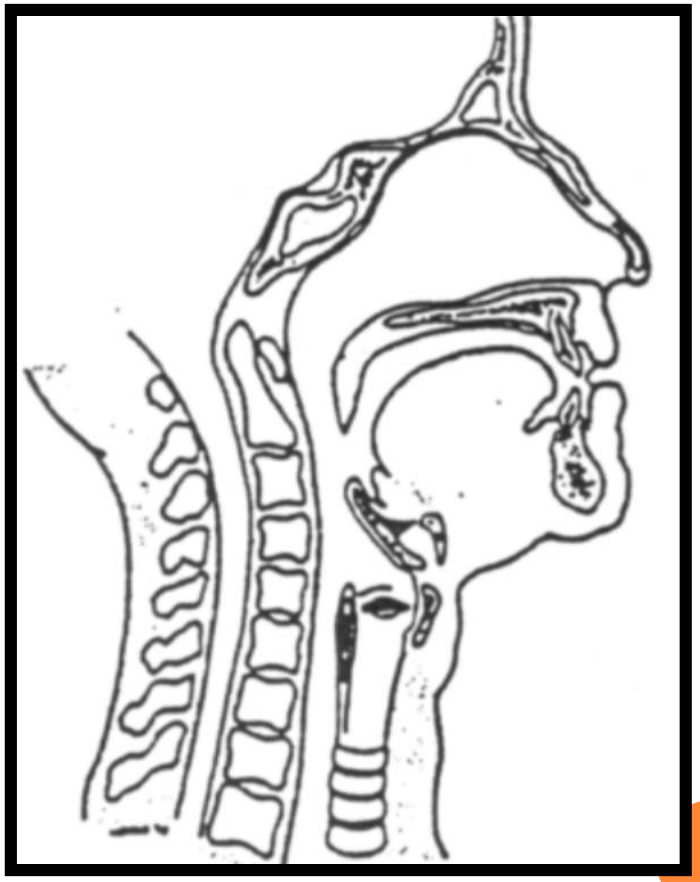
- Burned in closed space
- Facial or intra-oral burns
- Singed nasal hairs
- Soot in mouth, nostrils, larynx
- Hoarseness or stridor
- Respiratory distress
- Signs of hypoxemia

# 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

| Carboxyhemoglobin (%) | Signs/Symptoms |
|---|---|
| 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

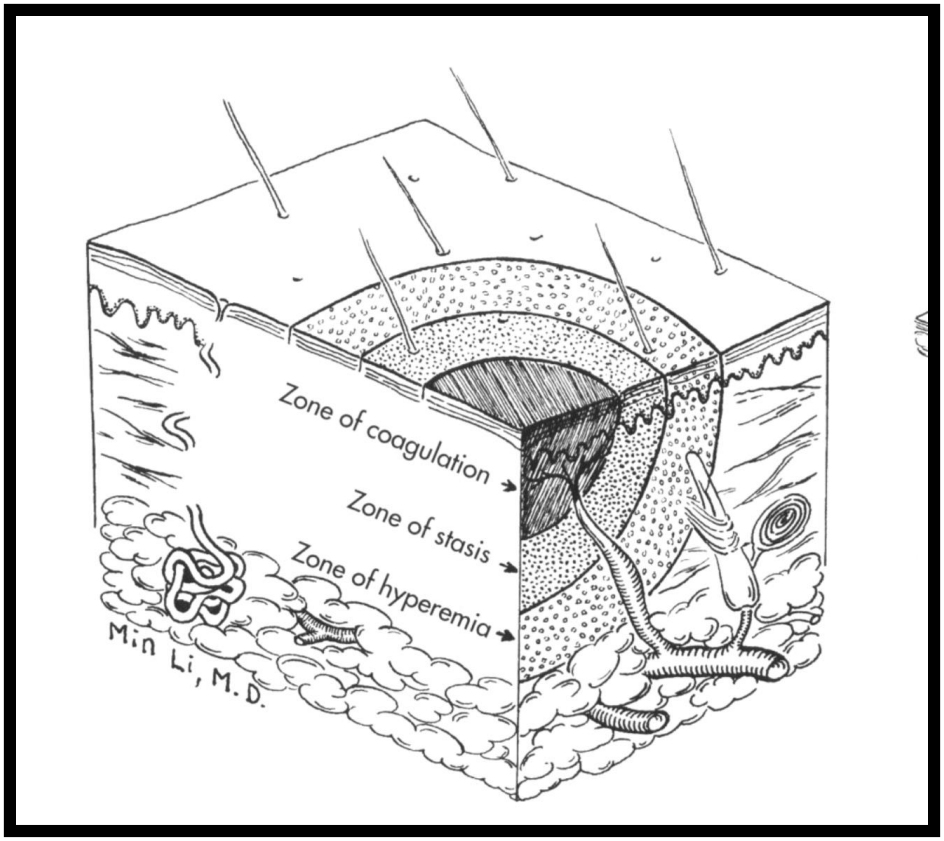
**Goal:**

- 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 ml RL x Kg body weight x % burn
  - Children: 3-4 ml RL x Kg body weight x % 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 ml of 5% albumin x Kg body weight x % 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 1/3 if u/o falls or exceeds limits by more than 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

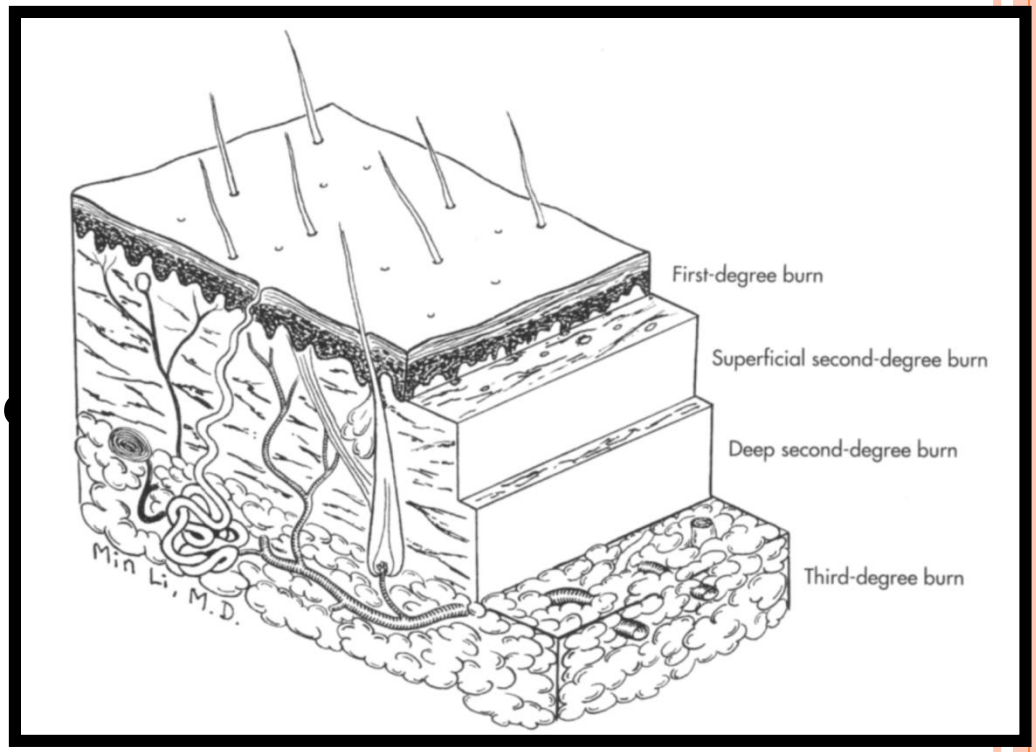
- CXR: daily for first 5-7 days
  - Normal study in first 24 hours does not r/o inhalation injury
- ECG:
  - All electrical injuries
  - Pre-existing cardiovascular disease

# 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 H20
- 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 arrythmia, 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
- Incuffed 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!


Emergency
Emergency Medicine and Trauma Care Research Center