



سوختگی های ویژه

دکتر علی رضا رستمی
متخصص جراحی عمومی
دانشگاه علوم پزشکی اراک

Frequency

67% occur in males *

Young adults (20-29 yr) *

Children < 9 years of age *

> 50 years of age fewest of
serious burns *

Major causes of burns *

Flame (37%) *

Liquid (24%) *

Children < 2 years of age *

Liquids/hot surfaces *

5% die as a result of their burns *

Flame burns *



Skin Anatomy and Function

Largest organ *

3 major tissue layers *

Epidermis *

Outermost layer *

Dermis *

Below epidermis *

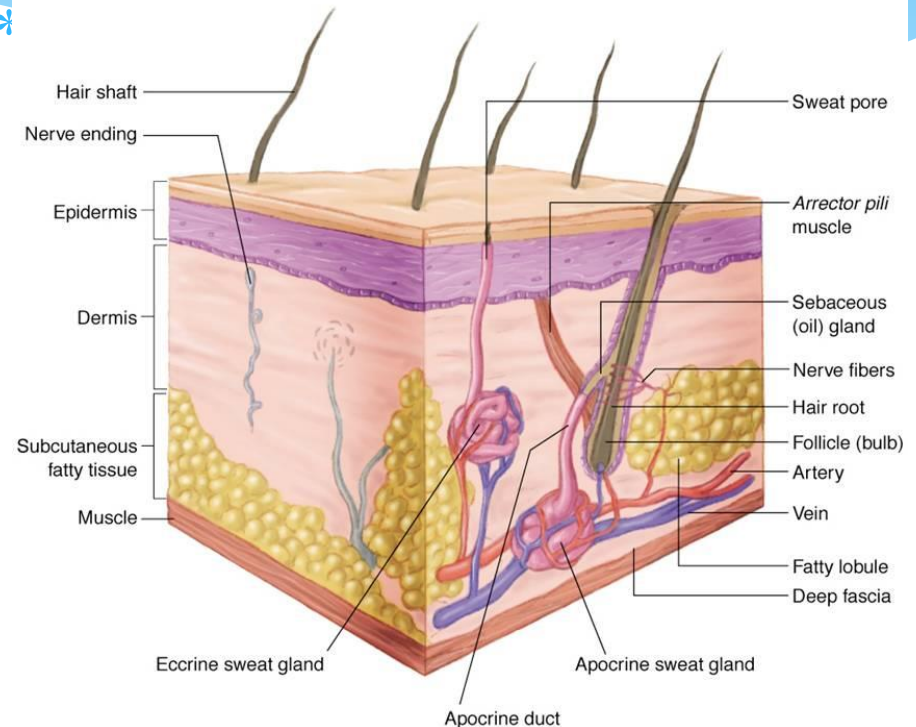
Vascular and nerves *

Thickness *

1-4mm (varies) *

Subcutaneous tissue *

Hair follicles *



Burn Depth

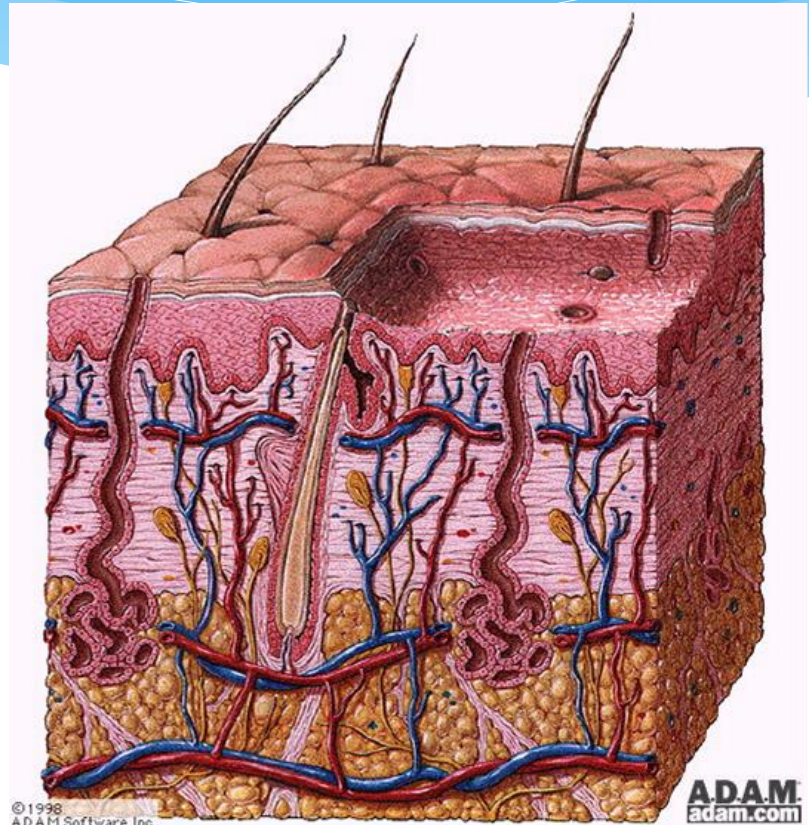
First-degree *

Minor epithelial damage *

Redness *

Tenderness *

No blistering *



Burn Depth

Second-degree

Partial-thickness *

Epidermis/superficial
dermis *

Pink, moist and tender *

Very tender *

Heals in 2-3 weeks *

No scarring *

Deep-partial thickness *

Deep dermal injury *

Red and blanched white *

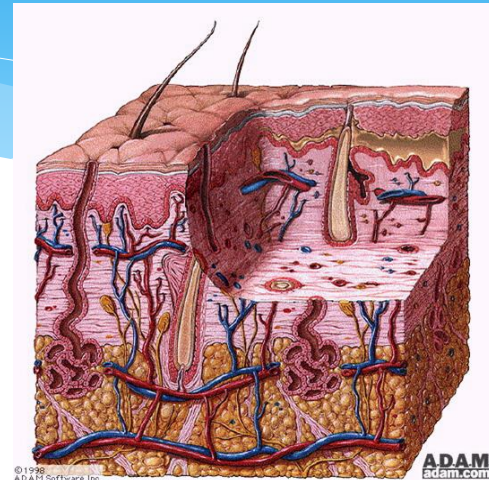
Capillary refill slow *

Blisters *

Heals in 3-6 weeks *

Scarring present *

Contractions may occur *



Burn Depth

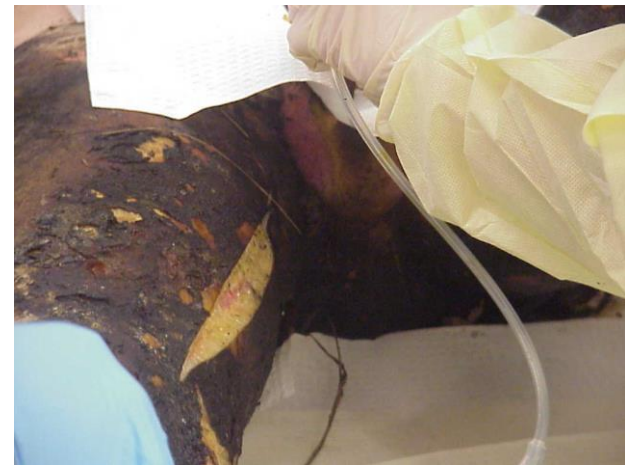
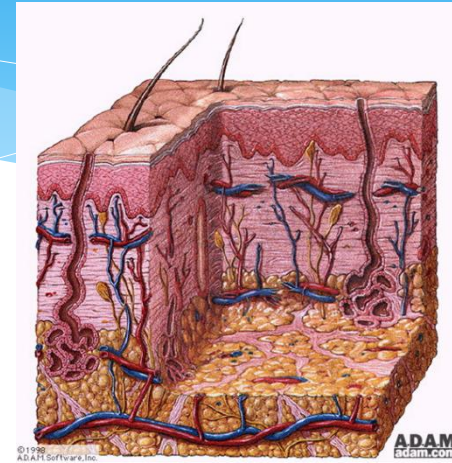
Third-degree *

Usually result of *

- immersion scalds, flame burns, chemical and high-voltage electrical injuries

Full thickness *

- Destroys *
- epidermis/dermis
- Capillary network *
- Skin white/leathery *



Burn Depth

Fourth-degree *

Full-thickness destruction *
of skin/subcutaneous
tissue

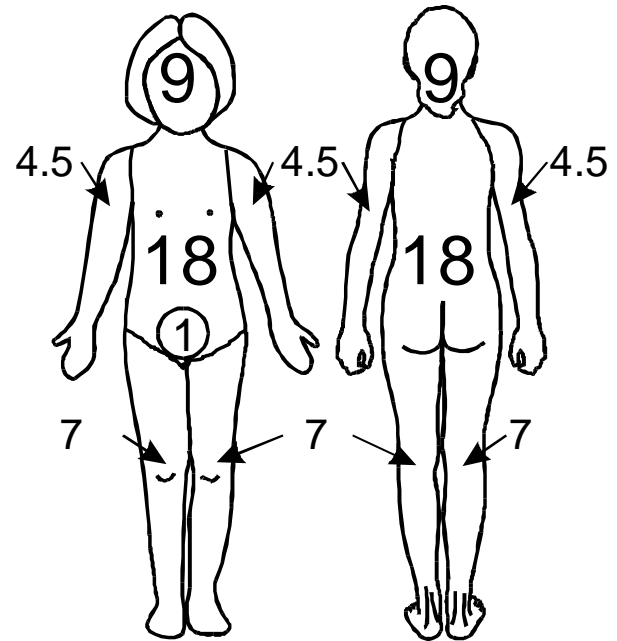
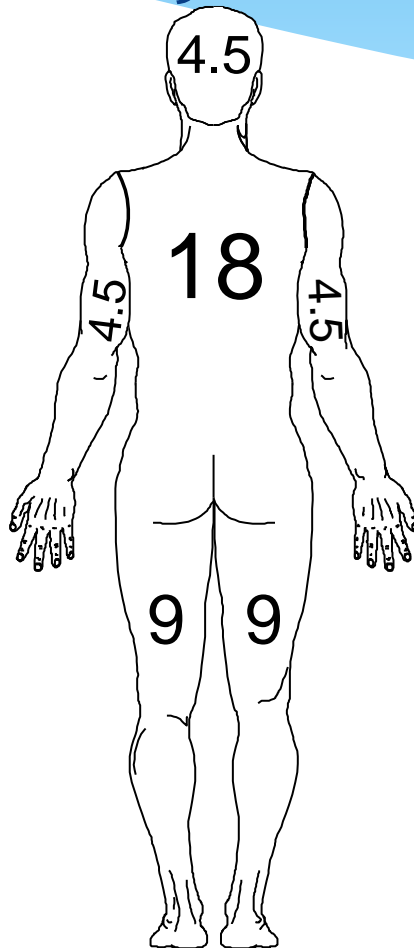
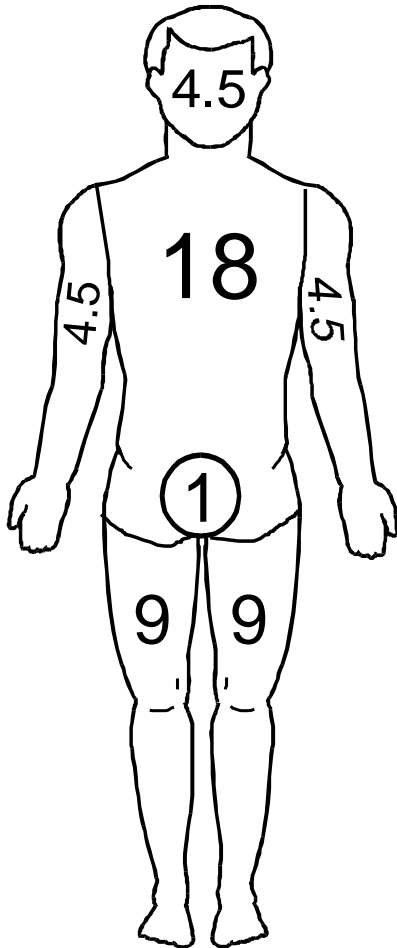
Involves underlying *
fascia, muscle, bone or
other structures

Prolonged disability *



Burn Size

Rule of 9's *



Minor Burn Injury

Less than 15% of TBSA in adults *

Less than 10% of TBSA in children or older population *

Less than 2% full thickness burn *

No functional loss to: *

Eyes *

Ears *

Face *

Hands/feet *

Perineum *

Moderate Burn Injury

Partial-thickness of 15-25% TBSA in adults *

10-20% TBSA in children or older person *

Full thickness of 2-10% TBSA *

No loss of function to: *

Eyes, ears, face, hands, feet or perineum *

Excludes: *

High-voltage electrical burns *

Inhalation injury *

Requires hospitalization *

Major Burn Injury

- Partial thickness burns > 25% of TBSA in adults *
- 20% of TBSA in children/older persons *
- Full-thickness of 10% of TBSA *
- Involving: *
- Face, eyes, ears, hands, feet *
or perineum
- Burns caused by: *
- Caustic agents *
- High-voltage electrical *
- Complicated inhalation injuries *
- Requires specialized care *



Treatment

Scene safety *

Airway/Breathing *

3 components *

Upper airway swelling *

Edema occurs within 12-24 hours *

Early intubation indicated *

Look for stridor, wheezing, grunting *

Acute respiratory failure *

Carbon monoxide intoxication *

100% O₂ *

Decreases CO half life *

Closed Space Injury

Inhalation Injury *

Cyanide poisoning *

Early intubation *

100% Oxygen *

Sodium Thiosulfate *

Symptomatic (unconscious/lethargic) *

Adults *

50cc of 25% solution *

Children (under 12 years) *

30cc of 25% solution *

Fluid Resuscitation

Influenced by percent of TBSA *

Restores plasma volume *

Avoids microvascular ischemia *

Maintains vital organ function *

Amount varies with age, body weight and TBSA *

Significant burns *

Lactated Ringers or .9% NS *

Adults → 500 cc/hr *

Children (5-15 yrs) → 250 cc/hr *

Children (< 5 yrs) not recommended to initiate IV *

Per Advanced Burn Life Support Protocol *

Parkland Formula *

Parkland Formula

Initial fluid resuscitation in first 24 hours *

Lactated Ringers or 0.9% NS *

4cc/kg/TBSA over 24 hours *

i.e., $4/70/50=14,000$ cc in 24 hours *

Half within first 8 hours *

Begins when burn occurs *

May need to play “catch up” *

Remainder within next 16 hours *

Children *

Greater fluid requirements *

Include maintenance rate *

Escharotomy

Circumferential full *
thickness burns

Chest *

Arms *

Legs *

Medial/Lateral incision *
thru burned skin



Airway considerations

Maintain low threshold for intubation and high index of suspicion for airway injury *

**Prior to intubation attempt: *
have smaller sizes of ETT available**

Swelling is rapid and progressive first 24 hours *

**Prepare for cricothyrotomy *
for tracheostomy**

Consider RSI to facilitate intubation – cautious use of succinylcholine hours after burn due to K⁺ increase *

**Utilize ETCO₂ monitoring – *
pulse oximetry may be inaccurate or difficult to apply to patient.**

Airway considerations

Upper airway injury (above the glottis): Area *
buffers the heat of smoke – thermal injury is usually confined to the larynx and upper trachea.

Lower airway/alveolar injury (below the glottis): *

- Caused by the inhalation of steam or chemical smoke.
- Presents as ARDS often after 24-72 hours

Criteria for intubation

- Changes in voice *
- Wheezing / labored respirations *
- Excessive, continuous coughing *
- Altered mental status *
- Carbonaceous sputum *
- Singed facial or nasal hairs *
- Facial burns *
- Oro-pharyngeal edema / stridor *
- Assume inhalation injury *
in any patient confined in a fire environment
- Extensive burns of the face / neck *
- Eyes swollen shut *
- Burns of 50% TBSA or greater *

Pediatric intubation

Normally have smaller airways than adults *

Small margin for error *

If intubation is required, an uncuffed ETT should be placed *

Intubation should be performed by experienced individual – failed attempts can create edema and further obstruct the airway *

$$+ 4 = \text{ETT size} \quad \frac{\text{AGE}}{4}$$

Ventilatory therapies

- Rapid Sequence Intubation *
- Pain Management, Sedation and Paralysis *
- PEEP *
- High concentration oxygen *
- Avoid barotrauma *
- Hyperbaric oxygen *

Ventilatory therapies

Burn patients with ARDS requiring *
PEEP > 14 cm for adequate ventilation should receive
prophylactic tube thoracostomy.

Circumferential burns of the chest

Eschar - burned, *
inflexible, necrotic tissue

Compromises ventilatory *
motion

Escharotomy may be *
necessary

Performed through non- *
sensitive, full-thickness
eschar



Carbon Monoxide Intoxication

Carbon monoxide has a binding affinity for hemoglobin which is 210-240 times greater than that of oxygen.

Results in decreased oxygen delivery to tissues, leading to cerebral and myocardial hypoxia.

Cardiac arrhythmias are the most common fatal occurrence.

Signs and Symptoms of Carbon Monoxide Intoxication

- Confused, irritable, *
restless
- Headache *
- Tachycardia, arrhythmias *
or infarction
- Vomiting / incontinence *
- Dilated pupils *
- Bounding pulse *
- Pale or cyanotic *
complexion
- Seizures *
- Overall cherry red color – *
rarely seen

Signs and Symptoms of Carbon Monoxide Intoxication

Usually symptoms not present until 15% of the hemoglobin is bound to carbon monoxide rather than to oxygen. *

Early symptoms are neurological in nature due to impairment in cerebral oxygenation *

Carboxyhemoglobin Levels/Symptoms

0 – 5	Normal value
15 – 20	Headache, confusion
20 – 40	Disorientation, fatigue, nausea, visual changes
40 - 60	Hallucinations, coma, shock state, combativeness
> 60	Mortality > 50%

Management of Carbon Monoxide Intoxication

Remove patient from source of exposure. *

Administer 100% high flow oxygen *

Half life of Carboxyhemoglobin in patients:

120-200 minutes Breathing room air *

30 minutes Breathing 100% O₂ *

Initial Airway Management

- Evaluate, and ensure airway patency *
- Determine the need for an artificial airway *
- intact airway reflexes? *
- risk factors for airway burns/edema? *
- Perioral burns, carbonaceous sputum subjective dysphagia, *
hoarseness or changes in phonation
- erythema to edema transition may be rapid *
- Ensure adequate air exchange, thoracic excursion *
- with tidal breaths

Breathing Assessment/Support

Ensure adequate oxygenation *

ABG with carboxyhemoglobin level preferred *

humidified 100% FiO₂ empirically *

Assess for possible inhalation injury *

history of an enclosed space, carbonaceous sputum, *

respiratory symptoms, altered LOC

younger children at greater risk *

NMB for intubation: avoid succinylcholine *

Breathing Assessment/Support

NG tube placement *

thoracic decompression; reduce aspiration risk *

Ventilatory support recommended for circulatory *
insufficiency, or GCS<8

decreased airway protective reflexes *

risk of inhalation injury/CO exposure *

risk of concomitant injury/trauma requiring *
evaluation/support

Airway compromise?
Respiratory distress?
Circulatory compromise?

Yes

No

Intubation, 100% O₂
IV access, fluids

Multiple trauma?

Yes

No

Evaluate &
treat injuries

Burns >15%, or
complicated burns?

No

Yes

Circumferential full
thickness burns?

IV access; fluid
replacement

Yes

No

Escharotomy

Burn care, tetanus prophylaxis, analgesia

Electrical Injuries

Frequency *

20,000 emergency *
department visits annually

1000 deaths per year *

Low voltage (60%) *

Children account for 20% of *
all low voltage injuries

Lightning *

Not a reportable injury *

300 – several thousand *
injuries per year

100 – 600 deaths per *
year



Electrical Injuries

Mortality/Morbidity *

Lightning fatality rate of 25-30% *

75% have permanent sequelae *

Cataracts *

Ruptured tympanic membrane *

Peripheral nerve damage *

Low voltage *

Low morbidity/mortality *

Increases as voltage increases *

Wet skin *

Decreases resistance *

Electrical Injuries

AC injuries *

3 times higher *
mortality/morbidity than
DC

Hand-to-hand current *

60% Mortality rate *

V. Fib 3 times more likely *

Foot-to-foot *

5% mortality *



Electrical Injuries

More common in males *

Toddlers *

Low voltage *

Older children/adolescents *

High voltage *

Unintentional *

History

Detailed history vital *

Current *

Low voltage *

120 – 440 V *

High voltage *

440 – 1000 V *

High-tension *

> 1000 V *

Type of current *

Alternating current (AC) *

Direct current (DC) *

History - continued

- Path of current *
- Hand-to-hand *
- Hand-to-foot *
- Foot-to-foot *
- Length on contact *
- Tetany *
- Lock-on phenomenon *
- Associated events *
- Fall *
- Burns *
- Water contact *

Pathophysiology

Follows path of least resistance towards ground *

Skin a resistor *

Skin *

Resistance of 25,000 ohms *

Wet skin *

Resistance of 1500 ohms *

Calloused skin *

Resistance of 2,000,000 ohms *

Types of Electrical Burns

Household current *

110 V *

Stimulates muscle into tetany *

Alternating current (AC) produces *

Three times more dangerous than DC at same voltage *

Tetany *

Locked-on phenomenon *

Increases injury *

Direct current (DC) produces: *

Large muscular contraction *

Throws patient *

May result in blunt trauma *

Electrical Burns-continued

Arc injury *

Patient part of arc *
between 2 objects

Most serious *

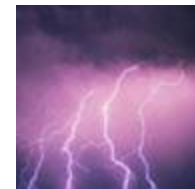
Temperatures may *
exceed 4532° F

Lightning *

DC of 2000 to *

2 billion V

Short duration *



Electrical Injuries

Disrupts body's electrical activities *

Neurological system *

Most commonly affected *

Maybe temporary *

Numbness/tingling *

Loss of consciousness *

Amnesia *

Coma *

Spinal cord involvement *

Transverse myelitis (poor prognosis) *

Cardiac Injuries

25% have cardiac *
dysrhythmia's

Maybe benign *

Sudden death *

V. Fib *

Arm-to-arm *

3 times more likely *

Asystole *

AMI *

Rare *



Lightning Injuries

Cardiac Arrest *

Asystole *

Massive depolarization leads to asystole *

Heart's automaticity usually restarts *

Apnea *

Massive depolarization of brain *

Stuns respiratory center *

Longer duration *

Provide ALS *

Survivability increases *

Thermal Injuries

Higher voltage *

Higher temperatures *

High voltage *

Devastating injuries *

Lightning *

Very little burns *

Short duration *

Vascular Injuries

Result of vascular spasm *

Coagulation *

Vascular occlusion *

Compartment Syndrome

Acute ischemic insult *

Rhabdomyolysis *



Renal Injuries

Occur due to: *

Rhabdomyolysis *

Myoglobinuria *

Due to release of *
myoglobin

Acute Renal Failure (ARF) *

Myoglobin *
crystallization



Physical Exam

Scene safety *

“Triage the Dead” *

ABC’s *

Neuro Exam *

Environmental factors *

Hypothermia *

Remove wet/burned clothing *

Extremities *

Fractures *

Injury due to: *

Tetany *

Falls *

Explosion *



Skin *

Burns *

Can be varying *

Flash burns *

High voltage *

External vs. internal injury *



Lightning *

Intense impulse *

Thermal burns *

Uncommon, unless clothing burned *

Feathering/ferning *

Electron shower *

Cutaneous markings *

Not a true burn *

Arc burns *

Significant internal energy *

Treatment

Scene safety *

“Triage the Dead” *

Airway *

Usually unaffected *

Unless direct injury *

Breathing *

Maintain adequate ventilation *

Central apnea *

Lightning strike *