Burn Shock and Resuscitation

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Objectives

- Understand the different type of burn depth
- Calculate the TBSA
- Understand the Parkland formula and when to implement it
- Understand Burn Pathophysiology
- Understand the consequence of over- and under-resuscitation.
- Understand causes for increased fluid needs.

Key Highlights in Burn Shock and Resuscitation

- 1830s—Duputryen and O’ Shaugnessy recognize that burn injury is very similar to cholera---leading to large volumes of fluid loss that “result in dehydration, electrolyte abnormalities and acidosis and that treatment depends on IV repletion of salt and water.”

Key Highlights in Burn Resuscitation

- 1921- Rialto Theater fire:
- Fire broke out backstage killing 8 and injuring 80
- Dr. Underhill-Fluid blisters were studied and found to be consistent with plasma fluid- therefore concluded burn shock was the result of fluid shifts; set stage for early fluid resuscitation
- recommended use of salt and protein solution monitoring hemoglobin to adjust therapy

The Cocoanut Grove Fire 1942

- 492 dead and many injured
- Busboy lit a match that find a light bulb
- Entrance limited to a rotating door and all side doors locked
- At Boston City hospital Dr. Lund received more than 300 patients (132 treated) and Mass General Dr. Cope received 114 pts (39 treated)
- Patients at both institutions received IV fluid resuscitation of equal parts of plasma and saline. Both noted that burns with inhalation injury required more fluid during resuscitation.

Advances from the Fire

- Burn shock led to hypovolemia from burn fluid loss but also large internal fluid shifts.
- Cope's Burn Budget Formula—non-weight based fluid resuscitation with Lactated Ringer's, 0.5 normal saline, colloid and glucose in water, with continuation of all of these fluids during the second 24 hours, except for the 0.5 normal saline.
- Dr. Charles Lund and Dr. Newton Browder published the renowned paper, "The estimation of areas of burns," in which they presented the "Lund and Browder Chart" for estimation of TBSA.

Burn Estimate and Diagram
Age vs Area

Initial Evaluation

Cause of burn ______________________

Date of Burn ______________________

Time of Burn ______________________

Age ______________________

Sex ______________________

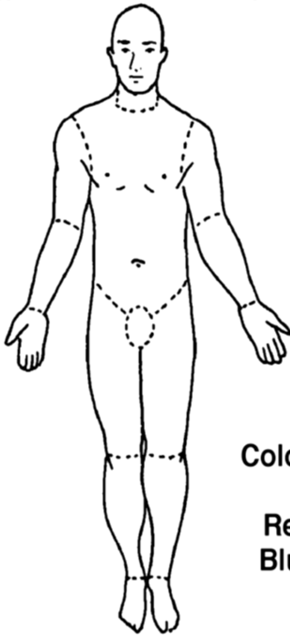
Weight ______________________

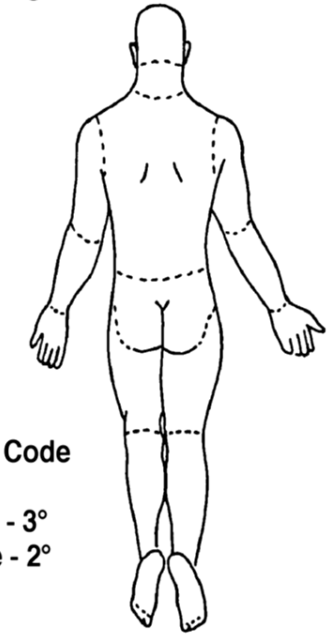
Date of Admission ______________________

Signature ______________________

Date ______________________

Burn Diagram



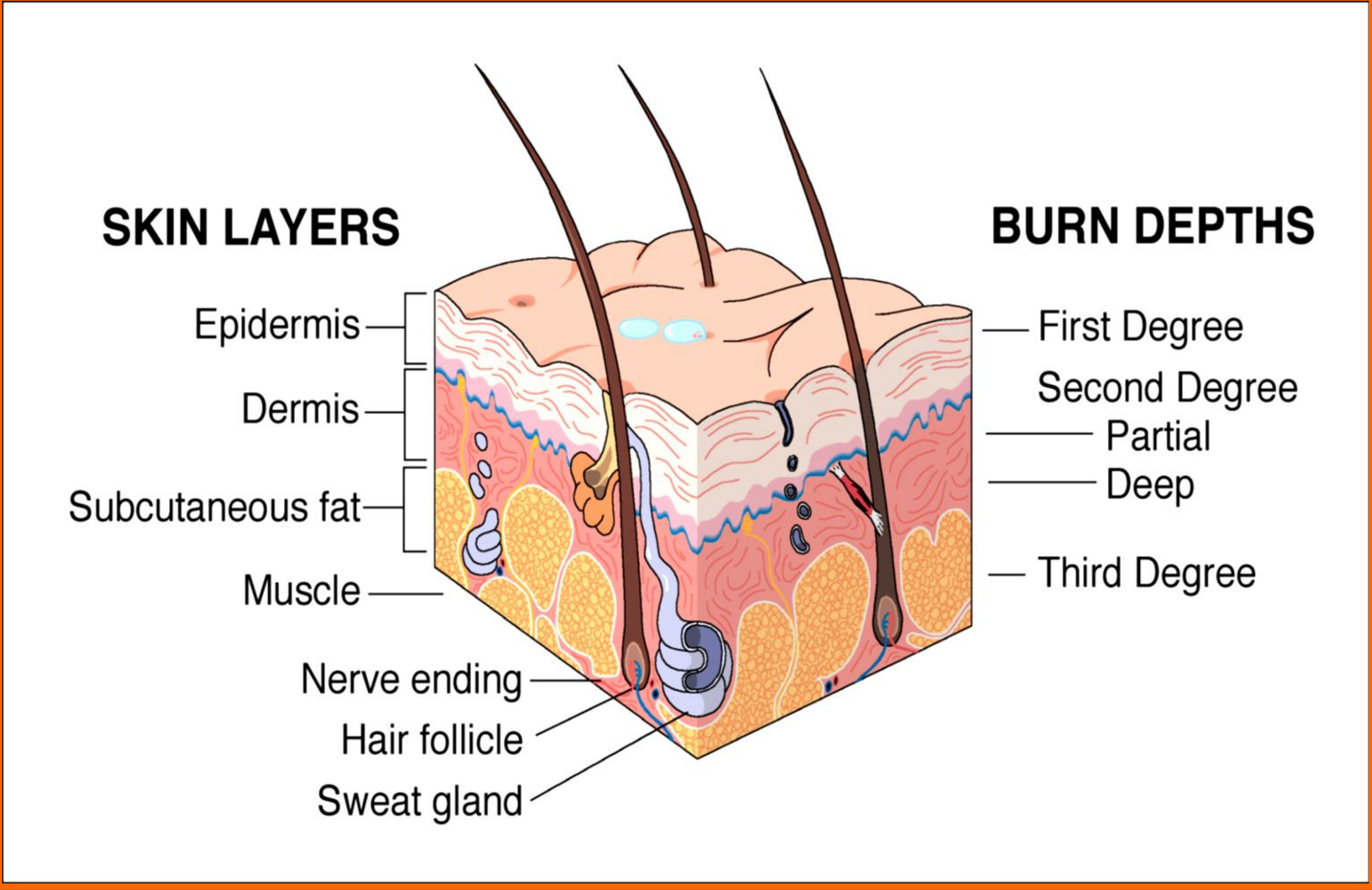


Color Code

Red - 3°
Blue - 2°

Area	Birth 1 yr.	1-4 yrs.	5-9 yrs.	10-14 yrs.	15 yrs.	Adult	2°	3°	Total	Donor Areas
Head	19	17	13	11	9	7				
Neck	2	2	2	2	2	2				
Ant. Trunk	13	13	13	13	13	13				
Post. Trunk	13	13	13	13	13	13				
R. Buttock	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2				
L. Buttock	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2				
Genitalia	1	1	1	1	1	1				
R.U. Arm	4	4	4	4	4	4				
L.U. Arm	4	4	4	4	4	4				
R.L. Arm	3	3	3	3	3	3				
L.L. Arm	3	3	3	3	3	3				
R. Hand	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2				
L. Hand	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2				
R. Thigh	5 1/2	6 1/2	8	8 1/2	9	9 1/2				
L. Thigh	5 1/2	6 1/2	8	8 1/2	9	9 1/2				
R. Leg	5	5	5 1/2	6	6 1/2	7				
L. Leg	5	5	5 1/2	6	6 1/2	7				
R. Foot	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2				
L. Foot	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2				
						Total				

Cross-section of the Skin



Parkland Formula or Baxter formula

- 1968: based on animal studies, and later trials on 11 patients with burns.
- LR 4 mL/kg/% burn
  - 1/2 volume during the first 8 hours and the remaining volume over the next 16 hours,
  - urine output as a clinical guide.
- plasma be administered at a rate of 0.3–0.5 mL/kg/% burn during the fourth 8-hour period of the initial resuscitation, crystalloid alone was not sufficient to correct the volume deficit.

Parkland Formula or Baxter formula

1979, 10 years follow-up:

Adequate fluid resuscitation in 70% of the patients

- In conclusion he stated, “lactated Ringer’s is effective as the initial and only fluid replacement for burned patients in the first 24 hours “
- plasma can be administered at any time post burn but is most effective if given between 24 and 30 hours.
- Patients requiring more fluid include those with deep burns, inhalation injuries, electrical burns, and patients who received delayed resuscitation.

Parkland Formula

First 24 hours: 4 ml LR/kg/% burn + basal fluids*

- **Rate of infusion:** **50% in 1st 8 hrs**
  25% in 2nd 8 hrs
  25% in 3rd 8 hrs

Second 24 hours: Basal + evaporative losses

→ Basal: 1500 ml / m^2 / day

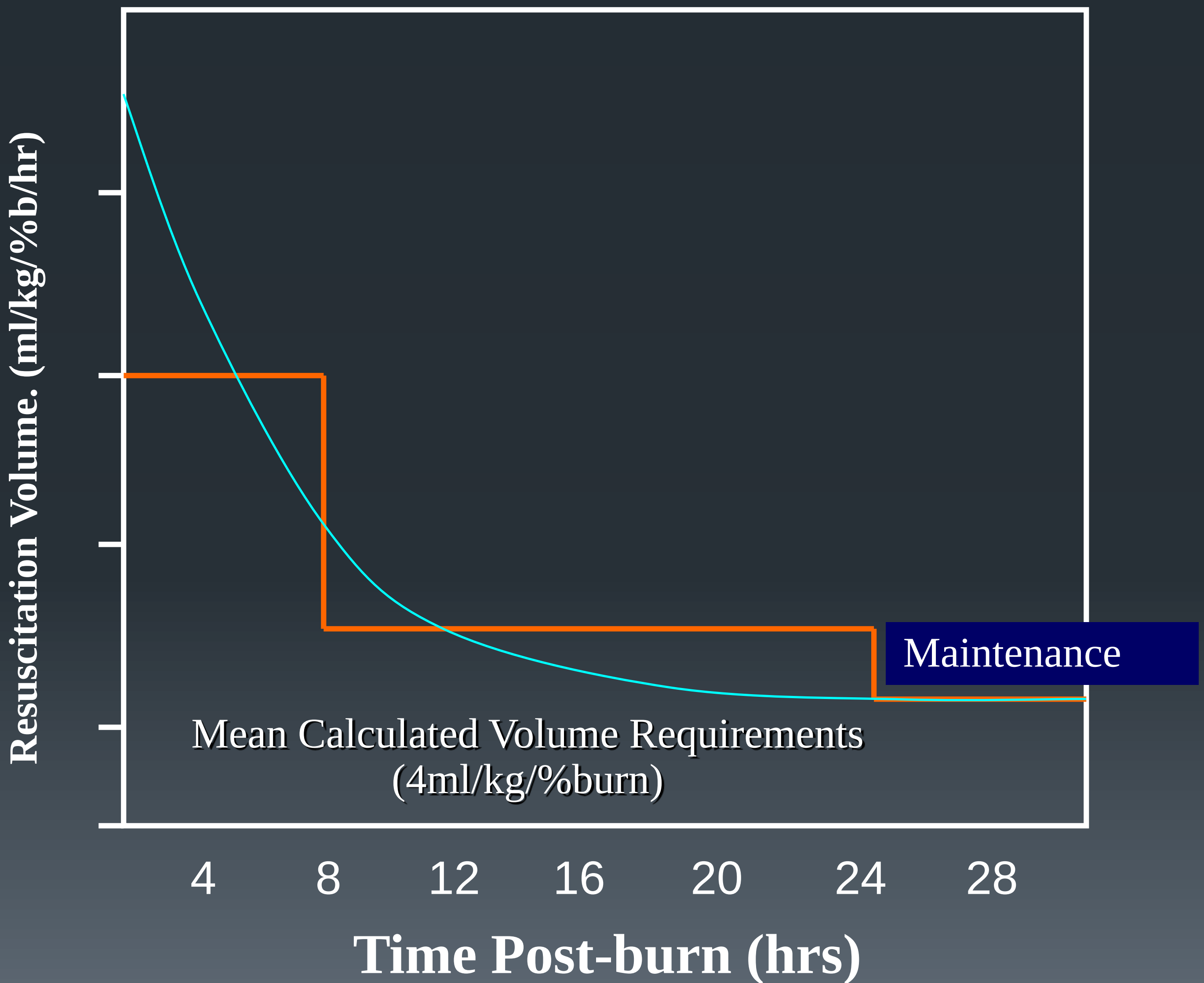
→ Evaporative: (25 + % burn) x m^2 = ml/hr

→ Consider colloid: 0.5 ml FFP / kg / % burn

ABA Guidelines for Burn Resuscitation

- Adults and children with burns greater than or equal to 20%
- Resuscitation formula 2-4 ml/kg/%TBSA
- Fluids titrated to maintain uop at 0.5-1 ml/kg/hr in adults and 1-1.5 ml/kg/hr in children
- Maintenance fluids should be administered to children in addition to their calculated fluid requirements
- Increased volumes anticipated for full- thickness burns, inhalation injury, electrical injuries, a delay in resuscitation
- (additional causes not mention—missed trauma, drug intoxication, cardiac dysfunction)

Burn Shock Resuscitation



ABA Guidelines for Burn Resuscitation--Options

- Colloid may decrease overall fluid requirements
- Oral resuscitation should be considered in awake alert patients with moderate size burns—needs further study
- Hypertonic saline should be reserved to providers experienced in this approach.
- High dose vitamin C may decrease fluid requirements—need further study

IV Replacement and Maintenance

01-04-02

Fluids

- Lactated Ringers: Na 130 pH 6.5 lactate
- Normosol : Na 140 pH 7.4 acetate
- Normal Saline : Na 155 pH 5.5

- Hypertonic Solution :
- 1 liter of LR or Normosol with 1 amp of Sodium Bicarbonate
- Increases sodium to 180-190 –monitor Na levels

Pathophysiology

- Decrease in cellular transmembrane potential in injured and noninjured tissue
- Na-ATPase pump disrupted leading to electrolyte abnormalities
- Fluid shifts leading to hypovolemia and cellular edema
- Worsened by capillary leak and inflammatory response mediators

Consequence of Fluid Resuscitation

- Under resuscitation leads to hypo perfusion, acute renal injury, and death
- Over-resuscitation- worsening edema, compartment syndromes, ARDS, and multiple organ failure.

- Goal of proper resuscitation- prevention of burn shock

Monitoring of Resuscitation

- **Vital Signs**
  - BP, Pulse, Respiratory rate, Temperature
- **Urine output**
  - Hourly output, Sp. Gravity, Pigment
- **Invasive methods**
  - CVP, PCWP, Cardiac Output
- **Laboratory tests**
  - Electrolytes & osmolality
  - Hematocrit
  - Albumin
  - Acid-base balance

Pain Pallor Parasthesia Paresis Pulselessness

- Clinical:
  - Pain out of proportion to injury, pain with passive movement, tense swelling
  - Diminished pulses and sensation develop late in course of syndrome
  - May not be possible to access completely if altered mental status, intoxicated, or LOC

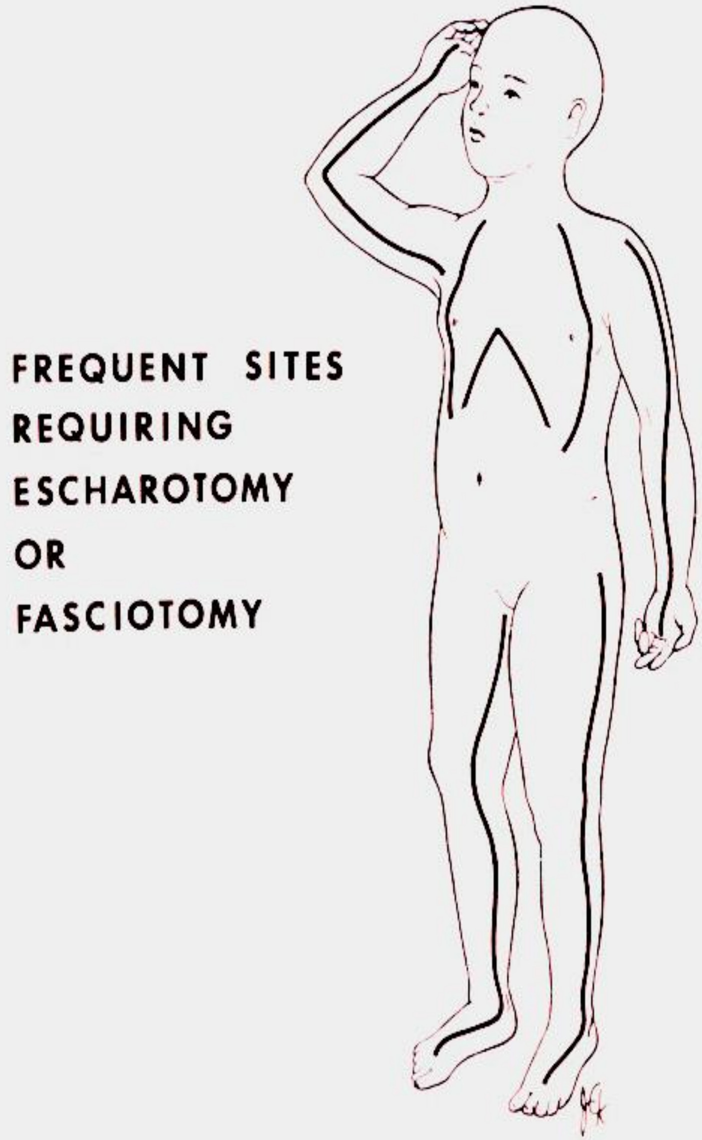
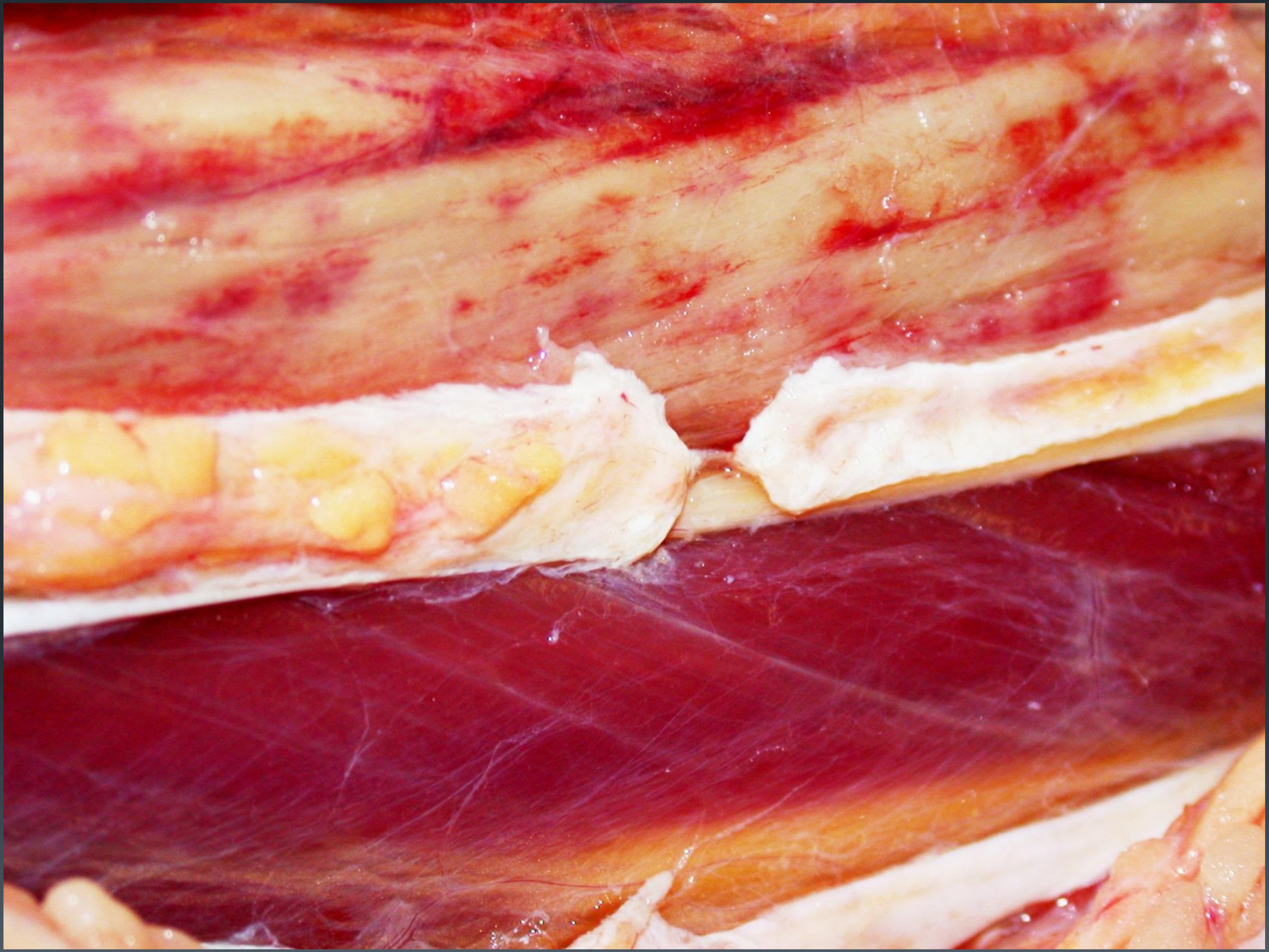


Figure 29-18 The locations of commonly used incisions for escharotomy and fasciotomy.



Inhalation Injury

- **Responsible for 50% of all burn deaths**
- **Doubles burn mortality**
- **Present in 5-30% of all burn admissions**
- **Associated with increased fluid needs**

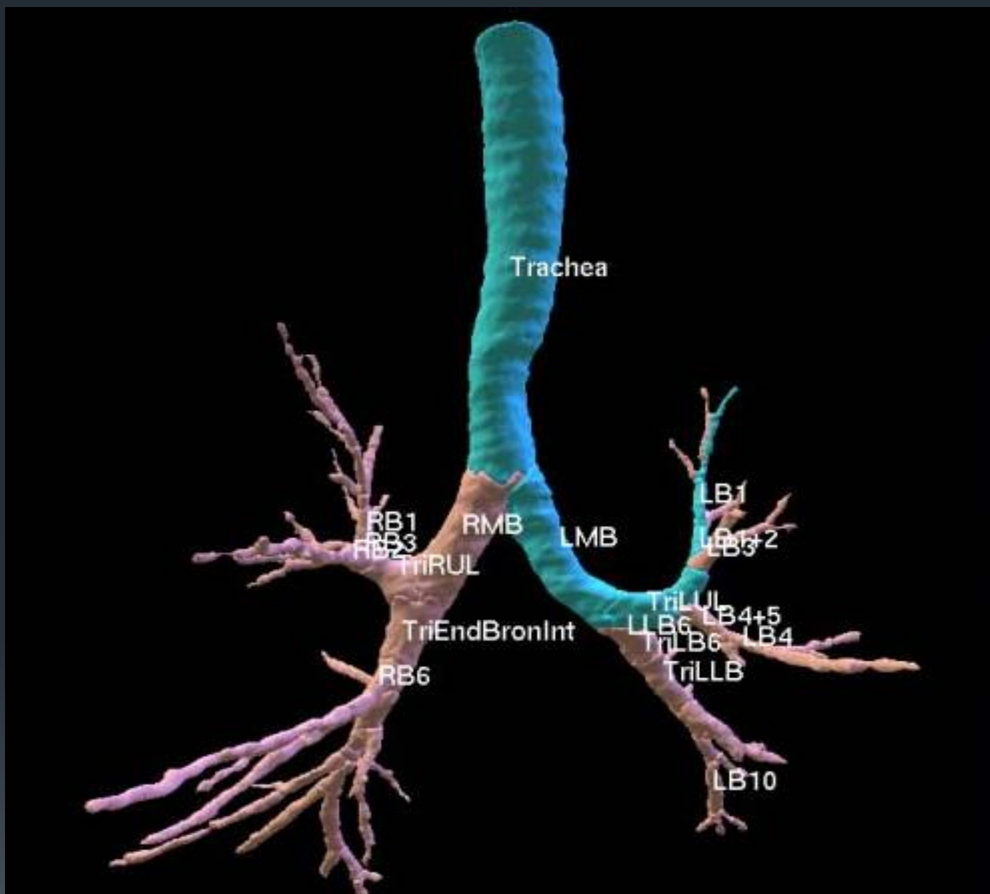
Treatment of Inhalation Injury

- Airway patency
  - prophylactic intubation preferred
  - bronchoscopy?
  - tracheostomy

- 100% Oxygen
  - half-life of CO-Hb is 30 min (4 hr on room air)

- Ventilatory support as needed

- **No steroids or prophylactic antibiotics**


Trachea
RB1
RB3
RB2
TriRUL
RMB
LMB
LB1
LB3
TriLUL
LB4+5
LLB6
TriLB6
LB4
TriEndBronInt
RB6
TriLLB
LB10


Additional Patient Care

- Airway- consider elective intubation for patients receiving large volumes of resuscitation
- Elevate affected limbs
- For circumferential burns, monitor for extremity compartment syndrome
- Monitor for intra-abdominal compartment pressures.
- Check labs q 6 hours – should see decrease in hemoconcentration, resolution of acidosis, correct electrolyte abnormalities.

Parkland Formula

- Example:

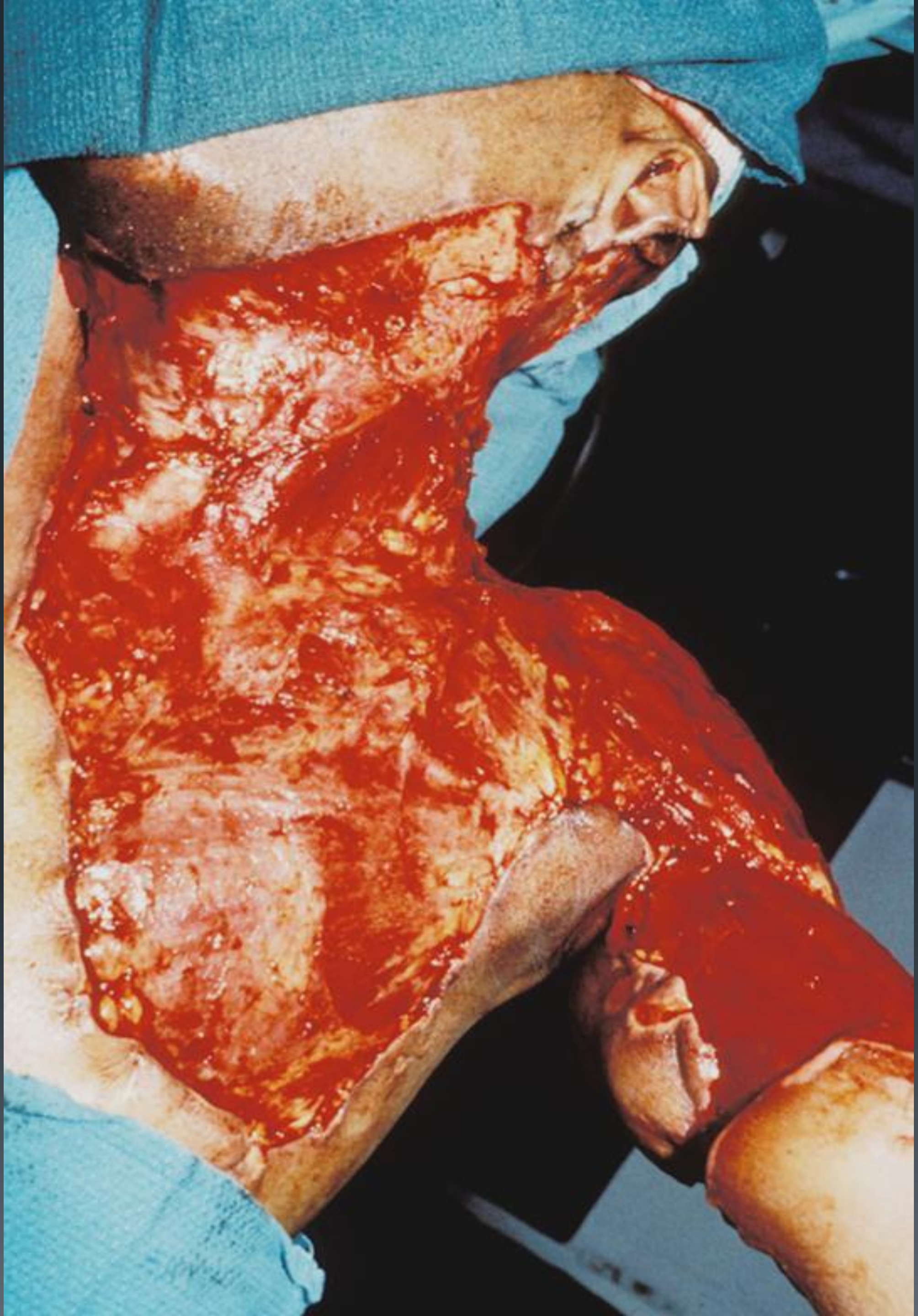
- 70 kg male 40 % TBSA

Parkland Formula

- 4 x 70 kg x 40% = 11,200 ml
- 11,200 / 2 = 5,600 ml
- First 8 hours= 700 ml/hr
- Remaining 16 hrs= 350 ml/hr

Time Line

Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Na ↑↓						
K↑↓	↓	↓	↓	↓	↓	↓
Ca	~↓	↓	↓	Nadir	↑ing	↑ing
Mg~	~	↓	Nadir	↑	↑ing	↑ing
Phos~	~↓	↓	Nadir	↑	↑ing	↑ing
WBC↑ ↓	↑↓	↓	Nadir	Nadir	↑ing	↑ing
Plts↑↓	↑↓	↓	Nadir	Nadir	↑ing	↑ing




89 5 1


90 5 30


90 5 30

Complications of Burns

- **Septic**
  - Invasive burn wound sepsis
  - Suppurative thrombophlebitis
  - Pneumonia
- **Gastrointestinal**
  - Ileus
  - Curling's ulcer

Electrical Injury

- **True** (direct)
  - Entry and exit wounds
  - Damage to all deep tissues
  - Depth and extend usually underestimated

- **Arc**
  - Electric current leaps from conductor to skin
  - Temp of arc approx. 2500°C
  - Arcing of 1” per 20,000 volts

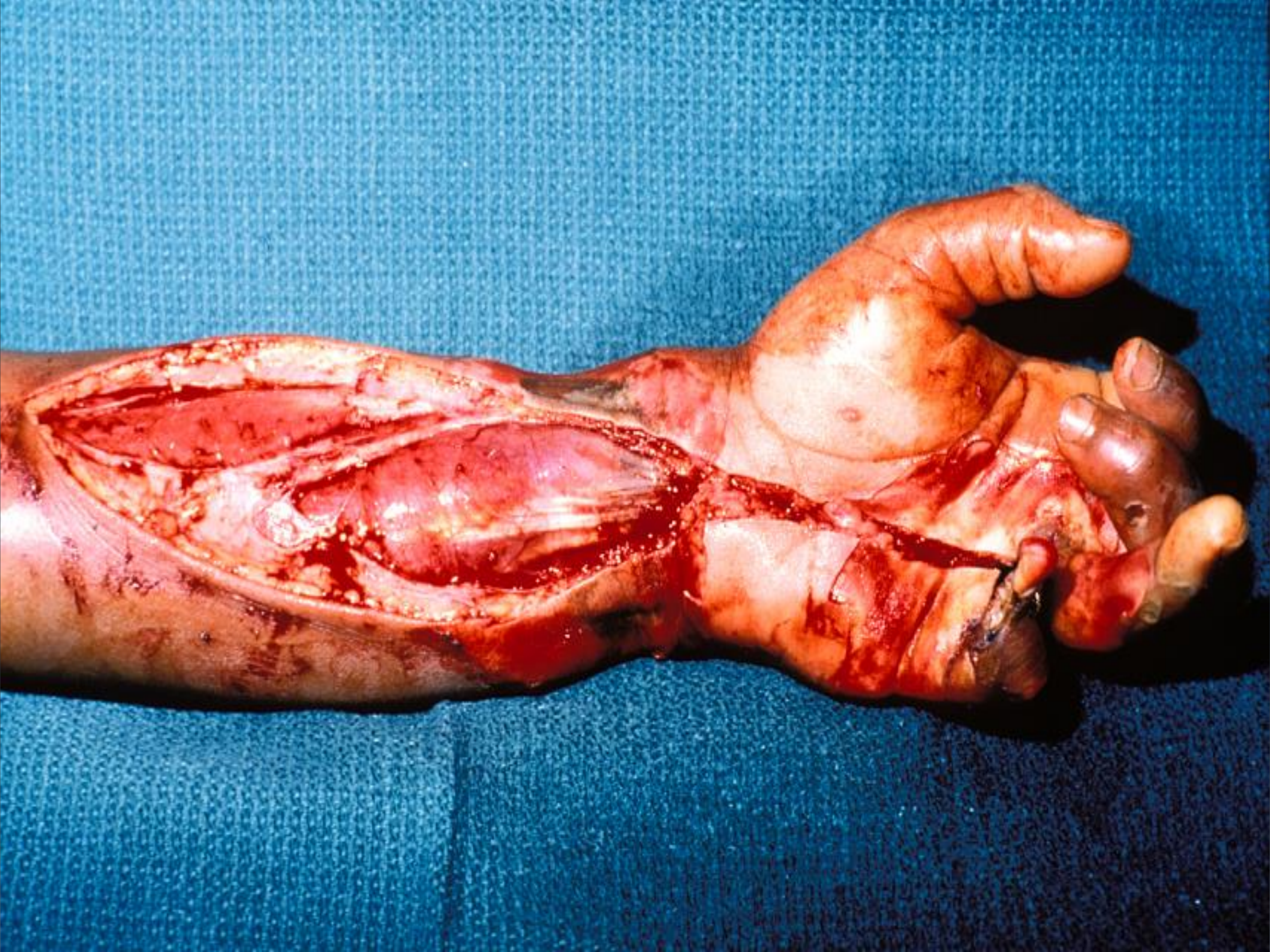
- **Flash**
  - Similar to thermal burns

Initial Management of Electrical Injuries

- **Airway**

- **Fluid replacement**
  - Fluid requirements may be underestimated
  - Maintain urine output above 1.0 ml/kg/hr
  - Follow EKG for transient arrhythmias

- **Wound Care**
  - Watch for vascular compromise
  - Early debridement in multiple stages
  - Bleeding precautions



Chemical Burns

- **Acid burns**
  - Eg. inorganic acids
  - Causes coagulation necrosis.
  - Treatment:
    - Remove clothing
    - Copious irrigation with water if liquid (brush away if powder)

- **Alkali Burns**
  - Eg. NaOH, lime, or ammonia
  - Treatment: same principles as for acids
  - Burns deeper due to fat saponification

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LA_{50} for Burn Injuries: 1940-2003

Shriners Hospitals for Children • Shriners Burns Hospital • Cincinnati, Ohio