Burn Injuries

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Disclosures

I do not have any relevant financial relationship(s) with any commercial interest that pertains to the content of this presentation.

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Objectives

- Epidemiology
- Depths of Burns
- Inhalational injury and airway management
- Basics of resuscitation
- Classes of burns
- Cases review

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Burn Epidemiology

- 2011-2015: About 486,000 burn injuries in US
- 2010: Burn related injuries
  - $1.5 Billion health care related costs
  - $5 Billions associated with lost work
- 25% of burn injuries in patients under 15 years of age
  - Younger children-usually scald burn
  - Older children-usually flame burns
- 128 burn centers in the U.S.
  - Responsible for 60% acute burn admission. Each center averaged 200 admission a year
  - Other 3500 acute care hospitals averaged 3 burns a year
- 180,000 burn deaths annually worldwide most in middle to low income nations

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Burn Epidemiology

- For admission to burn centers (2005-2015)
- **Survival Rate: 96.8%**

Gender: 68% Male, 32% Female
Ethnicity: 59% Caucasian, 20% African-American, 14% Hispanic, 7% Other
Admission Cause: 43% Fire/Flame, 34% Scald, 9% Contact, 4% Electrical, 3% Chemical, 7% Other
Place of Occurrence: 73% Home, 8% Occupational, 5% Street/Highway, 5% Recreational/Sport, 9% Other

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What is a Burn Injury?

- Tissue injury caused by fire, heat, radiation, electricity, or a caustic chemical agent. Burns are classified according to the degree of tissue damage.

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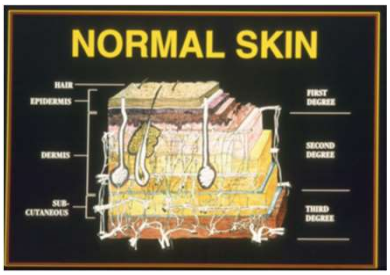

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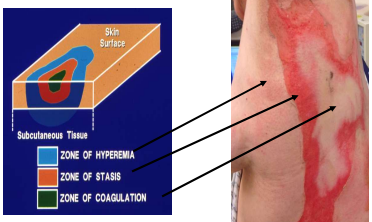
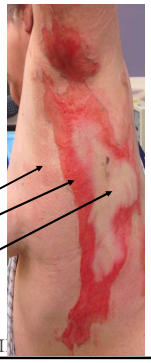
Zones of Injury





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Burn Depth

- Superficial or 1st degree burn
- Partial Thickness or 2nd degree burn
- Full thickness or 3rd degree burn

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Fourth degree burns

- Penetrates underlying
  - Fat
  - Muscle
  - Bone
- Often requires extensive soft tissue coverage
- May need amputation

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Total Body Surface Area (TBSA) Producing Expected 50% Mortality

Age	1953 (%TBSA)	1993 (%TBSA)	2006 (%TBSA)
0-14	49	98	99
15-44	46	72	88
45-65	27	51	75
65	10	25	33

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Advances in Burn Care

- Reduction in morbidity and mortality due to
  - Advances in fluid resuscitation and critical care
    - Updated guideline advocates for less fluid
  - Early excision and grafting of burns
    - Reduce infectious complications
    - Decreases length of stay
    - Increase survival
  - Infection control
  - Recognition and treatment of inhalational injury
  - Nutritional support
  - Rehabilitation services

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Pathophysiology

Heat causes coagulation necrosis of skin and subcutaneous tissue
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Release of vasoactive peptides
↓
Altered capillary permeability
↓
Loss of fluid → **Severe hypovolaemia**
↓

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Decreased cardiac output → Decreased myocardial function
↓
Decreased renal blood flow → Oliguria (Renal failure)

Altered pulmonary resistance causing pulmonary edema
↓
Infection
↓
Systemic inflammatory response syndrome (SIRS)
↓
Multiorgan dysfunction syndrome (MODS).

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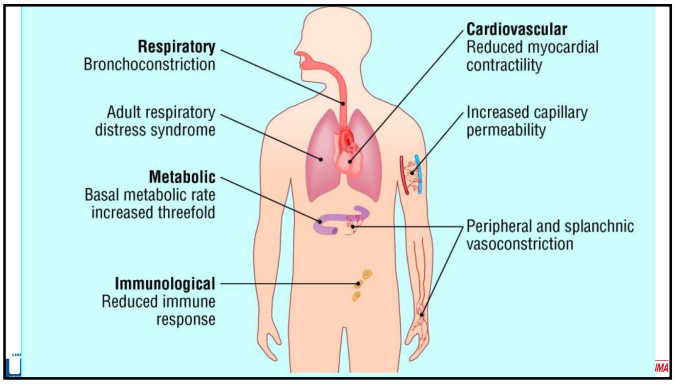

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Primary Survey

Airway with C-spine protection

Breathing and ventilation

Circulation, cardiac status

Disability, neurological deficit and gross deformity

Exposure, Examine, Environment

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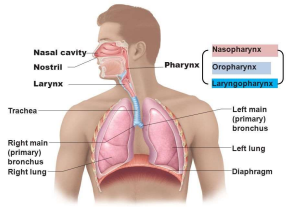
Airway Management

- Three types of inhalational injury
  - Injury from toxic gases
    - CO
    - Cyanide
  - Supraglottic injury
  - Subglottic injury



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Indications for early intubation

- Signs of airway obstruction
  - Hoarseness, stridor, dysphagia
- TBSA above 40%
- Extensive and deep facial burns
- Burns in the mouth
- Significant risk of edema
- Signs of respiratory compromise
  - Use of accessory muscles
  - Inability to clear secretions
  - Poor oxygenation
- Altered mental status
- Transfer of large burn without qualified personnel to intubate if needed

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Access and Initial Fluid Rates

- Patients with ≥20% TBSA burns should receive 2 large bore, peripheral venous catheters
- Ok to put peripheral IV through burnt skin
- Avoid burnt skin for central and arterial lines
- Burns with inhalation injury may require more fluids and starting resuscitation at a smaller tbsa burn
- Children require resuscitation at 15%
- Use LR because it most closely mimics intravascular fluids
- Pre-hospital (initial) fluid rates
  - ≤ 5 yrs. 125ml LR/hour
  - 6-13 yrs. 250ml LR/hour
  - ≥ 14 yrs. 500ml LR/hour

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Resuscitation

- Effect proportional to body surface injury
- Fluid loss – slow and progressive
- Adequate resuscitation:
  - restores cardiac output and tissue blood flow
  - prevents organ failure
- Proper fluid management is critical to survival
- Fluid Replacement – sustained overtime, avoid boluses
- Goals of resuscitation:
  - Maintains tissue perfusion and organ function
  - Avoids complications of too little or too much fluid therapy

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Importance of proper resuscitation

Overresusitation

- Excessive resuscitation more common than insufficient fluids
- Exaggerates edema formation in all body compartments
- Leads to morbidity of extremity and abdominal compartment syndromes
- May contribute to lung, cerebral edema

Underresuscitation

- Shock and acute kidney injury due to hypovolemia
- Multiple organ dysfunction syndrome
- Delay in resuscitation increases capillary leak and higher fluid requirement
- Prompt initiation of fluid resuscitation is critical

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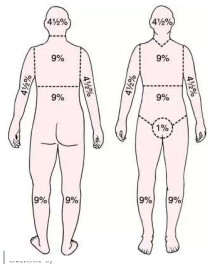
Secondary Survey

- Accurate history and complete head to toe exam
- Obtain accurate weight
- Determine tbsa of burn
- Determine adjusted fluid rates
- Rate based on 2nd and 3rd degree burns
- PALM OF PATIENT'S HAND IS ONE PERCENT



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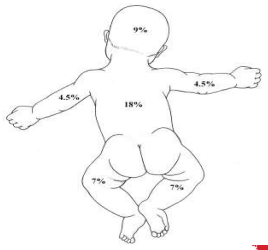
Rule of Nines

Infants



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Adjusted Fluid Rates

Category	Age and weight	Adjusted fluid rate
Flame or scald	Adults and older children (≥14 years old)	2 ml LR x kg x % TBSA
	Children (<14 years old)	3 ml LR x kg x % TBSA
	Infants and young children (≤30kg)	3 ml LR x kg x % TBSA Plus D5LR at maintenance rate
Electrical injury	All ages	4 ml LR x kg x % TBSA

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- Traditional formula calls for:
  - Infusion of ½ estimated volume over first 8 hours
  - Infusion of remainder over the next 16 hours
- But: hourly titration is more important than 8 vs. 16 hours concept
- Careful hourly titration of fluid rate based on patient's urinary output and physiologic response is CRITICAL

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45 y.o. (90kg) male with 25% TBSA burn

Prehospital, pre-TBSA estimate (LR): 500 ml/hour
Resuscitation (LR):
2ml x 90kg x 25% TBSA = 4500cc
½ in the 1st 8 hours = 2250ml
Adjusted fluid rate 2250/8 = 281 ml/hour

Category	Age and weight	Adjusted fluid rate
Flame or scald	Adults and older children (≥14 years old)	2 ml LR x kg x % TBSA
	Children (<14 years old)	3 ml LR x kg x % TBSA
	Infants and young children (≤30kg)	3 ml LR x kg x % TBSA Plus D5LR at maintenance rate
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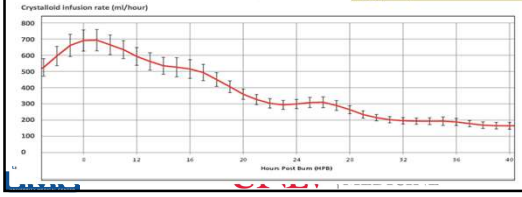

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Hourly urine output goals

Adults and older children (>30kg)
0.5 ml / kg / hour (30-50 ml / hour)

Smaller children (up to 30kg) and all electrical injuries
1 ml / kg / hour

Indwelling bladder catheter
Incrementally increase or decrease

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Thermal Injuries

- Occurs when the body absorbs more heat than it's capacity to dissipate it
- Typical causes: flame, hot liquids, hot objects, explosions, and exposure to the sun
- Most commonly occurring burn injuries

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Chemical Injuries

- Occur from exposure to hazardous agents in liquid, powder and aerosolized forms
- Three major categories of chemicals:
  - Alkalis: household cleaners and wet cement
  - Acids: bathroom and drain cleaners and pool chemicals
  - Organic Compounds: disinfectants and gasoline
- REMOVE CLOTHES!!!
- IRRIGATE, IRRIGATE, IRRIGATE!!!!!

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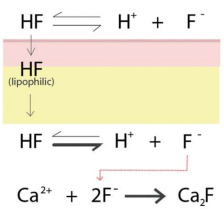
Hydrofluoric acid burns

- IRRIGATE, IRRIGATE, IRRIGATE
- TOPICAL CALCIUM
- INFILTRATE BURN WITH CALCIUM
- INTRAARTERIAL CALCIUM
- FREQUENT CHEMISTRY CHECKS



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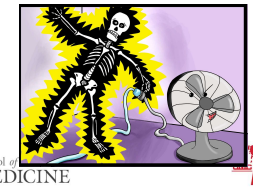
Electrical Injuries

- Occur when the body becomes part of an electrical circuit
- Extent of injury is determined by strength of current and length of exposure
- Over 1000 Volts-high voltage
- Most common causes are work related injuries and damaged electrical cords in the home
- Risk of arrhythmias, compartment syndrome, neuropathy, anxiety, **cataracts**
- Cutaneous burn may underestimate extent of involvement
- Parkland resuscitation for large burns



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Radiation Injuries

- Usually localized and indicative of high radiation doses
- Most common cause is medical treatment for cancer

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ABA Referral Criteria

- Size of burns
  - 10% TBSA partial thickness burn
  - Any 3rd degree burn
- Injury mechanisms that warrant specialized care
  - Electrical
  - Chemical
  - Inhalation

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ABA Referral Criteria

- Special locations involving functional and cosmetic components
  - Hands and feet
  - Face
  - Perineum/genitalia
  - Across major joints

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ABA Referral Criteria

- Special Considerations
  - Pre-existing medical problems
  - Burn with concomitant trauma
  - Burned children in hospitals not equipped for children
  - Patients who require special social, emotional or rehabilitation interventions

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In Conclusion

- Providing excellent burn care requires a comprehensive approach
- Appropriate resuscitation is essential in providing optimal care
- Over and under resuscitation carries significant morbidity
- Critical to keep patient warm and dry in the early stages of care
- Once adequately resuscitated, then start early excision with coverage

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Case Study # 1

- 50 y/o male arrives to ED via EMS after the stove exploded while he was "making THC with butane out of weed"
- Alert O x 3, c/o pain chest, abd., rt hand/arm, lt hand/arm and mouth
- Burn are noted on bilateral UE & LE, chest and abd. With singed facial hair
- TREATMENT PRIORITIES

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Case #1 Treatment

- Primary Assessment
- Fluids
- Secondary Assessment
- Transfer?

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Case Study # 2

- 52 y/o male walks into your ED with c/o burns from his Halloween costume catching on fire
- C/o pain no SOB
- Burns noted to bilateral thighs and buttocks, and scrotum
- TREATMENT PRIORITIES

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Case #2 Treatment

- Primary Assessment
- Fluids
- Secondary Assessment
- Transfer?

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Case #3

- 73 yo F, hx of COPD, tripped and fell on sidewalk during 105F weather while looking for her cat
- Landed on buttocks wearing shorts
- Unable to get up due to weakness
- Neighbor saw her about two hours later and helped her up
- Presented to hospital seven days later

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Case #3 Treatment

- Primary Assessment
- Fluids
- Secondary Assessment
- Transfer?

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Burn Information Line
1-855-Bad Burn

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Questions

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Burn Information Line
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Silvadene (Silver Sulfadiazene)

- topical antimicrobial therapy
- sulfadiazine antibiotic: binds to enzyme dihydropteroate synthase (DHPS)-essential for folate production
- silver: binds to DNA of organism
- effective against enterics, C. Albicans, S. aureus
- contraindicated with sulfa allergy
- Side effect: leukopenia
- Maximal WBC depression in 2 to 4 days
- Rebound shortly thereafter

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Sulfamylon (Mafenide Acetate)

- topical antimicrobial therapy
- carbonic anhydrase inhibitor
- NOT contraindicated with sulfa allergy
- deep penetration: can cause pain
- broad range including Pseudomonas and Clostridium
- side effect: metabolic acidosis

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Bacitracin

- Antimicrobial
- narrow spectrum
- targets gram positives
- used for 2nd degree
- Side effect: hypersensitivity reaction

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Additional therapies

- Gentamicin
  - Aminoglycoside
  - can be effective against pseudomonas
- Acticoat
  - silver impregnated dressing
  - bactericidal against VRE, MRSA, Pseudomonas, Candida
  - Can remain for several days

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6 y.o. (23kg) child with 20% TBSA burn

Prehospital, pre-TBSA estimate (LR): 250 ml/hour

Resuscitation (LR):

3ml x 23kg x 20% TBSA = 1380cc

½ in the 1st 8 hours = 690ml

Adjusted fluid rate 690/8 = 86 ml/hour

Maintenance (D_5LR):

Category	Age and weight	Adjusted fluid rate
Flame or scald	Adults and older children (≥14 years old)	2 ml LR x kg x % TBSA
	Children (<14 years old)	3 ml LR x kg x % TBSA
	Infants and young children (≤30kg)	3 ml LR x kg x % TBSA Plus D5LR at maintenance rate
Electrical injury	All ages	4 ml LR x kg x % TBSA

40ml for 1st 10 kg (4 ml/hr for each kg up to 10 kg)

20ml for next 10kg (2 ml/hr for each kg from 11-20 kg)

3ml for 3kg → Maintenance rate = 63ml/hour (1 ml/hr for each kg >20)

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Hourly urine output goals

Adults and older children (>30kg)
0.5 ml / kg / hour (30-50 ml / hour)

Smaller children (up to 30kg) and all electrical injuries
1 ml / kg / hour

Indwelling bladder catheter
Incrementally increase or decrease

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Outpatient care

- For burns that don't need immediate hospital to hospital transfer but still needs care in burn clinic
- Encourage unroofing of blisters above 2 cm
  - Allows better characterization of burn
  - Reduces risk of infection
  - Allows better ROM over joints
  - Allows better penetration of topical therapy
- Send out with topical antimicrobial therapy such as Silvadene
- **NO role of prophylactic ORAL antibiotics**

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