

Taking the Heat out of Burn Care

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Objectives

- Provide practical strategies for identification, assessment, and triage of burn injuries.
- Discuss pathophysiology of burn injuries and how it relates to initial injury presentation and subsequent management.
- Define three major priorities of initial burn care in the rural environment.
- Introduce initial fluid resuscitation strategy that is easily applicable and provides cognitive offloading for the clinician and improved care for the patient,
- Discuss major burn injuries and define “burn shock.”
- Provide a framework for pain management in the burn patient.
- Provide a brief insight into the trajectory of burn care after arrival at the burn center.

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Introduction to Burns

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Burn Statistics (ABA data from 2018)

- Males account for 71% of burn injuries
- 17% of patients are under the age of 5 years
- 67% of cases had TBSA <10%
- 65% of burn injuries occur at home
- 96% survival rate

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ABA Burn Center Referral Criteria

1. Partial thickness burns greater than 10% total body surface area (TBSA)
2. Burns that involve the face, hands, feet, genitalia, perineum, or joints
3. Third-degree (full-thickness) burns in any age group
4. Electrical burns, including lightning injury
5. Chemical burns
6. Inhalation injury

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ABA Burn Center Referral Criteria (Cont)

7. Burn injury in patients with preexisting medical disorders that could complicate management, prolong recovery, or affect mortality.
8. Any patients with burns and concomitant trauma (such as fractures) in which the burn injury poses the greatest risk of morbidity or mortality.
9. Burned children in hospitals without qualified personnel or equipment for the care of children.
10. Burn injury in patients who will require special social, emotional or rehabilitative intervention.

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Burn Centers in Minnesota

Hennepin Healthcare, Minneapolis



Regions Hospital, St. Paul



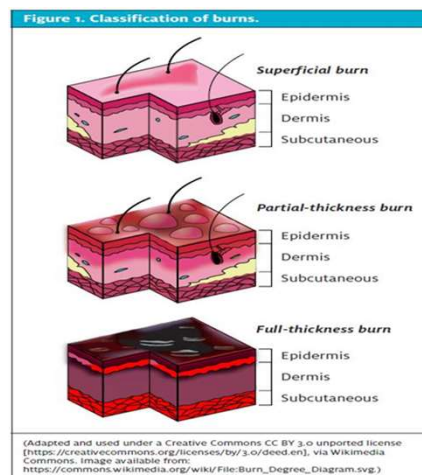
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ID and Classification of Thermal Burn Injuries

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Burn Depth & Classification

- Classified by thickness
- Dependent on 4 factors:
 - Temperature
 - Duration
 - Skin Thickness
 - Circulation
- Early classification is difficult



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Superficial-1st Degree

- Limited to epidermis
 - Redness
 - Hypersensitive/Pain
 - **No Skin Sloughing**
- Heals in a few days
 - No scars
- **Not Counted in TBSA**



<https://dermindy.com/why-does-my-skin-peel-when-i-get-a-sunburn/>

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Partial Thickness-2nd Degree

- Epidermis into the Dermis
 - Red & Blistered
 - Wet/weepy
 - **Edema**
- 2-3 weeks to heal
 - May scar
 - May require grafting
- **Can convert to deep burn**



<https://www.jems.com/patient-care/basics-burn-management/>

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Full Thickness-3rd Degree

- “Destruction” of Epidermis & Dermis
- White and/or charred
- “Leathery”
- Usually requires grafting



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Conversion



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4th Degree

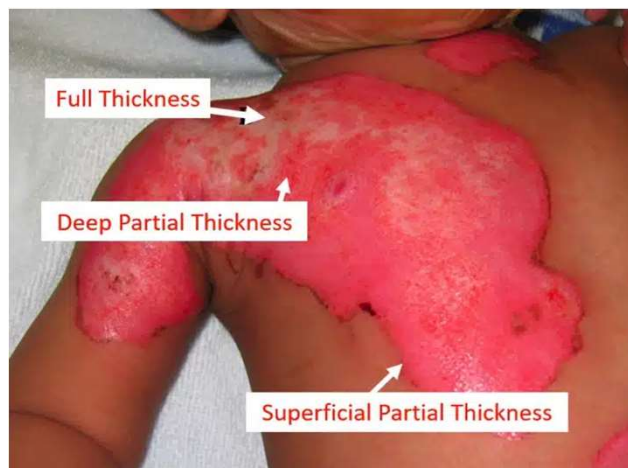
- Subdermal fat layer
- Eschar
- Coagulated blood vessels



<https://burncenters.com/burns/burn-services/thermal-burns/>

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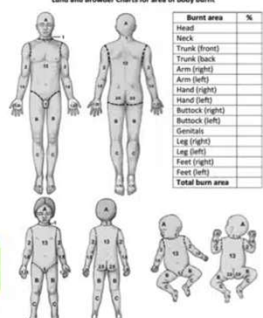
Dynamic Injuries



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Calculating TBSA

Lund & Browder Chart



Highest accuracy & inter-rater reliability





Rule of Palms

Use PATIENT'S hand & ENTIRE palmar surface

Good for TBSA < 15%


Burnt area		%
Head		
Neck		
Trunk (front)		
Trunk (back)		
Arm (right)		
Arm (left)		
Hand (right)		
Hand (left)		
Buttock (right)		
Buttock (left)		
Genitals		
Leg (right)		
Leg (left)		
Foot (right)		
Foot (left)		
Total burn area		

Age (years)	Under 1	2-4	5-9	10-14	15	Adult
A — % of head	9%	8%	6%	5%	4%	3%
B — % of one thigh	2%	3%	4%	4%	4%	4%
C — % of one leg	2%	2%	2%	3%	3%	3%

Pediatric		Adult	
			
1%	0.5%	0.8%	0.5%
Entire Palmar Surface	Palm Only	Entire Palmar Surface	Palm Only

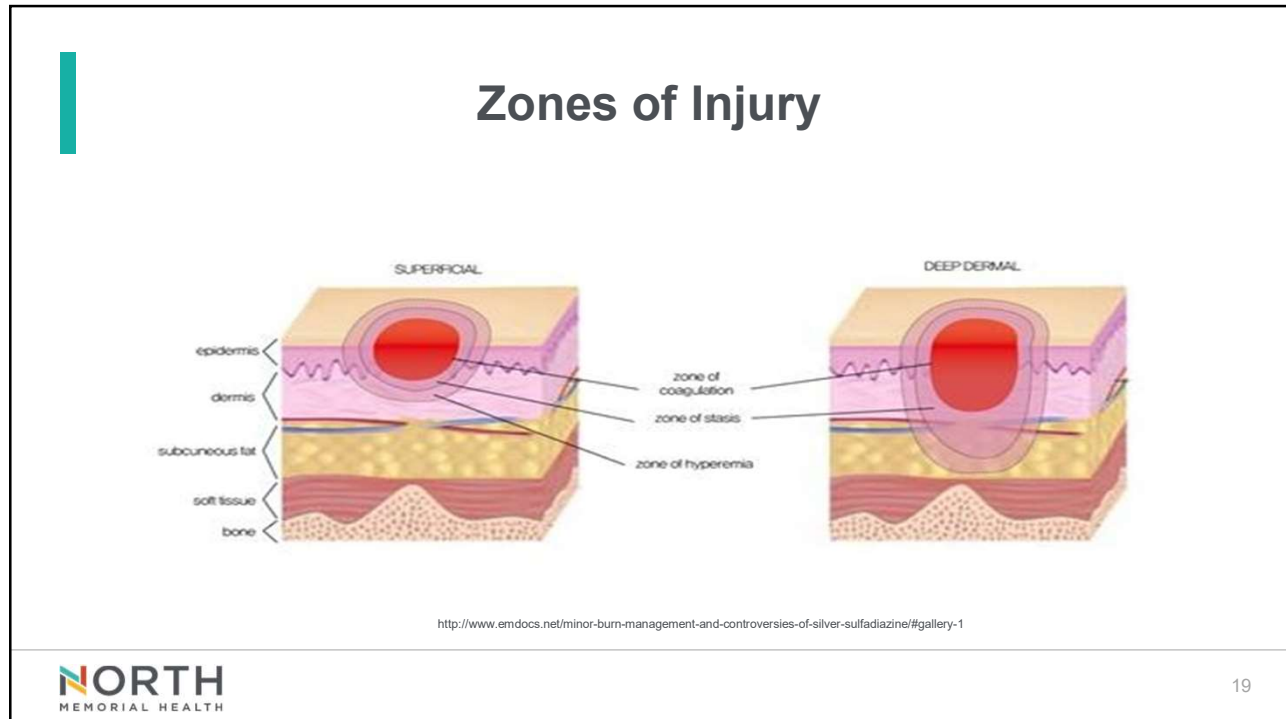
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Pathophysiology of Burns

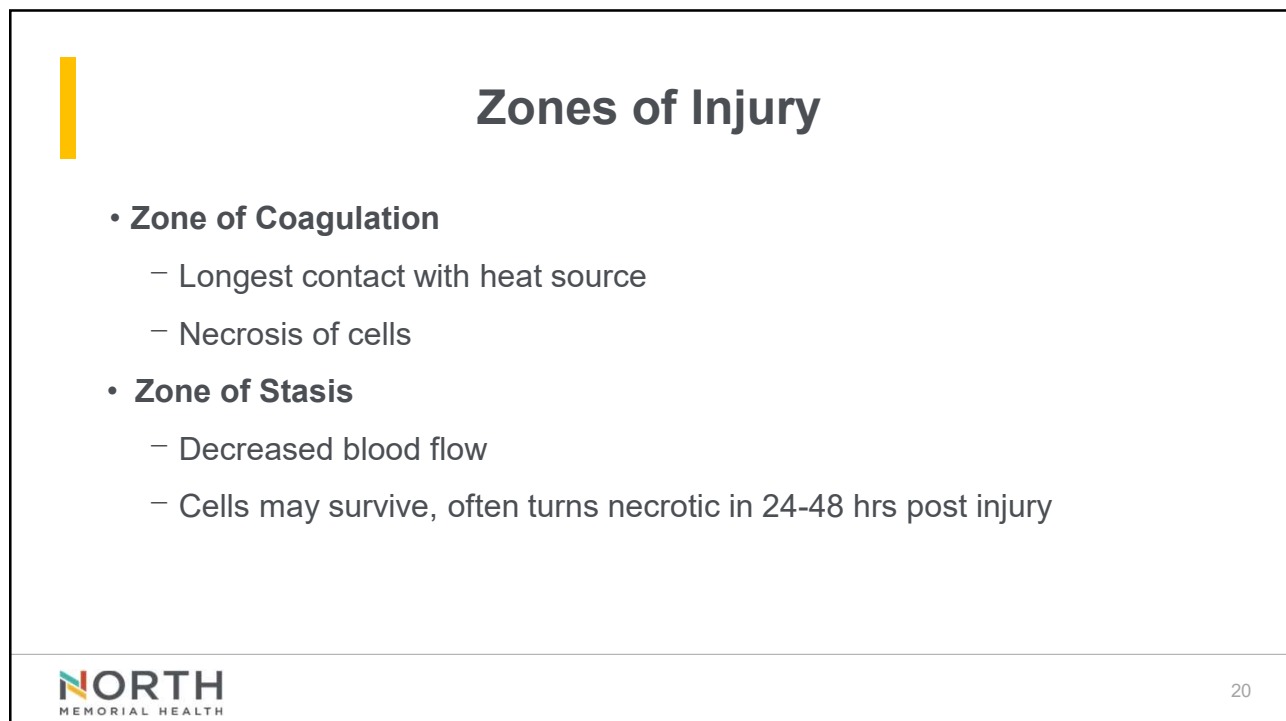


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Zones Of Injury

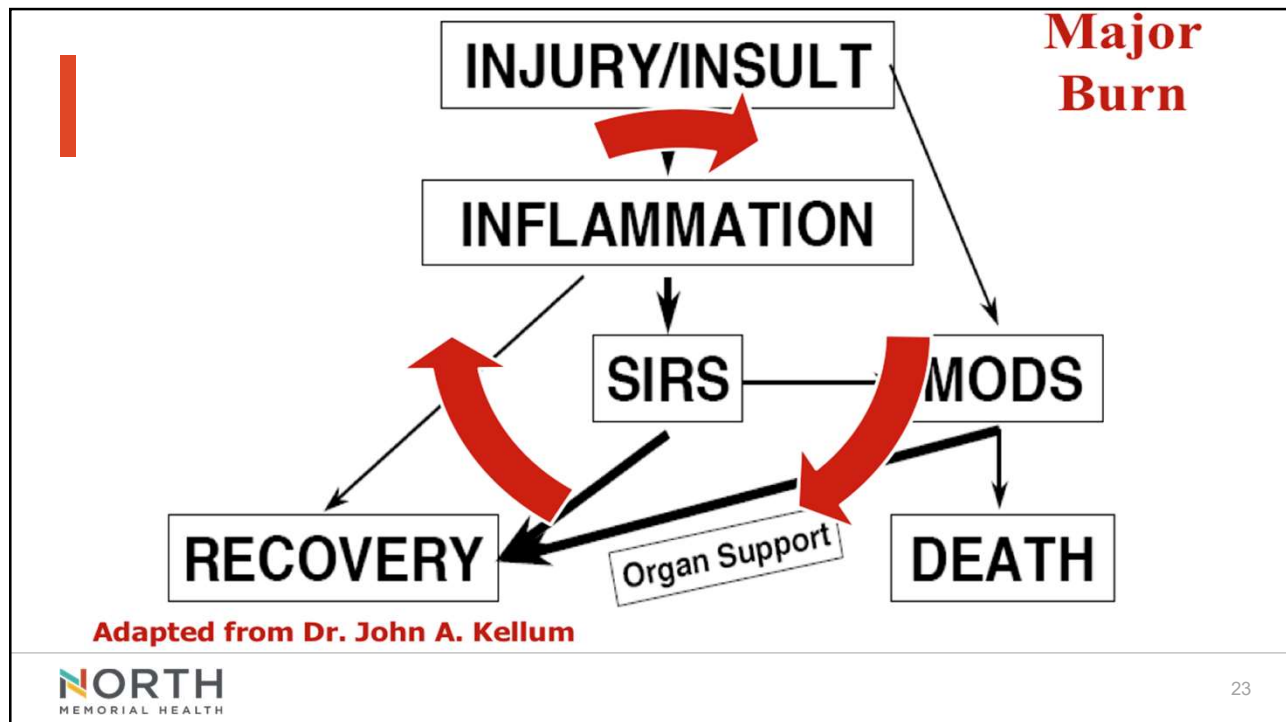
- **Zone of Hyperemia**
 - Less severe injury
 - Recovers in 7-10 days
- **Improper fluid management & wound care extends Necrotic Zone**

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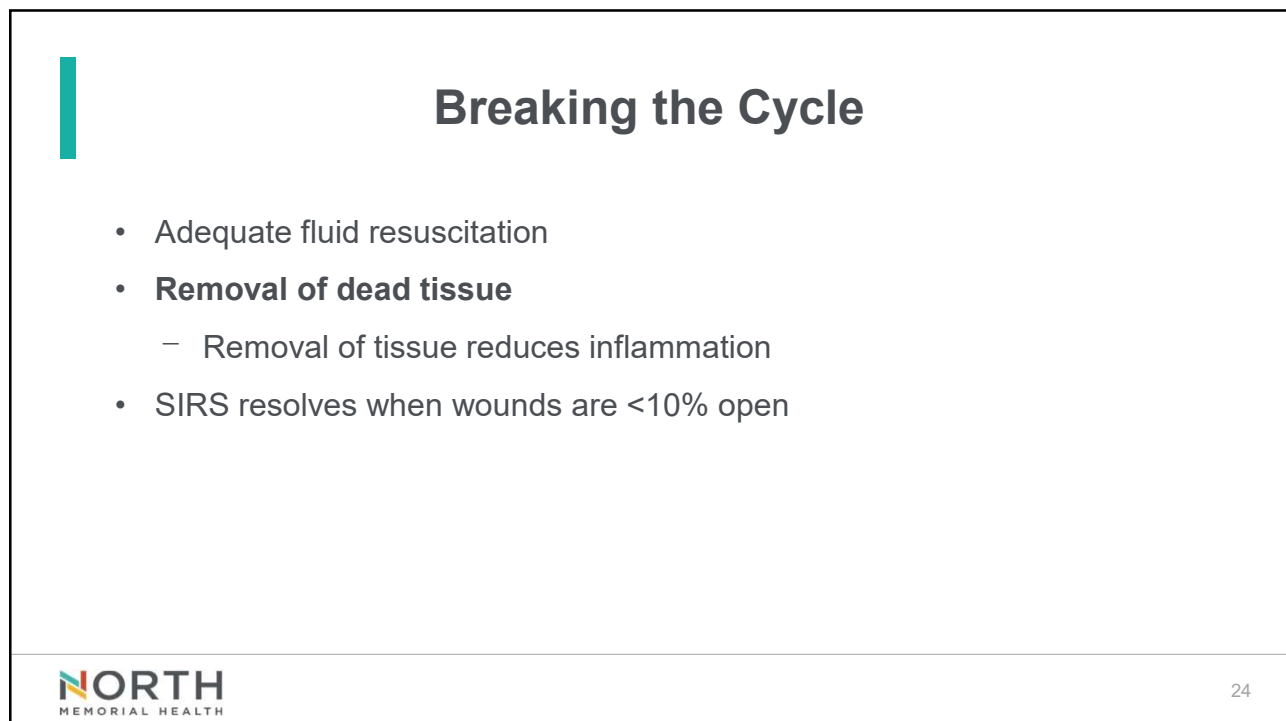
Leaky Vessels

- Burn injury leads to severe local inflammation (SIRS)
 - Inflammation causes capillary leakage (both burned & non-burned tissue)
 - Leakage includes electrolytes and proteins
- Edema accumulates in non-burned tissues
 - Fluid loss leads to hypovolemia and shock
 - Edema causes decreased blood flow

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Getting Off on the Right Foot

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Initial Priorities

- Complete primary assessment:
 - Airway
 - Breathing
 - Circulation
 - Disability
 - Exposure/Environmental Controls
- Comprehensive secondary assessment & history is key
- **Trauma & Toxidromes kill before burns**

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Environmental Controls

- **High Risk of Hypothermia**
 - **Contributes to acidosis and coagulopathy**
 - **Vasoconstriction worsens burns**
 - **Increases cardiac irritability**
 - **Pediatric patients highly susceptible**
- Stop the burning process
- Trauma Naked
 - Rings, watches, contacts need to be removed due to edema risk

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Environmental Controls

- Warm environment, should be uncomfortably warm for staff
- Remove cold/wet clothing
- Dry dressings on burns
- Change sheets as needed
- Warm IV fluids
- Apply blankets/bear hugger

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Dressings

- Adaptic
- Kerlix/dry gauze
- Stockinet (fishnet dressings)
- Mepilex
- Chux
- Bacitracin Topical
 - **Oral/IV antibiotics GENERALLY not indicated**

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Fluid Therapy



- Big or small burn?
- Big or small human?
- >20% TBSA = Burn ICU

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Fluid Resuscitation

- <5 years old: 125 mL per hour
- 6-13 years old: 250 mL per hour
- 14 years and older: 500 mL per hour
- Extreme injury: 750 mL per hour

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Fluid Resuscitation

- General output rules:
 - 0.5 mL-1.0 mL/kg/hr for pediatrics
 - 0.5 mL/kg/hr/ for adults or 30-50 mL/hr
 - Increase fluids by 10% if not meeting goal
- Adjust after TBSA calculation
 - 3 mL/kg/%TBSA for adults and kids
 - 4 mL/kg/%TBSA for electrical/rhabdo burns
- Lactated Ringers if available
- **Bolus for initial hypotension only**

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Best Friend



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Runaway Resuscitation

- Ideal fluid replacement is 2-4cc/kg/TBSA%
- >6 cc/kg/TBSA%=Positive Predictor of ACS
 - >250 mL/kg
- 45% TBSA + abdominal compartment syndrome=100% mortality

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Pro Tip: Vascular Access

- Can go through burned tissue
 - Tricky to secure
 - Ultrasound is your friend
 - Use all extremities
- IO access acceptable
- Big burns eventually require central & arterial access

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Medication Therapy

- Pain & Anxiety
- Use multiple modalities for various needs
- Often require higher doses



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Sick Burns

Burn Shock & Inhalation Injuries

NORTH
MEMORIAL HEALTH

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Red Flags

- Concurrent Trauma
- Inhalation injuries
- Electrical injuries
- Dehydration
- Delayed care
- Substance abuse
- Chemical burns
- Comorbidities



NORTH
MEMORIAL HEALTH

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Burn Shock

- SIRS response, capillary leak, & fluid shift (**Slow progression**)
 - Sustained hypovolemia
 - Distributive + Cardiogenic Shock states
- Baseline tachycardia (110-120 bpm)
- Relatively normotensive
- Urine is your friend:
 - 0.5 ml/kg/hr-1 ml/kg/hr (age & injury dependent)
- Mitigate with proper fluid resuscitation

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Are you Beating Burn Shock?

- HR should be “normalish”
 - How is the patient’s pain controlled?
- Adequate urine output
 - 0.5 mL-1.0 mL/kg/hr for pediatrics
 - 0.5 mL/kg/hr/ for adults or 30-50 mL/hr
- Mean arterial pressure >60

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Altered Mental Status or Sustained Hypotension?

- Toxicology
 - Cyanide Poisoning
 - AMS + Soot in mouth->60% chance of cyanide poisoning
 - AMS + Unexplained hypotension->80% of cyanide poisoning



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Altered Mental Status & Hypotension

- Carbon Monoxide
 - 200x > affinity for Hgb than O₂
 - Apply high flow O₂
 - Consider transfer to HCMC for burn + hyperbarics
- Several chemical culprits



Courtesy of Hennepin Healthcare

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One More Source of Hypotension to Worry About

Trauma

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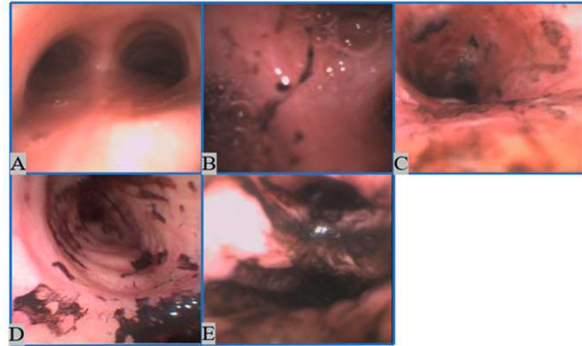
Inhalation Burns

- 10-20% of burn injuries
- Mortality increase
- $\frac{1}{3}$ of burn patients needlessly intubated in ED
- Singed nose hairs & facial burns are unreliable indicators

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Indications for Intubation

- Respiratory distress
- Hoarseness/stridor
- Blistering of oral cavity/oropharynx
- Deep facial/neck burns
- Provider discretion



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Inhalation Burn Management

- Protective vent settings
- Toileting
- Inhaled agents
 - Bronchodilators
 - Heparin
 - Acetylcysteine

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Inhalation Burn Management

- Advanced ICU therapies:
 - Percussive ventilation
 - Bronchoscopy
 - ECMO



Courtesy of UC Health

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Compartment Syndrome



- <https://itfl.com/roman-breastplate/>

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Compartment Syndrome

- >30 mmHG compartment pressure
 - Have high index of suspicion in circumferential burns
- Restricts breathing
 - High vent pressures
- Restricts blood flow:
 - Pale/dusky/cool extremities
 - “Tight feeling” skin
- Escharotomy and/or fasciotomy for relief

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Specialized Burn Injuries

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Electrical Injuries

- Highly complex injuries
- Deceptive
- Maintain high urine output
 - 4 mL/kg/TBSA%
 - 50-100 mL/hour UO adults
 - 1 cc/kg/hr UO pediatrics
 - Red urine is bad omen
- Cardiac monitoring
- Compartment syndrome risk
- Beware of trauma



Courtesy of the Archives of Plastic Surgery

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Chemical Burns

- **Safety is key, DECON!**
- Brush off powders
- Decon with copious H₂O
- Don't try to "neutralize"
- pH strips
- Rapid consults
 - Burn Center
 - Poison Control



WESTERN OPHTHALMIC HOSPITAL / SCIENCE PHOTO LIBRARY

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Extra Nasty Chemicals

- **Anhydrous Ammonia**
 - Activated by moisture
 - Wide variety of effects
 - Decon and copious H₂O flush
- **Cement Burns**
 - Forms strong base pH>12 w/H₂O
 - 6-12 hour evolution
 - 3rd degree burns w/eschar

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Extra Nasty Chemicals

- **Hydrofluoric Acid**
 - Fluoride binds free Ca
 - Cardiac failure & tissue necrosis
 - Topical & IV Calcium
 - Rapid transfer to burn center
- **Petroleum/Hydrocarbons**
 - Localized deep burns (initially look benign)
 - Systemic toxicity/MODS

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Extra Nasty Chemicals

- **Phenol Burns**
 - Acid
 - Common in disinfectants
 - Tissue necrosis/deep burns
- **Illicit Drug Manufacturing**
 - Patient may not be forthcoming
 - Hard to ID chemical compounds
 - Patient may be using product as well

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Cold Injuries (Thermal)



courtesy of orthobullets.com

- Crystallizing process
- Weeks to determine extent of injury
- Rewarm with water immersion
 - 15-30 minutes
- Pain administration
 - Ibuprofen

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Cold Injuries

- Blisters can be left in place
- Splint, pad, elevate
- Transfer to burn
 - Thrombolytics
 - Delay amputation
- Factoid: Classified by depth

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Inside the Unit

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Resuscitation Bay



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Tub Room



Courtesy of CHI Health

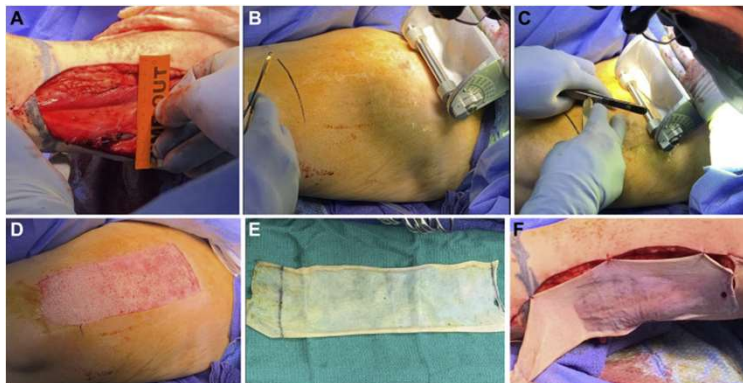
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ICU Care



Courtesy of US Army Institute of Surgical Research

Skin Grafting



Rehab



courtesy of SUNY Medical Center

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Summary

- Burns are complex injuries that involve all body systems
- Identification of large critical burns is key
- Initial management of large burns can cause upward or downward clinical trajectory
 - Keep Warm
 - Control Pain
 - Fluid Resuscitation
 - Airway Management

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Summary

- Aggressive care prevents decompensation
- There are several types of burn injuries with nuanced management
 - Consult early!
 - Rapid transfer to specialized care (if possible)
- Burn care is a team sport

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Questions?



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