SOCIETY OF TRAUMA NURSES

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Burn and Inhalation Injury

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Objectives

At the conclusion of this presentation the participant will be able to:

- Identify types of burn injury
- Describe assessment of the burn patient
- Identify patients requiring transfer to a burn center
- Understand the significance of inhalation injury on burn patient outcomes

Epidemiology

486,000 burns per year seen in ED

- 221,519 admitted with ICU stay
- 62% male
- 56% age 20 to 59.9 years
- 22.5% are <16 years
- 16.9% are >60 years
- 63% are < 10% (TBSA)
- 72.5% of burn injuries occur in the home

American Burn Association, 2019

Burns and Trauma

Type of Injuries

- Fractures: 45 - 64%
- Complex soft tissue injuries: 36 - 52%
- Traumatic brain injury: 17 - 26%
- Thoracic and abdominal injuries: 4 - 24%

Common Causes

- MVC
- Scald during assault
- Plane crash
- Explosion with shrapnel

Morbidity and Mortality

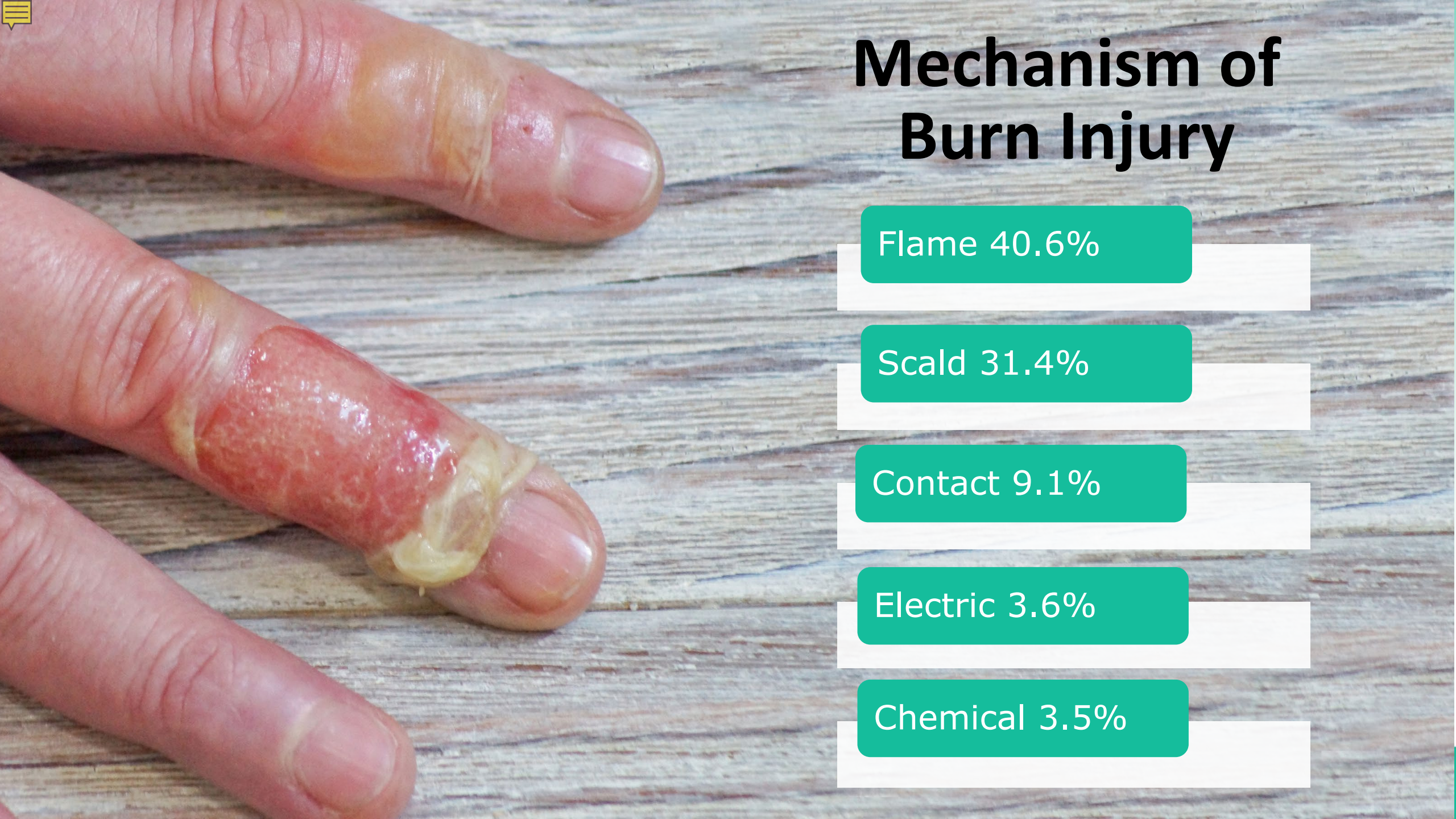
- Mortality for all cases ranged from 3.0-5.4% for fire/flame injuries.
- Average length of stay 8.5-10 days.
- Factors affecting mortality:
  - Age
  - % TBSA
  - Inhalation injury

Resource Utilization

- For survivors, average LOS was slightly greater than 1 day per % TBSA.
- For non-survivors, hospital stay was 2-3 weeks with TBSA < 80%.
- 87% were eventually discharged home.
- For burns > 10% TBSA, average cost is $268,435 - $354,560.
  - Higher among non-survivors

Mechanism of Burn Injury

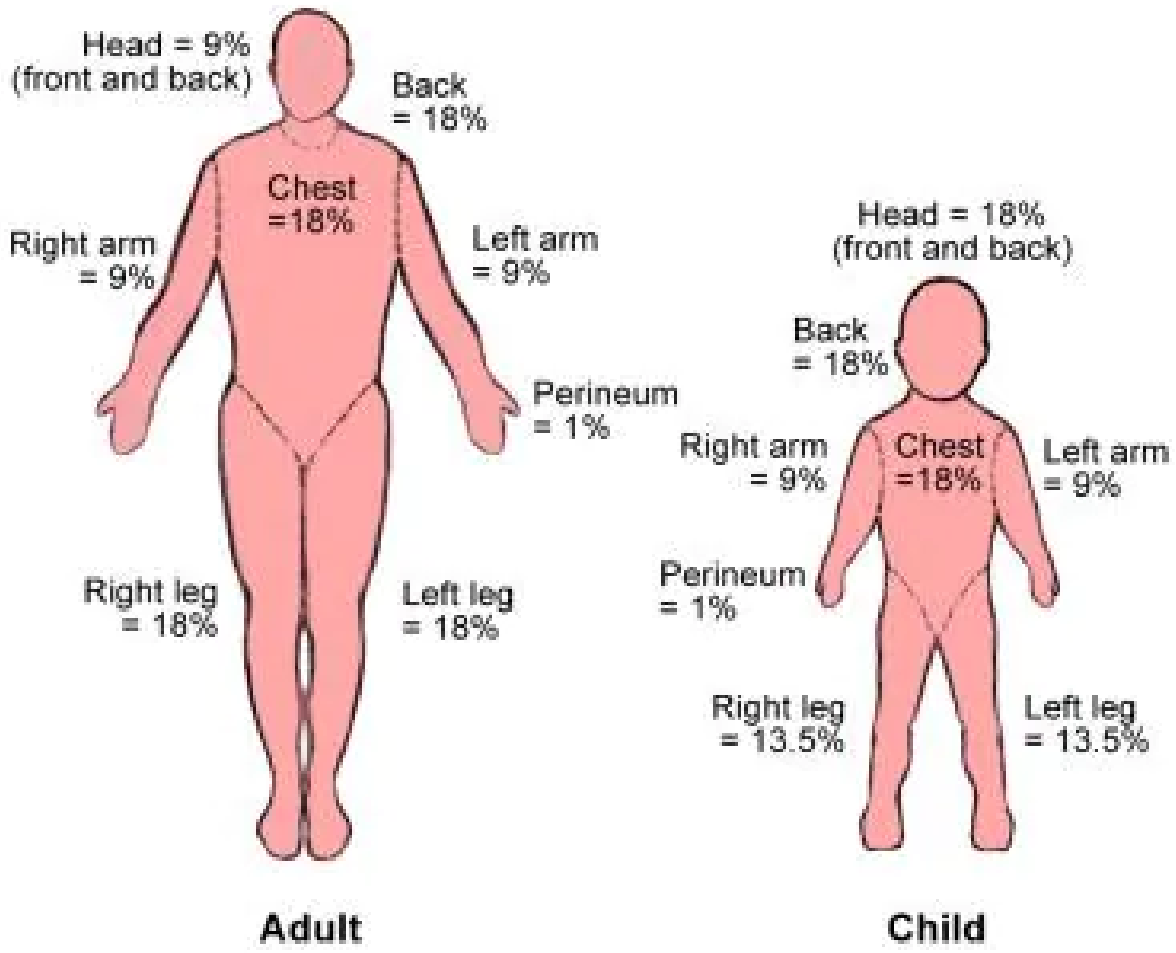
- Thermal
- Frostbite
- Inhalation



Mechanism of Burn Injury

- Flame 40.6%
- Scald 31.4%
- Contact 9.1%
- Electric 3.6%
- Chemical 3.5%

Rule of 9’s

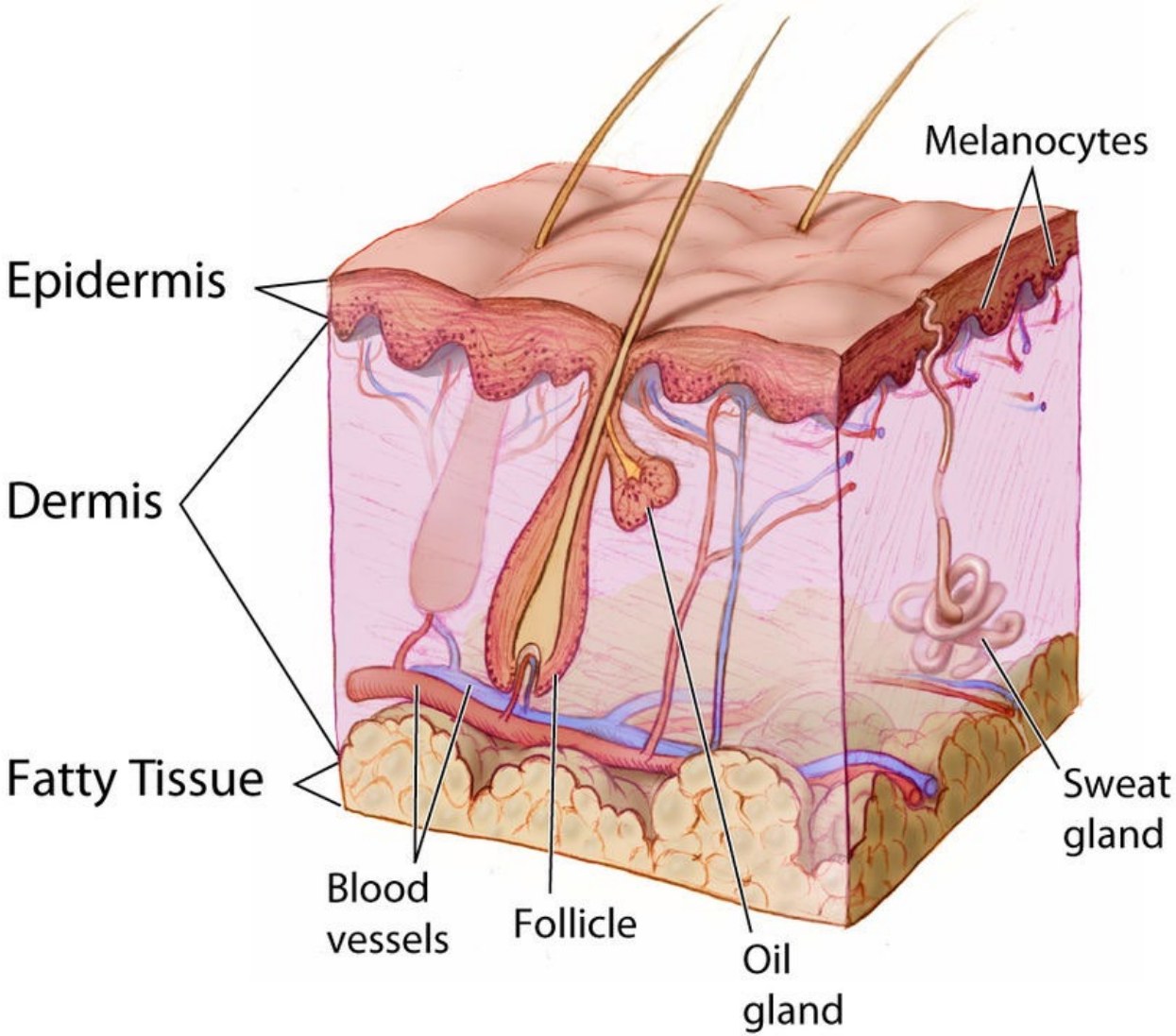


https://img.medscapestatic.com/pi/meds/ckb/89/7989.jpg

Severity of Injury

- **Depth**
  - Superficial
  - Superficial partial thickness
  - Deep partial thickness
  - Full thickness
- **Extent of burn**
- **Age**
- **Past Medical History**
- **Location of burn**
- **Concurrent trauma**
- **Smoke inhalation**

Anatomy of the Skin



Don Bliss (artist), Public domain, via Wikimedia Commons

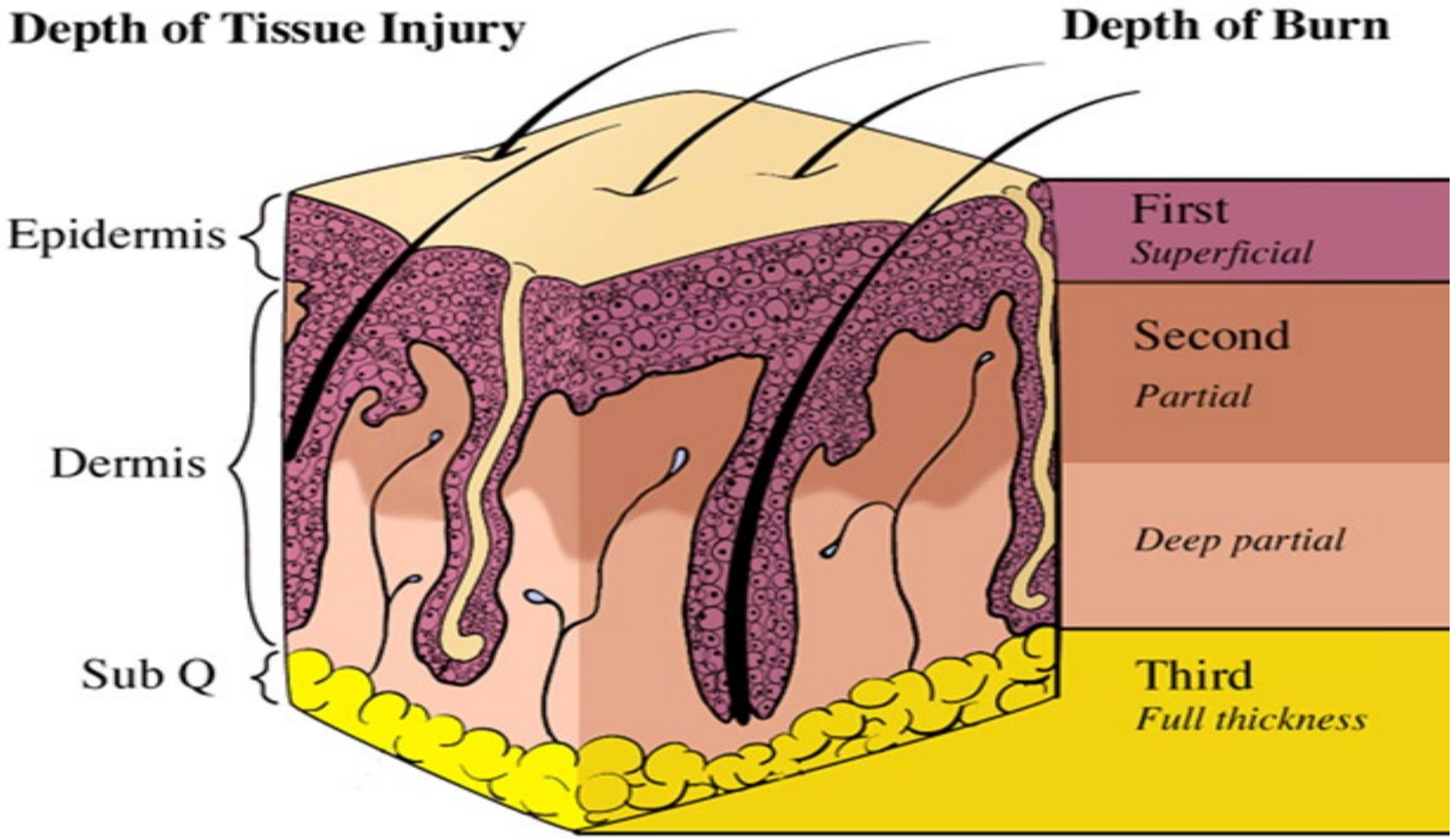
Functions of the Skin

- Prevention of infection
- Conserve body fluids
- Temperature regulation
- Cosmetic appearance
- Sensation and touch

Burn Pathophysiology

- Hypermetabolic state
  - Protein utilization
  - Loss of lean body mass
  - Hyperglycemia
- Inflammatory mediators
  - Shock
  - Hypovolemia
  - Increased pulmonary and vascular resistance
  - Myocardial depression

Anatomy of the Skin



Depth: Superficial Burns

- First degree
- Pink in color
- Damage to epidermis
- Do not count in TBSA calculation
- *No resuscitation fluid necessary*
- Heals on its own

Depth: Partial Thickness Burns

Depth: Full Thickness Burns

- Third degree
- White, black, brown in color, dry, leathery in appearance
- Burned skin non-pliable
- Circumferential third degree may require escharotomy.
- Skin grafting required.

https://www.mayoclinic.org/diseases-conditions/burns/symptoms-causes/syc-20370539

Inhalation Injury

- Average of 8.6% of admission to burns centers have concomitant inhalation injuries.
- Incidence increases with TBSA.
- Associated with higher mortality
  - Overall mortality rate 20% with inhalation injury versus 2.9% without inhalation injury
  - In those > 60 years, fatality increases above 50% with TBSA ≥ 20%.
- Diagnosed and graded 0 to 4 based on severity via bronchoscopy.

Inhalation Injury - Assessment

Assessment

- History
- Singed hair
- Soot in oropharynx
- Carbonaceous sputum
- Hypoxia, SOB
- Stridor, hoarseness
- Wheezing, rhonchi, use of accessory muscles
- Oropharyngeal erythema

Inhalation Injury - Treatment

- For patients suspected of having an inhalation injury, do not wait to intubate as with ongoing fluid resuscitation, swelling will increase and it will be difficult to pass an endotracheal tube.
- Stridor or hoarseness is a late sign!

ABA Burn Center Referral Criteria

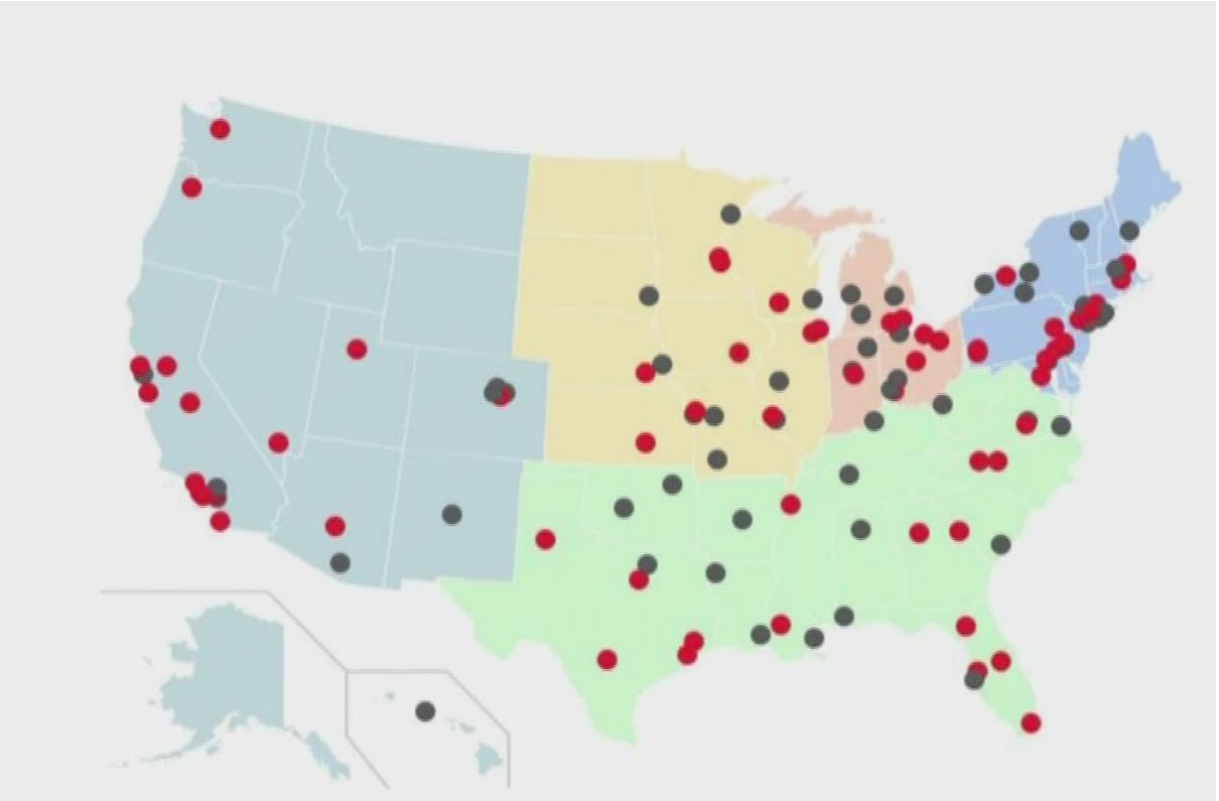
- Partial thickness burns >10%
- Burns to face, hands, feet, genitalia, perineum, or major joints
- Full thickness burns any age
- Electrical burns
- Chemical burns
- Inhalation injury
- Patients with pre-existing medical conditions
- Patients with burns & concomitant trauma
- Pediatric burns
- Patients who will require special social, emotional, or long-term rehab intervention

Preparation for Transfer

- Maintain patent airway
- Monitor urine output and adequacy of resuscitation
- Keep patient warm and dry
- Secure all lines and tubes
- Wound care
- Manage pain

US Burn Centers

- Over 60% of US burns admitted to 128 burn centers, 64 are ABA verified
- Offer functional and cosmetic outcomes
- Specialty OT, PT, Social Work, Psychologists



Red dots are ABA verified burn centers.

Initial Fluid Resuscitation

- Burns > 20% TBSA
- LR infusion for Adults > 30kg
- Pediatric < 30kg
  - < 10kg use D5LR
  - > 10-30kg use LR
- Monitor urine output and adjust fluids to achieve:
  - Adults 30-50 ml/hour
  - Infants 1-2 ml/kg/hour
  - Children 0.5-1 ml/kg/hour

Burn Resuscitation Formula

- Adult & Chemical Burns:
  - **2 ml LR X kg X %TBSA**
- Pediatric (14 years or under and less than 30kgs):
  - **3 ml LR X kg X %TBSA**
- Adult High Voltage Electric Injuries:
  - **4 ml LR X kg X %TBSA**
- Pediatric High Voltage Electric Injuries
  - Consult Burn Center
- % TBSA: calculated based on full & partial thickness burns, NOT superficial burns
- Administer half of the total fluids in the first 8 hours post burn and the second half in the next 16 hours

Example Resuscitation Formula

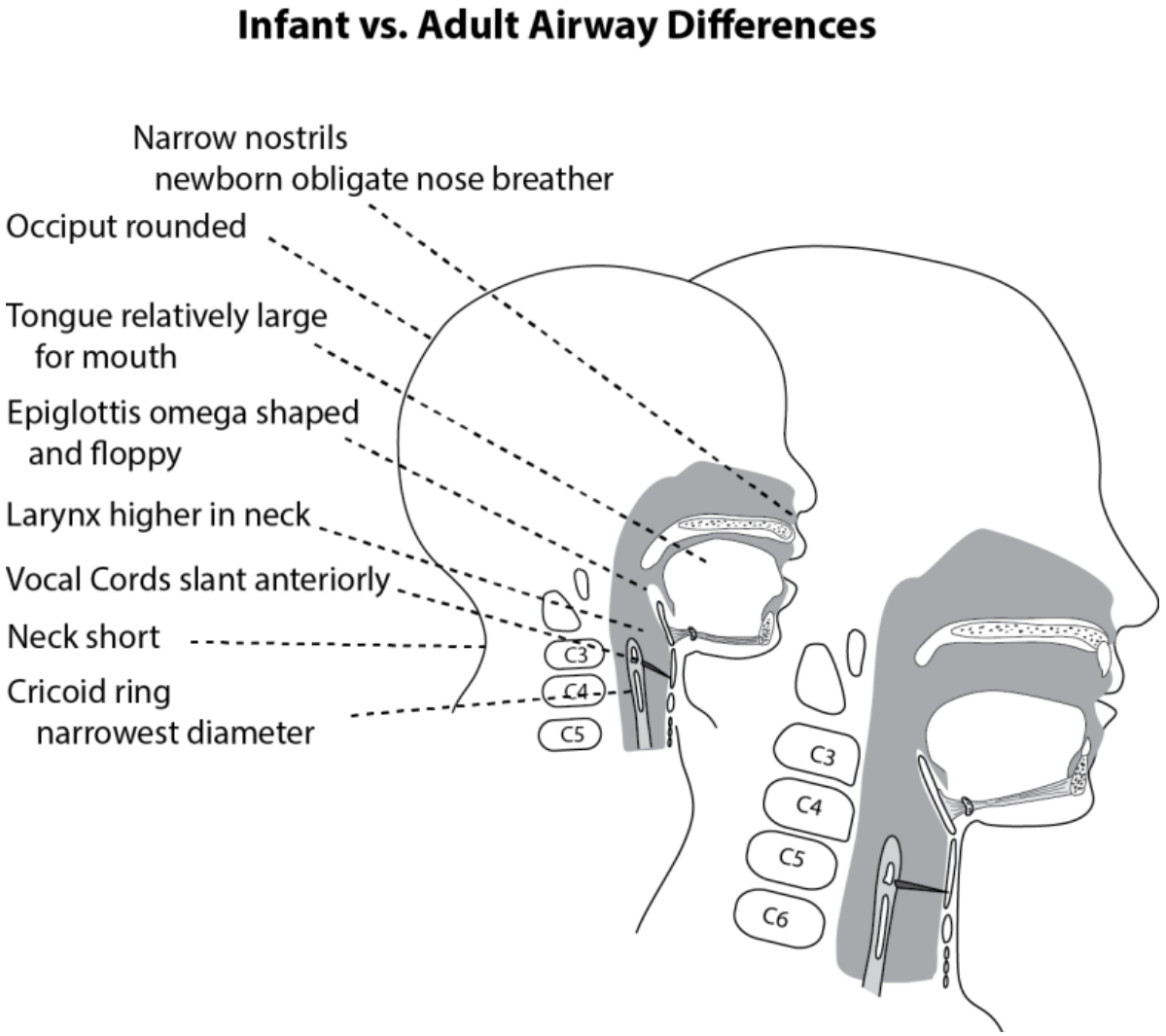
- 50% TBSA (Full and partial thickness degree burns only)
- Age: 28
- Mechanism: explosion
- Weight: 70 kg
- 2 ml X 70kg X 50% TBSA = 7,000 cc
- Give 3,500 ml over the first 8 hours
- Give the other 3,500 ml over the next 16 hours


Escharotomy
Circumferential Injury
Full Thickness Burns
Limb Threatening

Pediatric Burns

- Psychosocial issues
- Airway
- Breathing
- Circulation
  - Children < 10kg should have D5LR for resuscitation

Pediatric Burns



Respiratory

- Large tongue
- Small pharynx
- Larger, floppier epiglottis
- Larynx more anterior
- Narrowest at cricoid
- Trachea narrow and less rigid

https://airwayjedi.com/2016/04/18/intubating-infant-toddler/

Pediatric Burns

Circulation

- Larger surface area
- Increased volume needs
- Limited glycogen stores
- Hypothermia risk
- Thinner skin
- IV pain medication

Geriatric Burns

- Contact with flame is most common (50%), followed by scald (20%)
- Pre-injury health status-conditions
- Abuse or neglect
- Thin skin
- Decreased reserves
- May need additional monitoring to guide resuscitation
- May affect independence

Chemical Burns

- Most are strong acids or alkalis
- Contained in common household items:
  - Ammonia
  - Bleach
  - Cleaners for drain, toilet bowl, metals
  - Pool chlorinators
  - Battery acid
  - Concrete mix
- Pattern is full thickness in center surrounded by partial thickness
- Most common in young and those working with chemical products

Chemical Burns

Alkali > 7.0

Acid < 7.0

Organic

Treatment

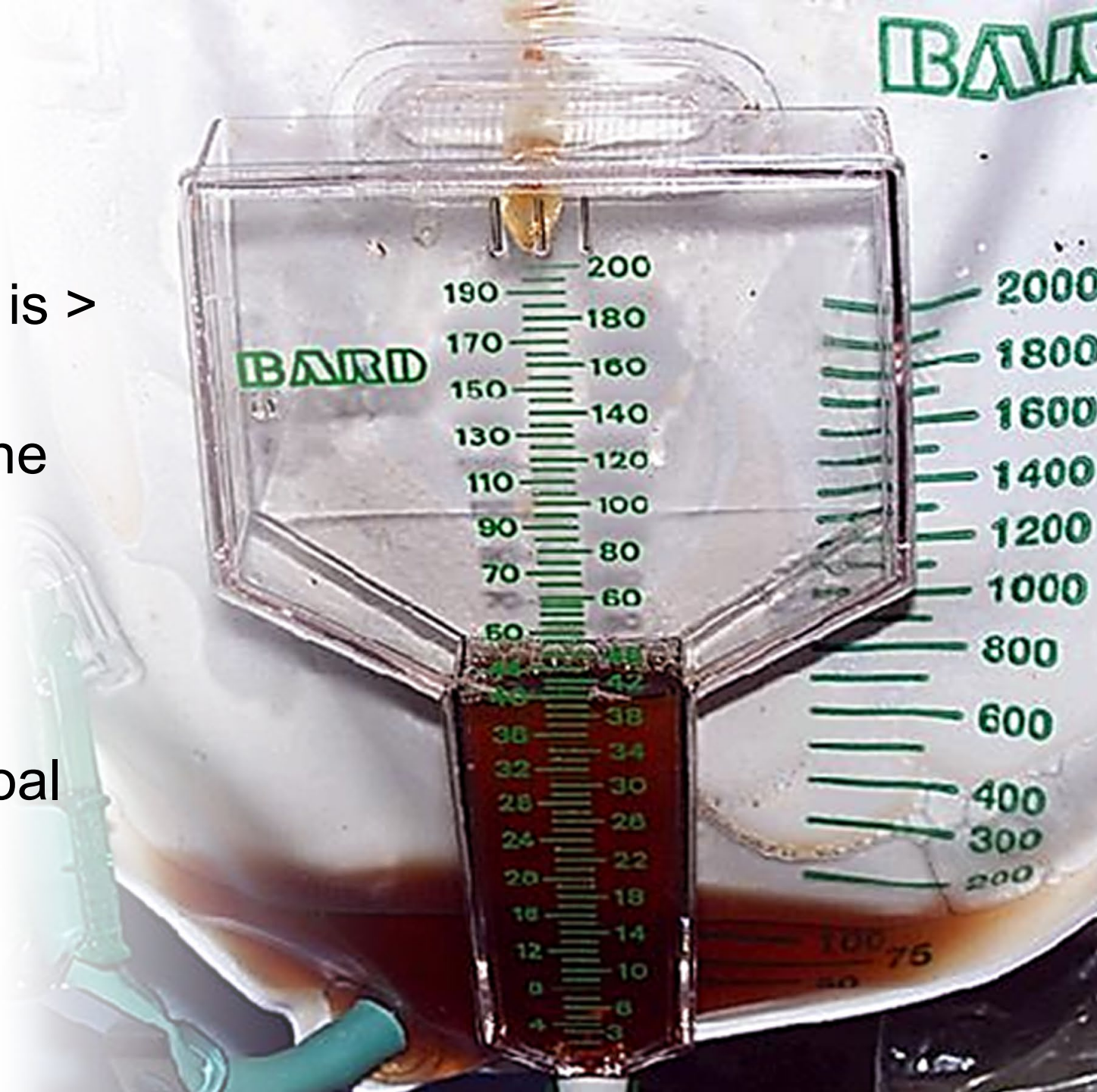
- Remove clothing
- Brush off powder
- Copious irrigation
- Splash injury common
- Check eyes

Hydrofluoric Acid Burn

- Unique: dilute solutions penetrate deeply before showing signs
- Requires additional neutralization of fluoride ions
- Fluoride ions → toxic, tissue necrosis, binds to serum calcium and magnesium
- Fluoride binds to calcium leading to hypocalcemia and dysrhythmias.
- Consult burn center for neutralization.

Electrical Burn

- Concerning when source is > 15,000 volts
- Extent difficult to determine
- Cardiac monitoring
- Hemoglobinuria
- Compartment syndrome
- Fluid resuscitation with goal of output 75-100 cc urine/hour

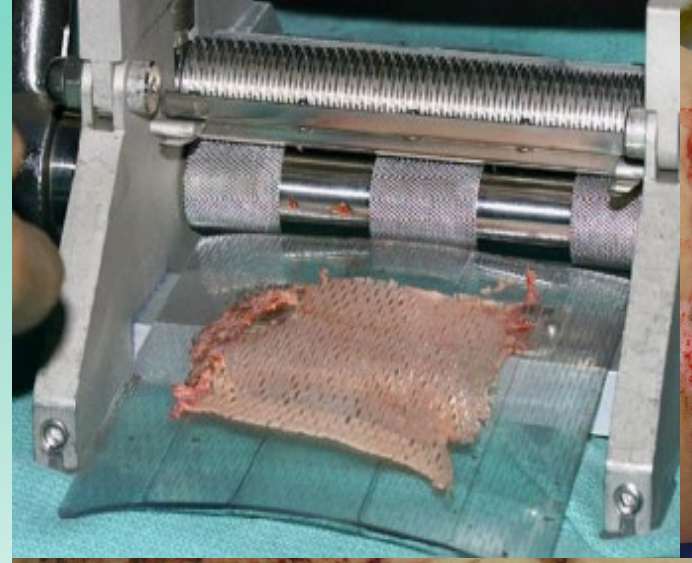


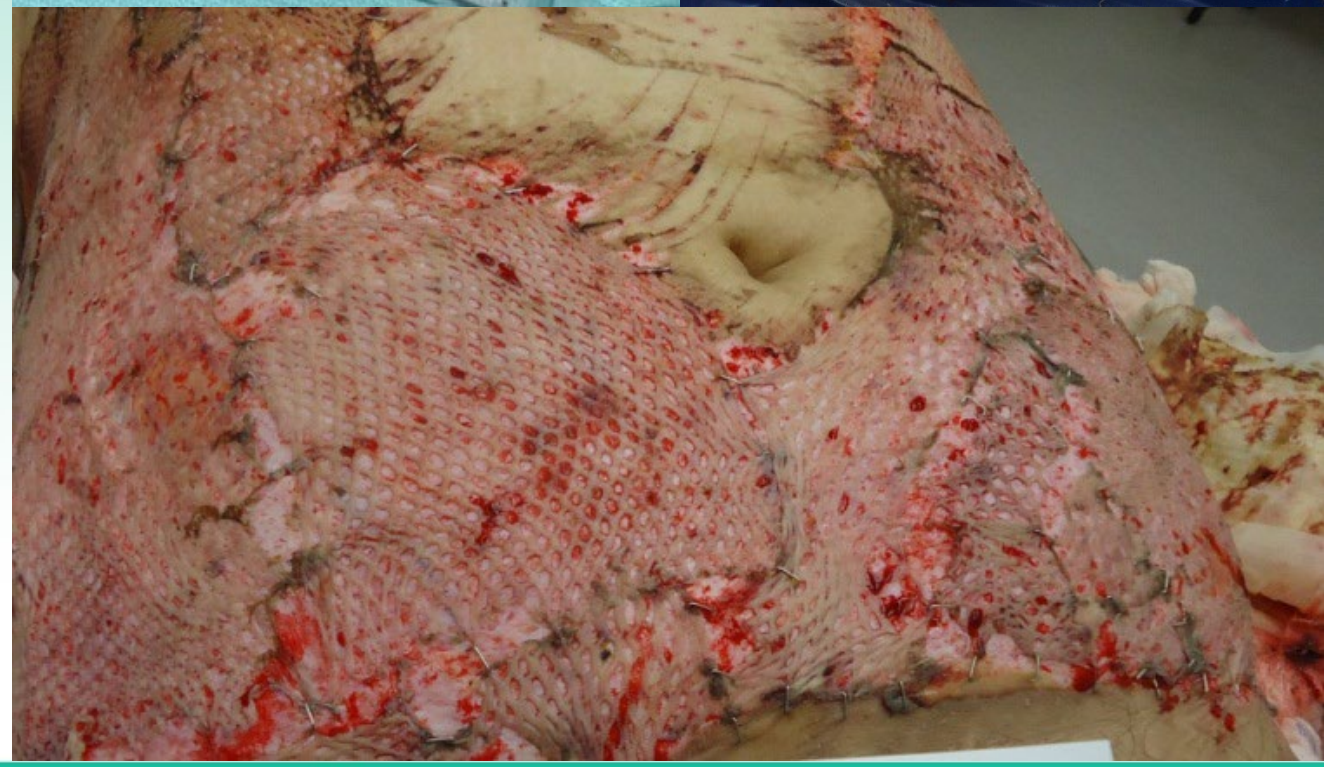
Frostbite

- Extracellular and intracellular ice form
- Gentle rewarming
- Reperfusion injury
- Several weeks to months to determine full extent of injury
- May result in loss of digits

Autologous Skin Grafting

- Split Thickness Skin Graft (STSG)
  - Full thickness burns
  - Meshed vs Sheet
- Donor site: partial thickness, into dermis, heals in 2 weeks
- Harvested skin is put through a skin mesher in order to create slits in the skin (mesh size is varied depending on how much donor site a patient has available).





Skin Grafting Options

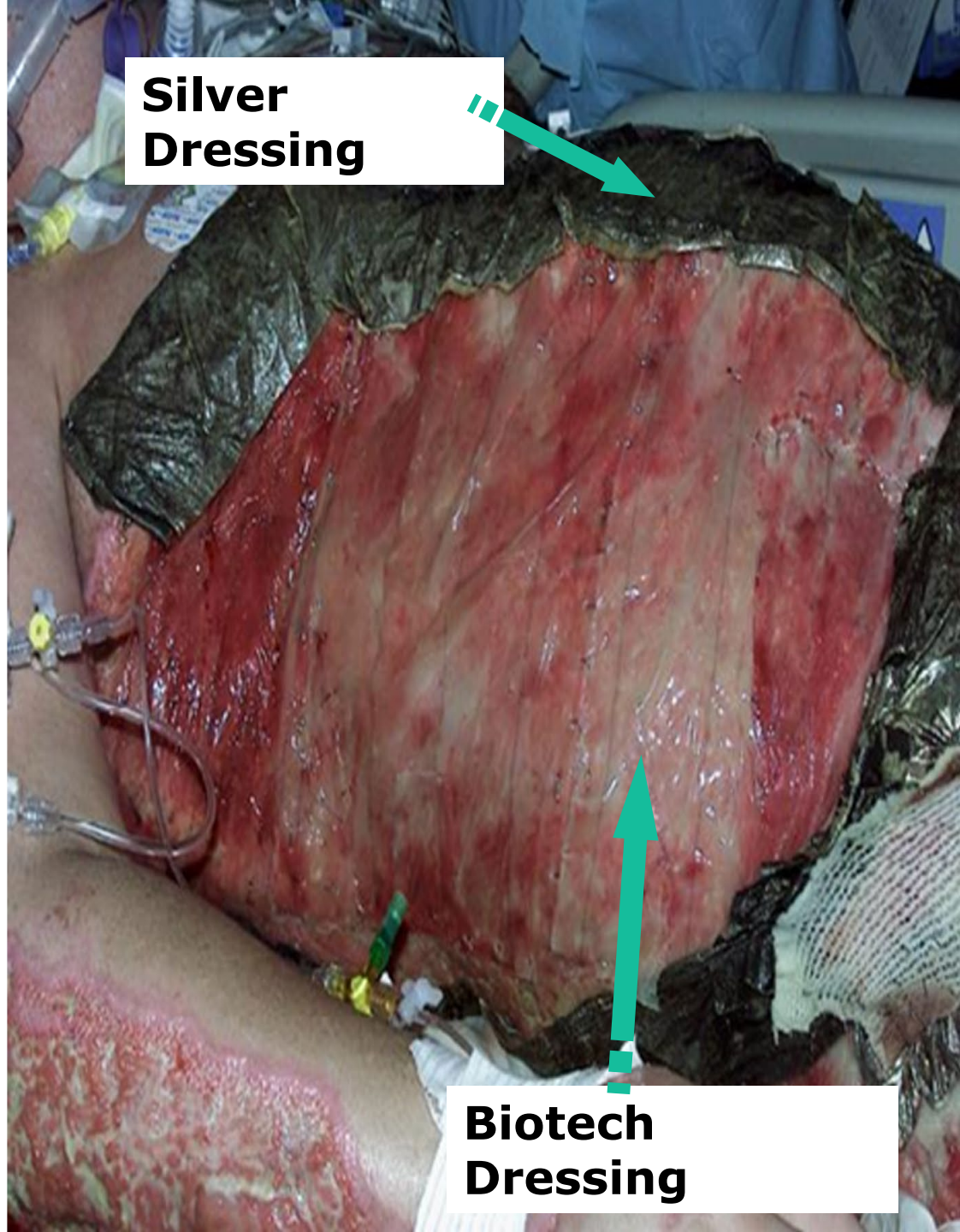
- Alternatives or adjuncts to autologous skin grafts
  - Used with large surface area burns and limited normal skin
- Cultured epidermal autografts
  - Uses skin cells from the person to grow epidermis sheets
  - Takes 3-4 weeks to create
  - Has been found to secrete growth factors critical for cell proliferation and migration, which can enhance healing when used with autografts
- Allogeneic cultured epidermis
  - Can be prepared in advance and cryopreserved to be used in combination with widely expanded split-thickness autografts enhancing epithelialization
  - Can be used in the acute phase while cultured epidermal autografts are prepared

Donor Sites

- Painful
- Heal on their own
- STSG donor sites may be re-harvested

Wound Care

- Cleanse wound with saline or soap and water.
- Frequent debridement in deep full thickness burns
- Topical antimicrobial creams
- Silver dressings
- Biotechnology dressings



Complications

- Inadequate resuscitation
  - Single or multiple organ dysfunction syndrome (MODS)
    - Often accompanied by SIRS
- Over resuscitation
  - Compartment syndrome- abdominal or extremity
  - Pulmonary edema, ARDS
- Ongoing resuscitation
  - Based on size of burn and if inhalation injury present
  - Comorbidities and age considerations
  - Monitor for coagulopathy and ensure use of thromboprophylaxis

Burn Research

- Burn registries and national EMS reporting systems have improved opportunities for burn research.
- Evidence based practice has increased in the past decade.
- Survival rates have improved but challenges remain.

JRmartinez, Public domain, via Wikimedia Commons

Future Considerations

- Biotechnology
- Epidermal replacement options
- Stem cells
- Reduce overall functional recovery time

Summary

- Initial burn management priorities include:
  - Maintain adequate airway
  - Adequate fluid resuscitation
  - Transfer patient to a burn center if necessary as quickly as possible.
- Special considerations when caring for pediatric or elderly
- Inhalation injury compounds and complicates healing, morbidity, and mortality.
- Continued research into treatment options to improve outcomes