Burns

Primary Care Paramedicine

Module: 14

Section: 02c

Lecture Outline

- Introduction
- Pathophysiology
- Assessment of thermal burns
- Management of thermal burns
- Electrical burns
- Chemical burns

Introduction

- More than 200 000 Canadians seen each year for burn injuries
- 3-5% are considered life threatening
  - Smoke inhalation is the most common cause of death
- Incidence has declined
  - Improved building codes
  - Safer construction techniques
  - Smoke detectors

Pathophysiology

- Understanding the pathophysiology of a burn injury is important for effective management
- Different causes lead to different patterns which require different management
- Therefore it is important to understand how a burn is caused and what kind of physiological response it will induce.

Pathophysiology

- Burns are diffuse soft-tissue injuries created by destructive energy transfer.
- Transferred via radiation, thermal, or electrical energy
- Temperatures higher than 44°C cause burns.
- Severity correlates directly with the amount of heat energy and duration of exposure.

Pathophysiology

Body tissues change chemically

- Evaporating water
- Denaturing proteins
- Widespread damage to skin

Consequences

- Fluid loss
- Infection
- Hypothermia

Burns

TYPES OF BURNS

Types of Burns

- Damage processes vary with different mechanisms
  - Thermal
  - Electrical
  - Chemical
  - Radiation

Types of Burns

THERMAL BURNS

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Body's Response to Burns

- The local and systemic inflammatory response to thermal injury is extremely complex
- Results in both local burn tissue damage and deleterious systemic effects on all other organ systems distant from the burn area itself.
- Although the inflammation is initiated almost immediately after the burn injury, the systemic response progresses with time, usually peaking 5 to 7 days after the burn injury
- Much of the local and certainly the majority of the distant changes are caused by inflammatory mediators

Body's Response to Burns

Local

- Jackson's Theory of Thermal

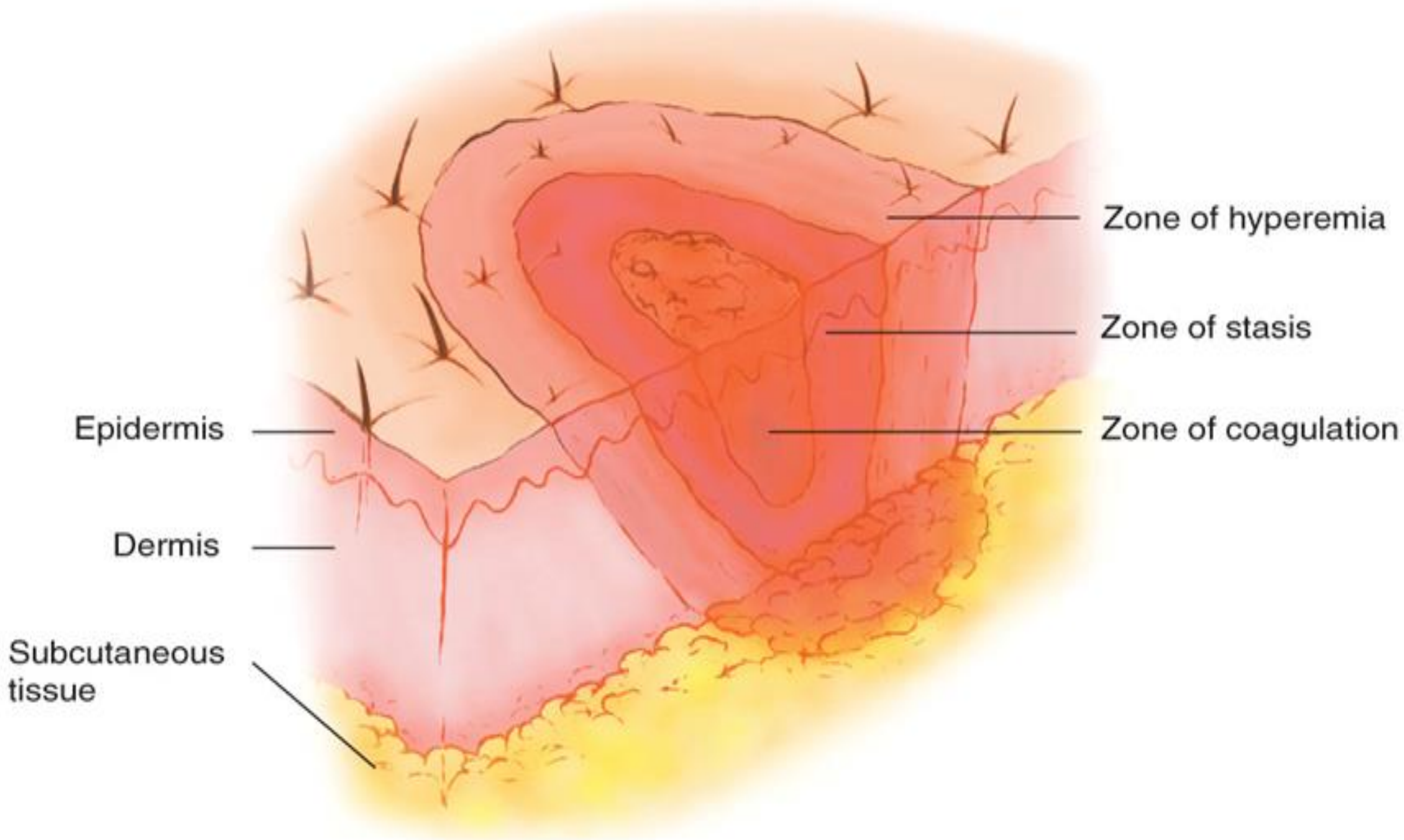
Systemic

- The release of cytokines and other inflammatory mediators at the site of injury has a systemic effect once the burn reaches 30% of total body surface area.
  - Cardiovascular
  - Pulmonary
  - Renal
  - GI
  - Immune

Thermal Burns

- Heat changes the molecular structure of tissue
  - Denaturing (of proteins)
  - Cell membranes break down
- Extent of burn damage depends on
  - Temperature of agent
  - Concentration of heat
  - Duration of contact

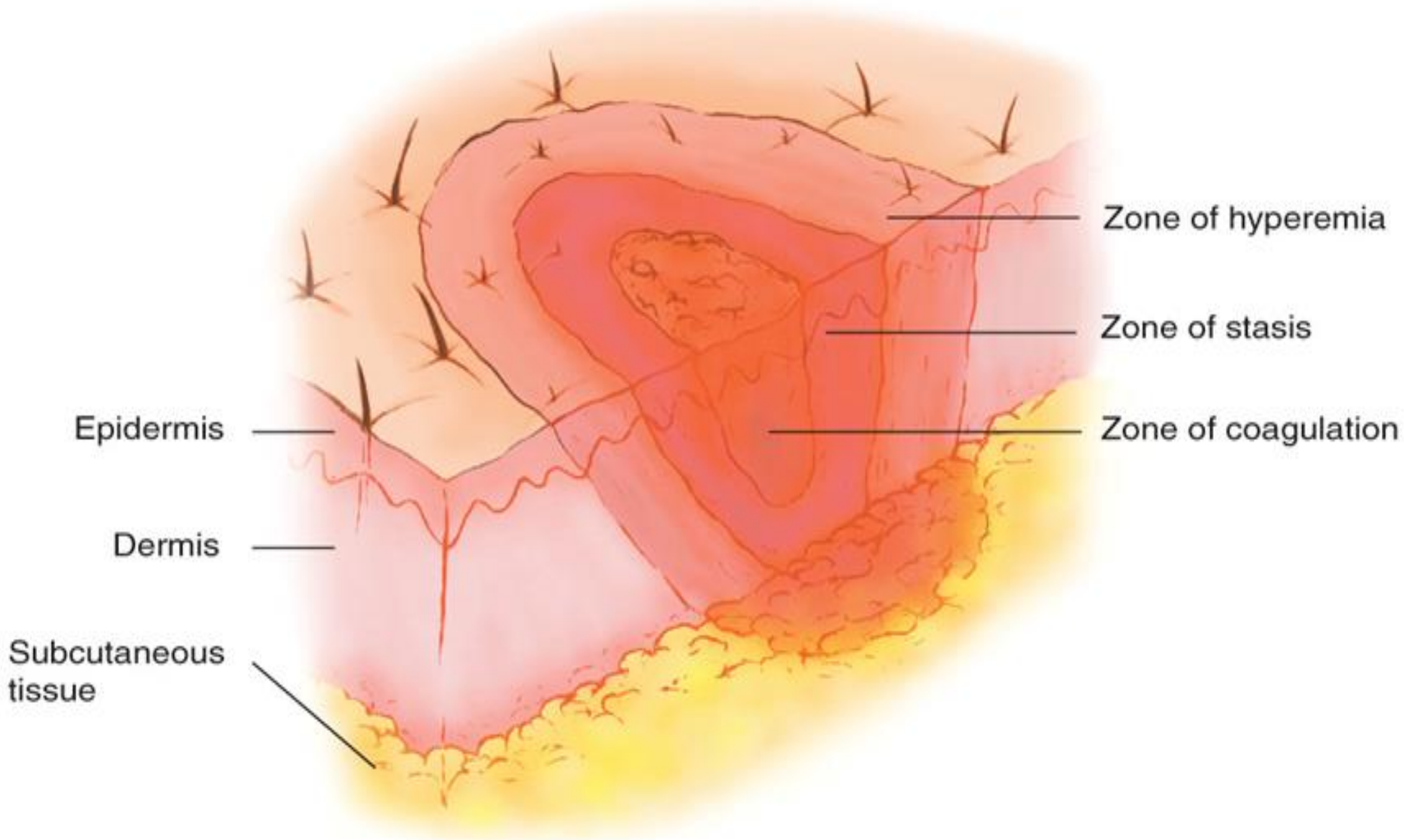
Jackson's Theory of Thermal Wounds



Zone of Coagulation

- Area in a burn nearest the heat source
- Suffers the most damage as evidenced by clotted blood and thrombosed blood vessels

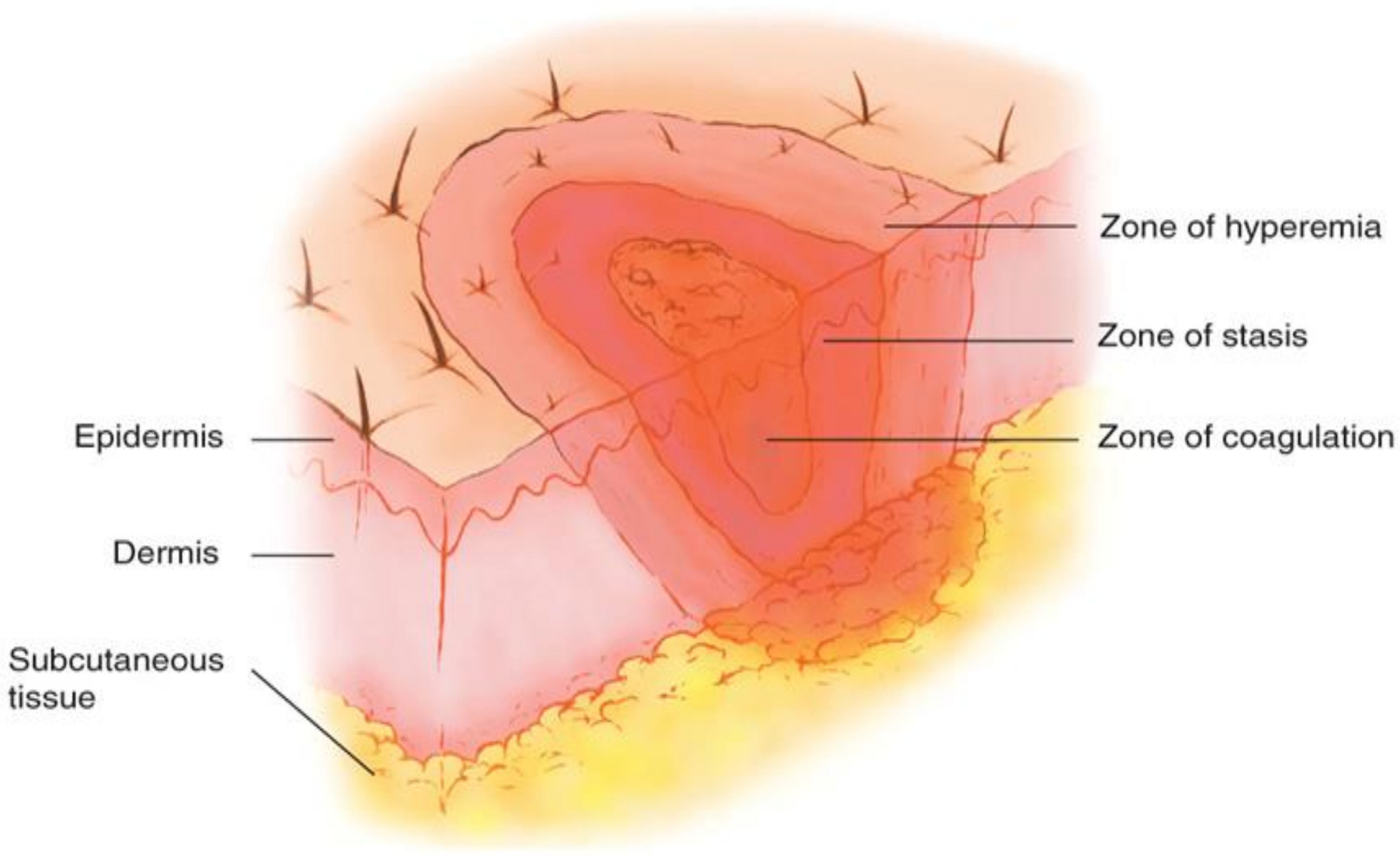
Jackson's Theory of Thermal Wounds



Zone of Stasis

- Area surrounding zone of coagulation
- Characterized by decreased blood flow

Jackson's Theory of Thermal Wounds



Zone of Hyperemia

- Peripheral area around burn that has an increased blood flow

Body’s Response to Burns

Emergent → Fluid Shift → Hypermetabolic → Resolution

- Emergent phase (stage 1)
  - Pain response
  - Catecholamine release
    - Tachycardia, tachypnea, mild hypertension, mild anxiety

Body’s Response to Burns

Emergent → Fluid Shift → Hypermetabolic → Resolution

- Fluid shift phase (stage 2)
  - Length 18 - 24 hours
  - Begins after emergent phase
    - Reaches peak in 6 - 8 hours
  - Damaged cells initiate inflammatory response
    - Increased blood flow to cells
    - Shift of fluid from intravascular to extravascular space
      - Massive edema

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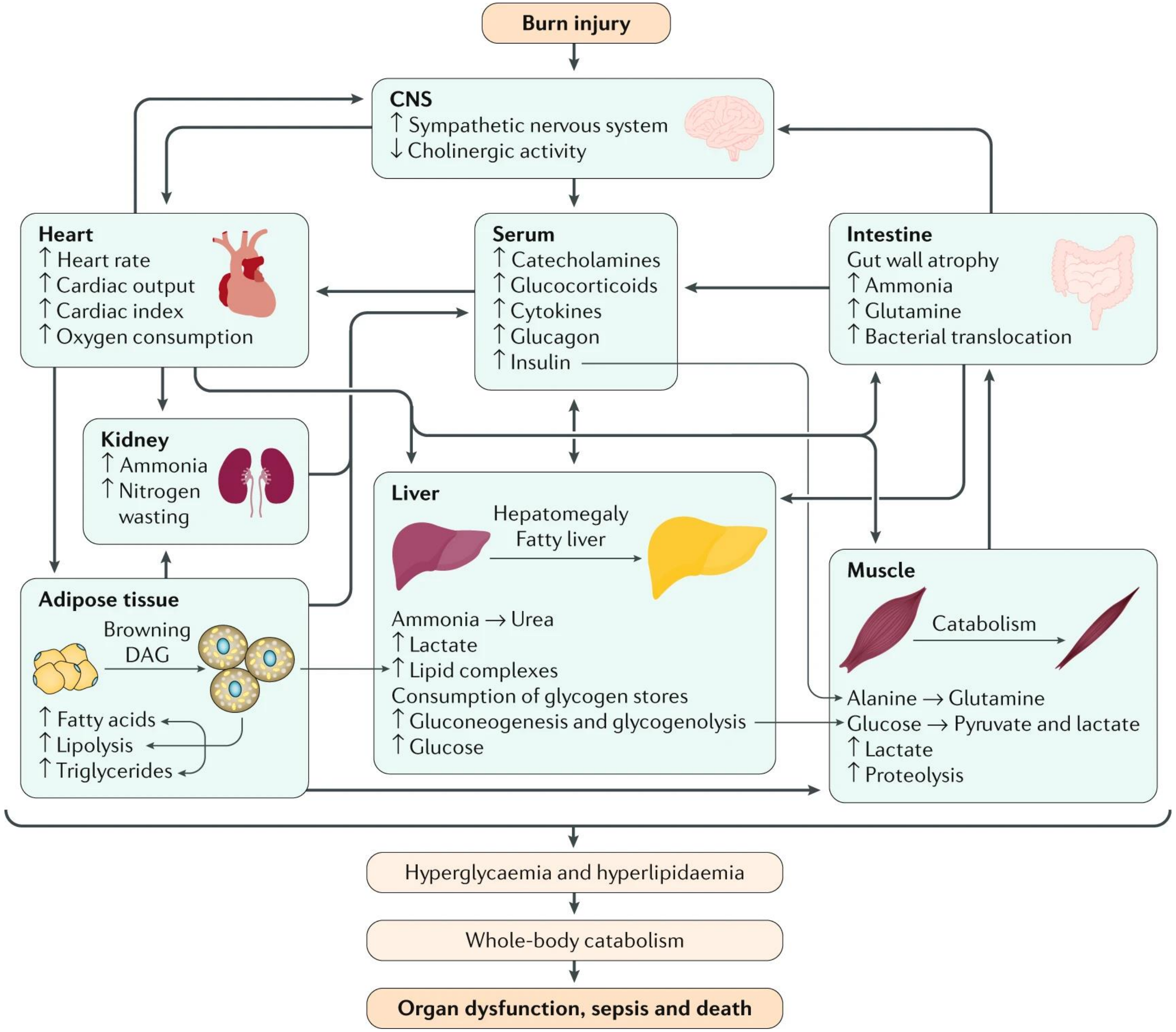
Body's Response to Burns

Emergent → Fluid Shift → Hypermetabolic → Resolution

- Hypermetabolic phase (stage 3)
  - Last for days to weeks or months
  - Large increase in the body's need for nutrients as it repairs itself

Hypermetabolic State



Body's Response to Burns

Emergent → Fluid Shift → Hypermetabolic → Resolution

- Resolution phase (stage 4)
  - Scar formation
  - General rehabilitation and progression to normal function

Systemic Responses to Burn Injury

Cardiovascular system	Renal System	Respiratory System	GI System
Acute (hypovolemia) phase: • ↓ blood flow • ↓ cardiac output • capillary permeability • peripheral vascular resistance	Acute (hypovolemia) phase: • ↓ renal blood flow • ↓ GFR	• hypoxemia • pulmonary hypertension • airway resistance • ↓ pulmonary compliance	• adynamic ileus • gastric dilatation • delay in gastric emptying • gastrointestinal hemorrhage • gastric secretions • ulcer incidence • ↓ intestinal & colonic motility • ↓ mesenteric blood flow • ↓ nutrient absorption • bacterial translocation • hepatic injury
Hypermetabolic phase: • blood flow • edema formation • cardiac arrhythmias • myocardial infarction • myocardial dysfunction/cardiac instability (end-diastolic volume and ↓ right ventricular ejection fraction)	Hypermetabolic phase: • renal blood flow • GFR • impaired tubular functions • acute renal failure		

Types of Burns

ELECTRICAL BURNS

Electrical Burns: Terminology

- Voltage
  - Difference in electrical potential between two points
  - Different concentrations of electrons
- Current
  - Rate or amount of electron flow
  - Measured in amperes
- Resistance
  - Opposition to electrical flow
  - Measured in ohms

Ohm’s Law

- Current is:
  - Directly proportional to the voltage
  - Inversely proportional to the resistance
    - V: Voltage (volts)
    - R: Resistance (ohms)
    - I: Current (amperes)

$$V = IR$$

$$I = \frac{V}{R}$$

Joules Law

- The rate of heat production is
  - Directly proportional to the resistance
  - Directly proportional to the square of the current

$$P = I^2 R$$

  - P: Power
- Skin is resistant to electrical flow

Electrical Burns

- Greatest heat occurs at the points of resistance
  - Entrance and exit wounds
  - Wet skin offers less resistance
- Longer the contact, the greater the potential of injury
- Smaller the point of contact, the more concentrated the energy, the greater the injury

Injuries Due to Electrical Shock

a. Entrance wound

b. Exit wound

Electrical Burns

- Current flow
  - Tends to follow blood vessels and nerves
  - Offer less resistance
  - Muscle and bone tend to create heat
- Effects
  - Serious vascular and nerve injury
  - Interferes with muscular control
  - Release of toxins from tissue
  - Flash burns

Electricity-Related Nonburn Injuries

- Asphyxia
- Cardiac arrest
- Neurologic complications (seizures, delirium, confusion, coma, and temporary quadriplegia)
- Kidney damage
- Severe tetanic muscle spasms may lead to fractures and dislocations.

Lightning Injuries

- Lightning kills an average of 9 or 10 Canadians each year.
- Most victims are not struck directly.
- Prevention is a priority.
  - Do not be the tallest object that is a good conductor.
  - Do not stand under or near the tallest object that is a good conductor.
  - Take shelter in a substantial structure.
  - Avoid touching good conductors during a lightning storm.
- Lightning carries enormous electrical power: 100 million volts / 200,000 amps
- A lightning burn may have a feathery or zigzag appearance.

Types of Burns

CHEMICAL BURNS

Chemical Burns

- Denature the biochemical makeup of cell membranes and destroy cells
- Not transmitted through tissue
  - Generally tend to be self-limiting
- Most common types
  - Acid burns
  - Alkali burns

Chemical Burns

Table 23-1 Chemical Burns

Chemical Type	Examples	Injury
Acids	Battery acid (sulfuric acid), hydrochloric acid, hydrofluoric acid	Causes immediate pain and coagulation necrosis; deeper tissue typically not injured
Bases and alkalis	Potassium hydroxide, sodium hydroxide, lime, drain cleaner, oven cleaner, lye	Causes little pain but extensive damage by liquefaction necrosis: breakdown of protein and collagen, saponification of fats, dehydration of tissues, thrombosis of blood vessels
Oxidizing agents	Hydrogen peroxide, sodium chlorate	Exothermic (heat) reaction in addition to tissue destruction; could cause systemic poisoning
Phosphorous	White phosphorous, tracer ammunition, fireworks	Burns when exposed to air; could cause systemic poisoning
Vesicants	Lewisite, sulphur mustard (mustard gas), phosgene oxime	Blister agents; respiratory compromise if inhaled

- Mechanisms
  - Reduction
  - Oxidation
  - Corrosion
  - Protoplasmic poisons
  - Desecration
  - Vesication

Chemical Burns

Burns

ASSESSMENT

General Assessment of Burns

- Chief complaint may be “I’m terribly cold.”
- Severity of injuries may not become apparent until you complete your assessment.
- Seriously burned patients may need to be transferred from tertiary facilities to larger burn centres.
- Patient may have an escharotomy, a surgical cut through the eschar (burned tissue) to allow swelling.
- The many types of burns can challenge your assessment skills.

Scene Assessment

- Rescue requires training and equipment.
- Safety is the primary concern.
- For a recently burned patient:
  - Extinguish the flame and cool the burn
  - Stop, drop, and roll
  - Remove smouldering clothing
  - Determine the mechanism of injury
- Wear the most appropriate personal protective equipment.

Assessment

- All burns should be treated as a trauma and hence require a focused and rapid trauma assessment as well as:
  - Assess for possible airway involvement
  - Determine if hot air or gases inhaled
  - Expose the entire body surface
  - Determine the time of injury
  - Determine the type of burn
  - Location (closed space, traumatic forces involved, explosions)
  - Cardiac monitoring (especially with electrical burns) should be initiated

Assessment

- Primary survey
  - Patients progress rapidly from mild dyspnea to respiratory failure
  - Anticipate and take definitive action early
  - Anticipate high index of suspicion for c-spine injuries if there was a blast or electrical injury (consider immobilization)
  - Assess airway for compromise and treat with oxygen (consider advanced airway support if necessary)

Inhalation Injury

- Burn environment frequently produces inhalation injury
  - Especially unconscious patients or in an enclosed space
- Patient inhales gases, heated air, flames or steam
- Result in airway and respiratory injuries

Toxic Inhalation

- Synthetic resins and plastics release toxic gases as they burn
- Combustion forms toxic agents
  - Cyanide compounds
  - Hydrogen sulphide compounds
- Effects
  - Gases react with lung tissue causing chemical burns
  - Gases diffuse across alveolar membranes causing systemic poisoning

Carbon Monoxide

- Colorless, odorless, tasteless gas
- Byproduct of incomplete combustion of carbon products
  - Suspect with faulty heating unit
- 200 X greater affinity for hemoglobin than oxygen
  - Hypoxemia
  - Hypercarbia

Airway Thermal Burn

- Supraglottic structures absorb heat and prevent lower airway burns
- Moist mucosa lining the upper airway
- Injury is common from superheated steam
- Risk Factors
  - Standing in the burn environment
  - Screaming or yelling in the burn environment
  - Trapped in a closed burn environment

Airway Thermal Burn

- Symptoms
  - Stridor or “Crowing” inspiratory sounds
  - Singed facial and nasal hair
  - Black sputum or facial burns
  - Progressive respiratory obstruction and arrest due to swelling

Airway Thermal Burn

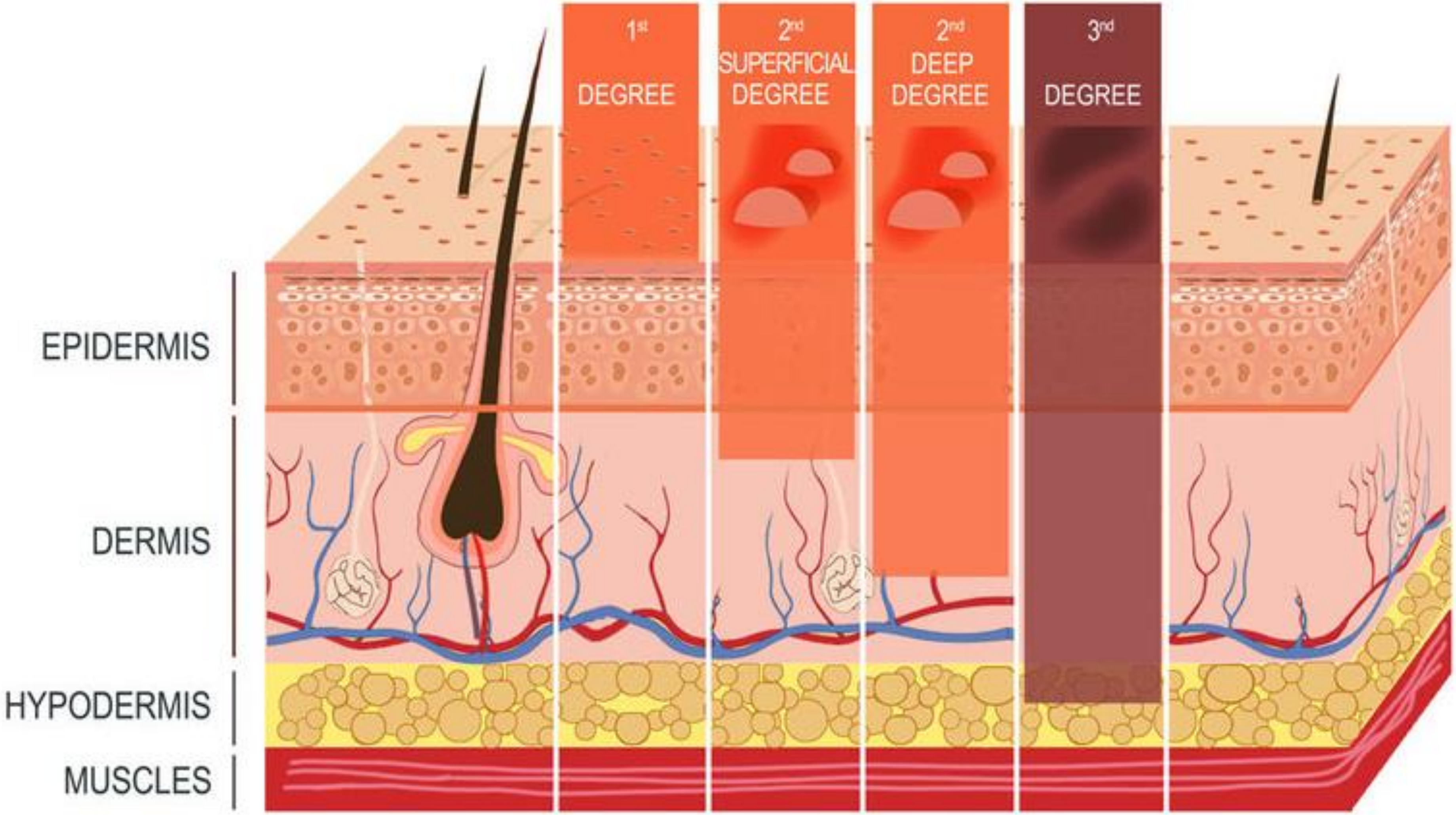
Airway Thermal Burn

- Facial burns or carbonaceous material around the mouth and nose suggest the possibility of chemical and thermal burns to the airway.

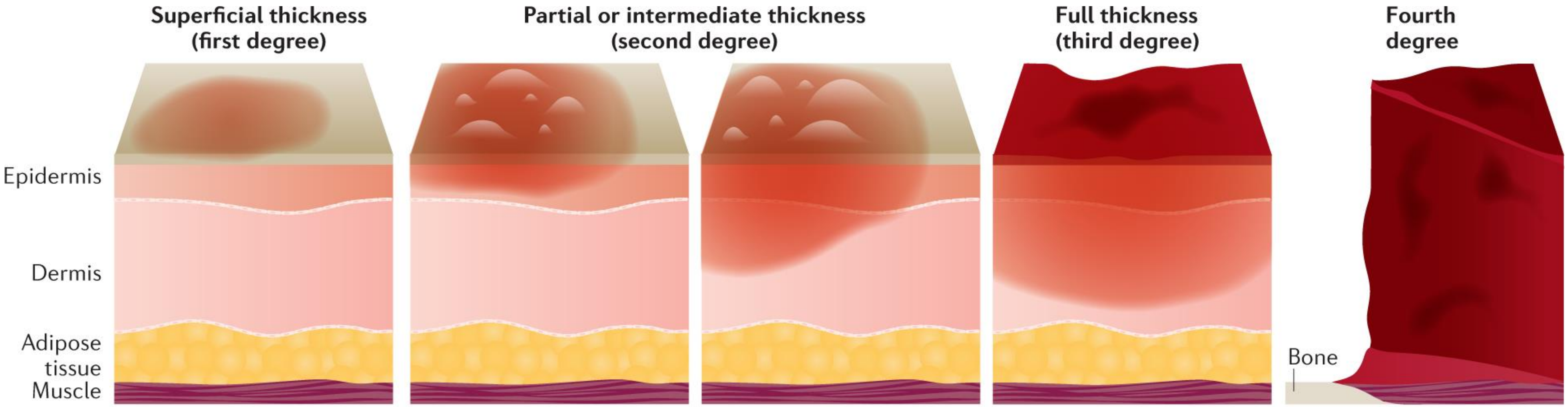
Depth of Burn

- The severity of the burn and subsequent management depends on the burn depth:
  - Superficial
  - Partial-thickness
  - Full-thickness

Depth of Burn



Depth of Burn



Superficial thickness (first degree)

- Painful
- Does not blister
- Does not scar

Partial or intermediate thickness (second degree)

Superficial partial thickness burns do not require surgery, but may scar and be more painful

Deep partial thickness burns require surgery and form more scars and are less painful

- Blisters and weeps
- With increasing depth, increased risk of infection
- With increasing depth, increased risk of scarring

Full thickness (third degree)

- Dry
- Insensate to light touch and pin prick
- Small areas will heal with substantial scar or contracture
- Large areas require skin grafting
- High risk of infection

Fourth degree

- Involves muscle or bone
- Leads to loss of the burned part

Table 21-1 Characteristics of Various Depths of Burns

	Superficial (First-Degree)	Partial Thickness (Second-Degree)	Full Thickness (Third-Degree)
Cause	Sun or minor flame	Hot liquids, flame	Chemicals, electricity, hot metals, flame
Skin colour	Red	Mottled red	Pearly white and/or charred, translucent, and parchment-like
Skin	Dry with no blister	Blisters with weeping	Dry with thrombosed blood vessels
Sensation	Painful	Painful	Anesthetic
Healing	3–6 days	2–4 weeks	May require skin grafting

Superficial
1st Degree Burns

Partial Thickness
2^{nd} Degree Burns

Full Thickness
3rd Degree Burns

Extent and Severity of Burn

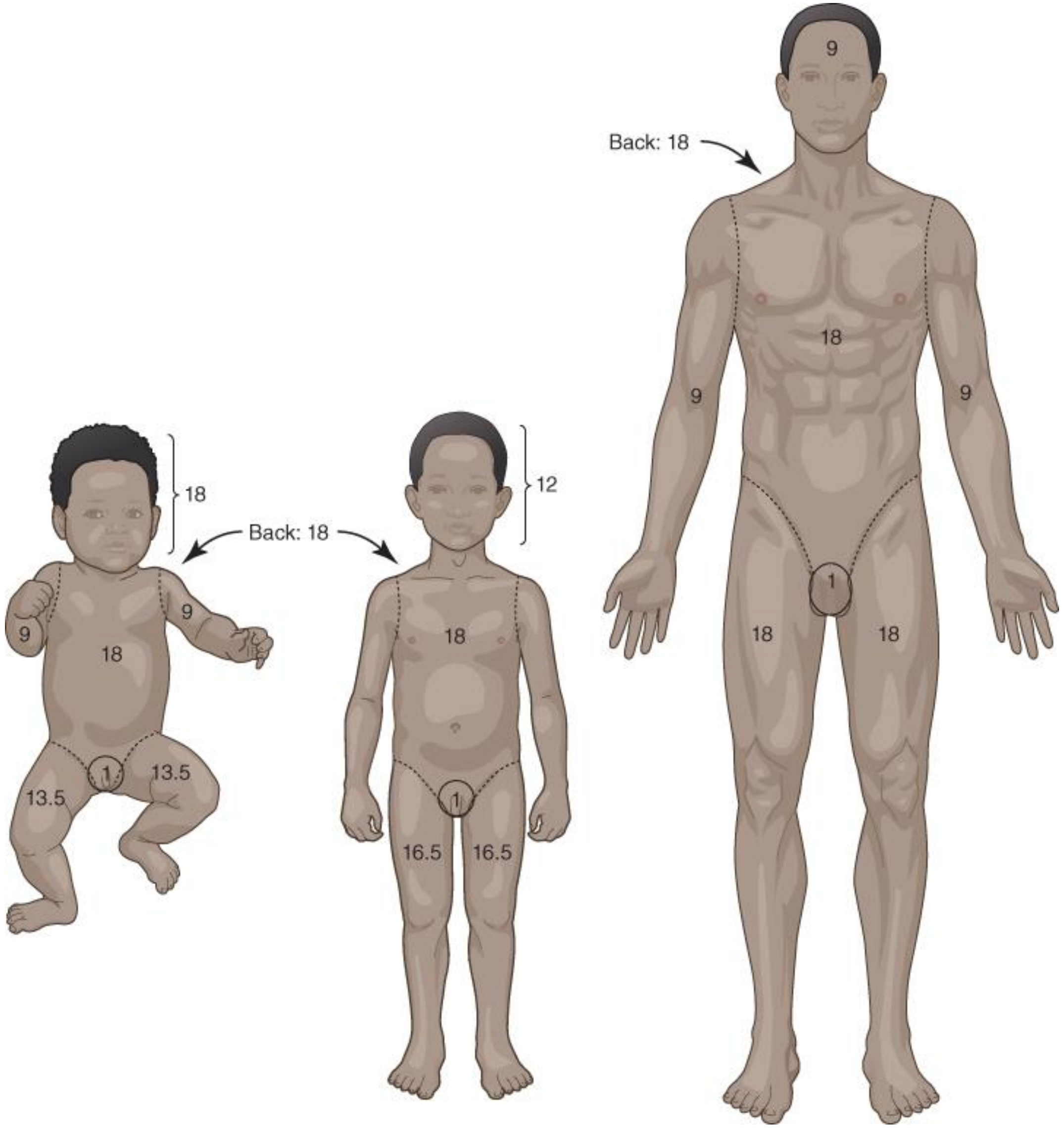
- Determine the body surface area (BSA) affected
- Calculated by assessing the amount of 2^{nd} and 3^{rd} degree burns (does not include 1^{st} degree burns)
- Multiple methods to calculate area burned
  - Rule of nines
  - Palmar surface method
  - Lund and Browder chart
  - Special concerns
    - Hands, feet, genitalia, circumferential burns

Rule of Nines

- Identifies 11 topographical areas of the body
- Approximates 9% of body surface each
- Best used for large surface areas
- Adapted for pediatrics

Surface Area

- Total body surface area (TBSA)
- Rule of nines
  - Divides body into 11 sections, worth 9% each
  - Final 1% is genitalia
  - Rule varies for infants and small children.



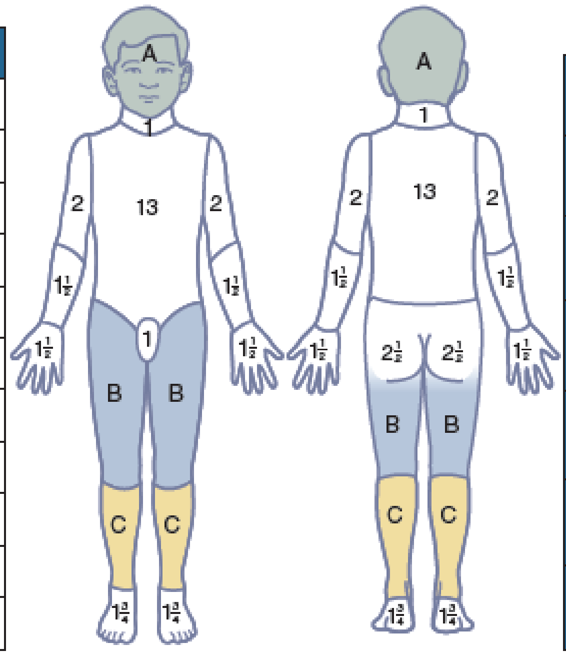
Palmar Method

- Palmer surface (hand and fingers) of the patient’s hand is approximately 1% of their body surface
- Guesstimating the number of palms that would cover the burn estimates the BSA
- Easier for small burns of up to 10%

Lund and Browder Chart

- A complex but accurate method of calculating BSA
- Compensates for changes in body shape and size
- Best method for pediatrics

Region	%
Head	
Neck	
Ant. Trunk	
Post. Trunk	
Right arm	
Left arm	
Buttocks	
Genitalia	
Right leg	
Left leg	
Total burn	



Relative percentages of body surface area affected by growth

Age (years)	A ($\frac{1}{2}$ of head)	B ($\frac{1}{2}$ of one thigh)	C ($\frac{1}{2}$ of one leg)
0	$9\frac{1}{2}$	$2\frac{3}{4}$	$2\frac{1}{2}$
1	$8\frac{1}{2}$	$3\frac{1}{4}$	$2\frac{1}{2}$
5	$6\frac{1}{2}$	4	$2\frac{3}{4}$
10	$5\frac{1}{2}$	$4\frac{1}{4}$	3
15	$4\frac{1}{2}$	$4\frac{1}{2}$	$3\frac{1}{4}$
Adult	$3\frac{1}{2}$	$4\frac{3}{4}$	3

Table 23-2 Classification of Burn Severity

Burn Classification	Criteria

Major burns	▪ Burns involving hands, feet, face, major joints, or genitalia, or circumferential burns of other areas
	▪ Full-thickness burns covering >10% of TBSA
	▪ Partial-thickness burns covering more than:
	  • 25% of TBSA if age 10–50 years
	  • 20% of TBSA if age younger than 10 years or older than 50 years
	▪ Burns associated with respiratory injury (smoke inhalation or inhalation injury)
	▪ Burns complicated by fractures or trauma
	▪ High-voltage electrical burns
	▪ Chemical burns
	▪ Burns on patients younger than 5 years or older than 55 years that would be classified as moderate on young adults

Moderate burns	▪ Full thickness burns involving 2% to 10% of TBSA (excluding hands, feet, face, genitalia, and upper airway)
	▪ Partial thickness burns covering:
	  • 15% to 25% of TBSA if age 10–50 years
	  • 10% to 20% of TBSA if age younger than 10 years or older than 50 years
	▪ Superficial burns covering more than 50% of TBSA
	▪ Low-voltage electrical burns
	▪ Major burn characteristics absent

Minor burns	▪ Full thickness burns covering <2% of TBSA
	▪ Partial thickness burns covering:
	  • <15% of TBSA if age 10–50 years
	  • <10% of TBSA if age younger than 10 years or older than 50 years
	▪ Superficial burns covering <50% of TBSA
	▪ Major burn characteristics absent

Abbreviation: TBSA, total body surface area

Data from: Pappas-Taffer L. Burns. In: Ferri FF, ed. *Ferri's Clinical Advisor*, 2017. Philadelphia, PA: Elsevier; 2017:219-221; and Tintinalli JE, Stapczynski JS, Ma OJ, et al. *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*. 8th ed. McGraw-Hill; 2016.

Table 21-3	Injuries that Benefit from Burn Center Care
	Partial thickness (2^{nd}-degree) burn greater than 15 percent of BSA
	Full thickness (3^{rd}-degree) burn greater than 5 percent BSA
	Significant burns to the face, feet, hands, or perineal area
	High-voltage electrical injuries
	Inhalation injuries
	Chemical burns causing progressive tissue destruction
	Associated significant injuries

Source: American Burn Association.

Focused History and Physical Examination

- Make sure that no other injuries have higher priority for treatment.
- Cover injured eyes with moist, sterile pads.
- Check the neck, chest, and extremities for circumferential burns.
- To the degree possible, get a brief history from the patient.
- Detailed physical examination and ongoing assessment
  - Perform a detailed physical examination en route to the ED.

Assessment of Radiation Burns

- Scene safety is number one priority.
- Contact the hazardous materials response team.
- Assess the patient's mental status and ABCs, and then prioritize the patient's prehospital care.
- Burns over more than 70% of the TBSA are usually fatal.
- Burn and radiation that together affect more than 30% of the TBSA are probably fatal.
- Triage smaller radiation burns as higher priorities.

Burns

MANAGEMENT

Management

- Scene safety is priority
- Assess and manage life-threats
- Stop the burning process
- Cool the burn (but warm the patient)
- Cover the burn
- Provide fluids
- Provide analgesia
- Transport

Safety

- Scene assessment
  - Be wary of entering enclosed space
  - Stop the burning process
  - Consider other mechanisms/injuries
  - Rapid evacuation is scene is unsafe

Safety

- Consider cause of the burn to determine required resources and PPE
  - Fire departments
  - Power companies
  - HazMat teams
- Do not come in contact with any chemical agents
- Seek out MSDS forms for reference with chemical burns if available

Electrical Injuries

- Safety
  - Turn off power
  - Energized lines act as whips
  - Establish a safety zone
- Lightning Strikes
  - High voltage, high current, high energy
  - Lasts fraction of a second
  - No danger of electrical shock to EMS
- Consider reverse triage

Manage Life-Threats

- Remember that the patient may have other injuries besides the burn injury
- These should be suspected (based on MOI) and treated accordingly
  - C-spine considerations if blast injury or electrical burn
- Airway
  - If airway or respiratory involvement (or patient was involved in structure fire) provide oxygen therapy aiming for SpO_2 of 100%
  - Consider need for advanced airways (ALS)

Stop the Burning Process

- Remove patient from the source
- Remove all burnt clothing (unless adhered to patient)
- Remove jewelry (can cause constriction)
- If chemical, determine chemical and if powder brush it away prior to cooling with water (ensure chemical is not reactive with water first – refer to MSDS)

Cool the Burn

- Small burns
  - Can be cool with water for a minimum of 10 minutes
  - Cold wet clothes can also be used
  - Remember to keep patient warm during this process
- Large burns (>15% partial or full-thickness or >5% full-thickness)
  - Should not be cooled due to increased risk of hypothermia

Cover the Burn

- Utilize dry sterile dressings
- Keep area as clean as possible
- Small burns can be dressed after cooling and a wet cloth placed over the dressing to continue the cooling process
- Large burns should be covered with sterile burn sheets
- Burns to hands and/or feet should have fingers/toes separated with non-adherent dressings to prevent the digits from adhering

Cover the Burn

Provide Fluids

- Obtain IV Access and initiate fluid resuscitation for thermal burns
- Keep patient warm to avoid hypothermia since IV fluids are often cooler than body core temp
- Burns over IV sites
  - May have to place IV in partial thickness burn site
  - Consider IO placement (ALS) if IV unobtainable
- If patient does not have adequate perfusion provide fluids as per shock guidelines

Parkland Burn Formula

- Should be used in patients with burns > 15% BSA (10% in pediatrics)
- Over 24 hours from the time of the burn
  - Receive ½ this amount in first 8 hrs
  - Remainder in 16 hrs

Total Fluid=4 ml X pt weight (kg) X % BSA

Parkland Formula

- How would the Parkland Formula look for a 220 lb man with deep 2nd degree burns to his face and entire anterior portion of the thorax and abdomen?
- Calculate the fluid administration per hour and per minute

Parkland Burn Formula

- Step 1
  - Face = 4.5%
  - Anterior thorax/abd = 18%
  - Total BSA = 22.5%
- Step 2
  - Calculate their weight in Kg

$$\text{Weight (kg)} = \frac{220 \text{ lb}}{2.2 \text{ kg}} = 100 \text{ kg}$$

Parkland Burn Formula

- Step 3
  - Calculate total fluid requirements for the 24 hour period

$$\text{Total Fluid} = 4 \text{ ml X pt weight (kg) X \% BSA}$$
$$= 4 \text{ ml X } 100 \text{ kg X } 22.5\ \%$$
$$= 9000 \text{ ml (or 9 L)}$$

Parkland Burn Formula

- Step 4
  - Calculate the drip rate for half the fluid to be given in the first 8 hours of resuscitation

$$\text{Drip Rate} = \frac{\text{VTBI X Drip Set}}{\text{Time}}$$

$$\text{Drip Rate} = \frac{4500 \text{ ml X } 10 \ \frac{\text{gtt}}{\text{ml}}}{480 \text{ mins}}$$

$$\text{Drip Rate} = \frac{45000 \text{ gtt}}{480 \text{ mins}}$$

$$\text{Drip Rate} = 93.8 \ \frac{\text{gtt}}{\text{mins}}$$

Parkland Burn Formula

- Step 5
  - Calculate the drip rate for the remaining fluid over 16 hours of resuscitation

$$\text{Drip Rate} = \frac{\text{VTBI X Drip Set}}{\text{Time}}$$

$$\text{Drip Rate} = \frac{4500\text{ ml X } 10\ \frac{\text{gtt}}{\text{ml}}}{960\text{ mins}}$$

$$\text{Drip Rate} = \frac{45000\text{ gtt}}{960\text{ mins}}$$

$$\text{Drip Rate} = 46.9\ \frac{\text{gtt}}{\text{mins}}$$

Provide Analgesia

- Cooling and covering the burned area is one step
- Opioid analgesics may be considered (ALS)

Transport

- On-scene time should be kept to a minimum, most interventions can be done enroute
- Patients with the following burns should be considered to be transported to burn facility:
  - Burns to face, hands, perineum, flexible areas (neck, axilla)
  - Circumferential burns involving the chest
  - Total BSA >10% (>5% for pediatrics)
  - Pt's with significant existing conditions
  - Burns caused by inhalation, radiation, high-tension electrical, chemicals or high pressure steam

Transport

- Adult burns involving the airway or > 15% BSA are considered major trauma
- Air medical transport should be considered if transport time to trauma center > 30 minutes

Burns

OTHER POINTS

Circumferential Burns

- Circumferential full thickness burns represent an additional problem
- Stiffening of the skin along with internal edema cut off, venous blood and lymph flow creates a tourniquet effect
- Can impedes recovery, and the swelling will ultimately cause nerve compression and the blockage of arterial flow
- In burns encompassing the torso, chest expansion will become restricted
- Require rapid, safe transport for escharotomy to restore circulation and to maintain adequate tidal volume

Circumferential Burns

Electrical Injuries

- Assessment
  - Entrance and exit wounds
  - Remove clothing, jewelry and leather items
- Treat any visible injuries
  - Thermal burns
- ECG monitoring
  - Bradycardia, tachycardia, VF or asystole
- Treat cardiac and respiratory arrest
  - Aggressive airway, ventilation, and circulatory management
- High-voltage burns may result in rhabdomyolysis and renal failure

Rhabdomyolysis

- The breakdown of muscle fibers that leads to the release of muscle fiber contents (myoglobin) into the bloodstream
- Myoglobin is harmful to the kidney and often causes kidney damage
- May be seen in sever full-thickness burns or high-voltage electrical burns

Rhabdomyolysis

- Symptoms could include:
  - Symptoms of kidney failure (poor urine output)
  - SOB with excessive fluids in lungs
  - Lethargic
  - Weakness
  - Hyperkalemia (ECG changes could be noted)
  - DIC

Chemical Burns

- Scene assessment
  - Identify nature of chemical spill, hazards
    - CANUTEC manual
  - Hazardous materials team
  - Establish hot, warm and cold zones
  - Prevent personnel exposure from chemical

Specific Chemicals

- Phenol
  - Gelatinous caustic agent, industrial cleaner
  - Dissolve with water then irrigate
- Dry lime
  - Strong corrosive that reacts with water
  - Brush off then irrigate
- Sodium
  - Unstable metal that reacts destructively with variety of materials and human tissue
  - Brush off then cover with oil
- Riot control agents
  - Tear gas, mace, pepper spray
  - Supportive care, irrigate eyes

FIGURE 21-20 Chemical burns should be flushed with large quantities of water. Dry lime should be first brushed away before applying cool water.

Irrigation

- Pay special attention to eyes
  - Sensitive to even mild chemicals
  - Blepharospasm (eyelid spasm)
- Alkali burns
  - Flush for at least 15 minutes
- Acid burns
  - Flush for at least 5 minutes

Burns

PREVENTABLE COMPLICATIONS

Systemic Complications

- Hypothermia
  - Disruption of skin and its ability to thermoregulate
- Hypovolemia
  - Shift in proteins, fluids, and electrolytes to the burned tissue
  - General electrolyte imbalance
- Eschar
  - Hard, leathery product of a deep full thickness burn
  - Dead and denatured skin
  - Potential for significant respiratory compromise
    - Circumferential eschar can cause compartment syndrome issues

Systemic Complications

- Infection
  - Greatest risk of burn is infection
  - Breakdown of physical barriers and ideal growth medium for bacteria
  - Increased risk of sepsis
- Organ Failure
  - Release of myoglobin and cellular contents
  - Renal failure, liver failure, dysrhythmias

Systemic Complications

- Special Factors
  - Pediatric patients
    - High body surface to weight ratio
    - Less subcutaneous fat
  - Geriatric patients
    - Less mechanisms for fluid retention
    - Less able to combat infection
    - Health factors
- Physical Abuse
  - Always consider for elderly, infirm or young

Abuse

- Burn injury from placing a child's buttocks into hot water as punishment

Summary

- Pathophysiology
- Assessment of thermal burns
- Management of thermal burns
- Electrical burns
- Chemical burns