Chapter 32

Burns
Trauma

Integrates assessment findings with principles of epidemiology and pathophysiology to formulate a field impression to implement a comprehensive treatment/disposition plan for an acutely injured patient.
Soft-Tissue Trauma

Recognition and management of

- Wounds
- Burns
  - Electrical
  - Chemical
  - Thermal
- Chemicals in the eye and on the skin
Pathophysiology, assessment, and management of Wounds
- Avulsions
- Bite wounds
- Lacerations
- Puncture wounds
- Incisions
Pathophysiology, assessment, and management of (cont’d)

- Burns
  - Electrical
  - Chemical
  - Thermal
  - Radiation
- High-pressure injection
- Crush syndrome
Introduction

- Ability to treat burns has improved due to:
  - Better understanding of “burn shock”
  - Advances in fluid therapy and antibiotics
  - Improved ability to excise dead tissue
  - Use of biologic dressings
  - Formation of specialized teams
Anatomy and Physiology of the Skin

• Skin has a crucial role in maintaining homeostasis within the body.

• Four functions:
  - Protects underlying tissue from injury/exposure
  - Aids in temperature regulation
  - Prevents excessive loss of water
  - Keeps the brain informed about environment
Anatomy and Physiology of the Skin

• Victims may have:
  - Difficulty with thermoregulation
  - Inability to sweat
  - Impaired vasoconstriction and vasodilation
  - Little or no melanin
  - Inability to grow hair
  - Little or no sensation
Layers of the Skin

- **Epidermis**
  - Outer layer
  - Body’s first line of defense
  - Composed of several layers

- **Dermis**
  - Inner layer
  - Composed of:
    - Collagen fibers
    - Elastin fibers
    - Mucopolysaccharide gel
Layers of the Skin

- **EPIDERMIS**
- **DERMIS**
- **SUBCUTANEOUS TISSUE**

- Hair
- Pore
- Germinal layer of epidermis
- Sebaceous gland
- Nerve (sensory)
- Sweat gland
- Hair follicle
- Blood vessel
- Subcutaneous fat
- Fascia
- Muscle
Layers of the Skin

• Enclosed within the dermis are:
  − Nerve endings
  − Blood vessels
  − Sweat glands
  − Hair follicles
Layers of the Skin

- Beneath the dermis is the subcutaneous layer.
- Beneath the subcutaneous layer are the muscles, tendons, bones, and vital organs.
The Eye

- Sensitive to burn injuries
- Intense heat, light, or chemical reactions can burn the thin membrane covering the eye.
Pathophysiology

- Burns are soft-tissue injuries created by destructive energy transfer via radiation, thermal, or electrical energy.
Burn Shock

- Occurs because of two types of injury:
  - Fluid loss across damaged skin
  - Series of volume shifts within the body
- Intravascular volume oozes into the interstitial spaces.
Burn Shock

- Involves the entire body
  - Limits distribution of oxygen and glucose
  - Hampers ability to remove waste products
- Adequate fluid resuscitation is essential.
Thermal Burns

• Can occur when skin is exposed to temperatures higher than 111°F (44°C)

• Severity correlates with:
  – Temperature, concentration, or amount of heat energy
  – Duration of exposure
Thermal Burns

- Heat energy can be transmitted in a variety of ways.
  - Flame burns
  - Scald burns
  - Contact burns
  - Steam burns
  - Flash burns
Burn Depth

- Described by three pathologic progressions
  - Zone of coagulation
  - Zone of stasis
  - Zone of hyperemia
- Treatment: salvage as much of the injured tissue as possible.
Burn depth is categorized by severity.

- Paramedics should limit their assessment to:
  - Superficial
  - Partial-thickness
  - Full-thickness
Burn Depth

• Superficial burns
  - Involves the epidermis only
  - Skin is red and swollen.
  - Patients experience pain.
  - Will heal spontaneously in 3 to 7 days
• Partial-thickness burns
  – Involves the epidermis and dermis
  – Subdivided into:
    • Moderate partial-thickness burn
    • Deep partial-thickness burn
  – May be difficult to delineate between the two
Burn Depth

- Full-thickness burns
  - Involves destruction of both layers of the skin
  - Incapable of self-regeneration
  - Skin may appear white and waxy, brown and leathery, or charred.
  - Sensory nerves are destroyed.
Inhalation Burns and Intoxication

- Can cause serious airway compromise
  - Steam/hot particulate matter associated with damage to:
    - Vocal cords and larynx
    - Lower airway
  - Superheated gases associated with damage to:
    - Upper airway
Inhalation Burns and Intoxication

• Smoke inhalation
  - Causes the majority of deaths from fires
  - Exposure to smoke from a fire may cause:
    • Thermal burns to the airway
    • Hypoxia from lack of oxygen
    • Tissue damage and toxic effects
Inhalation Burns and Intoxication

- Carbon monoxide intoxication
  - CO evolves from incomplete combustion of carbon compounds.
  - CO can displace oxygen.
    - Being exposed to relatively small concentrations will result in higher blood levels of CO.
Inhalation Burns and Intoxication

• Carbon monoxide intoxication (cont’d)
  – Patients usually present with an O$_2$ saturation of normal or better.
  – Never trust a pulse oximeter.
Patient Assessment

• Victims may not act sick.
  - The severity of the injuries may not become apparent until after assessment.
  - Initially stable conditions may be deemed more serious after careful evaluation.
Scene Size-Up

- Do not run into a burning building if you are not trained and properly equipped.
- Stage yourself in a safe place to provide patient care.
Scene Size-Up

• When a burned patient comes to you:
  - Extinguish the flame and cool the burn.
  - Do not permit a person on fire to run.
    • Have the patient stop, drop, and roll.
  - If smoldering cloth adheres to the skin, cut it away.
Scene Size-Up

- If possible, determine the mechanism of injury (MOI).
  - Consider and examine other mechanisms associated with the burn.

- Wear appropriate personal protective equipment and follow standard precautions.
Primary Assessment

- Form a general impression.
  - Clues may help identify severity.
  - Use compassion when approaching the patient.
  - Patients may have varied mental status responses.
Primary Assessment

• Airway and breathing
  - Signs of airway involvement include:
    • Hoarseness
    • Cough
    • Singed nasal or facial hair
    • Facial burns
    • Carbon in the sputum
    • History of burn in an enclosed space
Primary Assessment

- Airway and breathing (cont’d)
  - Early ET intubation could be lifesaving.
    - Listen to lung sounds.
    - Note if signs and symptoms of edema are present.
  - Anyone suspected of having a burn to the upper airway may benefit from humidified, cool O₂.
Primary Assessment

• Circulation
  - During the first 24 to 48 hours, fluid resuscitation is emphasized to prevent burn shock.
  - Do not delay transport by making multiple attempts at vascular access.
Primary Assessment

- Assess burn severity.
  - Rule of nines
    - Divide the body into 9% segments.
    - Add portions to obtain total of area affected.
Primary Assessment

- Assess burn severity (cont’d).
  - Rule of palms (rule of ones)
    - Use the patient’s palm to represent 1% of the body surface area.
    - Helpful when the burn covers less than 10% of the body surface area.
Primary Assessment

- Assess burn severity (cont’d).
  - The Lund and Browder chart

<table>
<thead>
<tr>
<th>Region</th>
<th>%</th>
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<tbody>
<tr>
<td>Head</td>
<td>1</td>
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<tr>
<td>Neck</td>
<td>1</td>
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<tr>
<td>Ant. Trunk</td>
<td>1</td>
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<tr>
<td>Post. Trunk</td>
<td>1</td>
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<tr>
<td>Right arm</td>
<td>1</td>
</tr>
<tr>
<td>Left arm</td>
<td>1</td>
</tr>
<tr>
<td>Buttocks</td>
<td>1</td>
</tr>
<tr>
<td>Genitalia</td>
<td>1</td>
</tr>
<tr>
<td>Right leg</td>
<td>1</td>
</tr>
<tr>
<td>Left leg</td>
<td>1</td>
</tr>
<tr>
<td>Total burn</td>
<td>1</td>
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</tbody>
</table>

• Assess burn severity (cont’d).
  - The American Burn Association has published classifications.

<table>
<thead>
<tr>
<th>Table 1 Classification of Burns in Adults</th>
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<tbody>
<tr>
<td><strong>Burn Classification</strong></td>
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<tr>
<td>-------------------------</td>
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<tr>
<td>Critical (severe) burns</td>
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<tr>
<td>Moderate burns</td>
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<tr>
<td>Minor burns</td>
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</table>
Primary Assessment

Transport decision

The following should be transferred to burn unit:

- More than 10% of body involved
- Face, hands, feet, genitalia, perineum, or joints involved
- Full-thickness burns
- Electrical burns
- Chemical burns
- Inhalation burns
- Burns in conjunction with preexisting medical conditions
- Risk of morbidity or mortality
- Special rehabilitation required
History Taking

• Get a brief history from the patient.
• Patients with preexisting diseases may be triaged as critical even if the injury is small.
Secondary Assessment

- Pay attention to the circumstances of the burn and the possible MOI.
- Look for injuries to the eyes.
- Check for circumferential burns.
- Check and document distal pulses often.
Reassessment

• If the patient has a significant MOI, perform en route to the ED.

• Reassessment of vital signs is done every:
  – 5 minutes for critical patients
  – 15 minutes for lower priority patients
Definitive burn care can be divided into four phases.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Time Frame</th>
<th>Treatment Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial evaluation and resuscitation</td>
<td>First 72 hours</td>
<td>To provide initial resuscitation, secure the airway, achieve accurate fluid resuscitation, and perform a thorough evaluation</td>
</tr>
<tr>
<td>Initial wound excision and biologic closure</td>
<td>Days 1 through 7</td>
<td>To identify and remove all full-thickness wounds and obtain biologic closure</td>
</tr>
<tr>
<td>Definitive wound closure</td>
<td>Day 7 through week 6</td>
<td>To replace temporary covers with definitive ones and close small, complex wounds</td>
</tr>
<tr>
<td>Rehabilitation, reconstruction, and reintegration</td>
<td>Entire hospitalization</td>
<td>To maintain range of motion and reduce edema and to strengthen and prepare the patient for return to the community</td>
</tr>
</tbody>
</table>
General Management

• Only turn your attention to the burn itself when the ABCs are under control.
  – Have all resuscitative equipment ready for use.
General Management

• Patient with an acutely decompensating airway who requires field intubation
  – Includes:
    • Burn patients in cardiac or respiratory arrest
    • Responsive patients whose airways are swelling
  – Surgical airways or rescue devices may be necessary.
General Management

• Patient with deteriorating airway who might require intubation
  – Better to defer treatment to hospital teams.
  – Attempt to intubate only if the airway continues to swell and intubation will become impossible.
General Management

• Patient whose airway is patent but who has a history consistent with risk factors for airway compromise
  - Use cool, humidified O$_2$ from a high-output nebulizer or an aerosol nebulizer with saline.
  - Report the patient’s history to hospital personnel.
General Management

• Patient with no signs of or risk factors for airway compromise who is in no distress
  – Provide supplemental O₂.
Fluid Resuscitation

• Needed for patients with burns covering more than 20% of the body’s surface
  – If delayed more than 2 hours, mortality increases.
  – Begin to deliver as soon as is reasonable.
Approximate the amount of fluid needed by using the Consensus formula.

- During the first 24 hours, the patient will need:
  - $4 \text{ mL} \times \text{body weight (in kg)} \times \text{percentage of body surface burned}$
  - Half is given during first 8 hours.
  - Half is given over the subsequent 16 hours.
Pain Management

• Assess pain before administering analgesia.
  - Burn patients may require higher doses.
• Pain medication is best given via IV route.
• Narcotics remain the drugs of choice.
Burn Shock

• Sets in during a 6- to 8-hour period
• Mortality increases if fluid resuscitation is delayed longer than 2 hours.
• Obtain vascular access and begin fluid resuscitation in the field.
## Thermal Burns

While assessing burns, consider:

- Pain
- Swelling
- Skin color
- Capillary refill time
- Moisture and blisters
- Appearance of wound edges
- Foreign bodies, debris, contaminants
- Bleeding
- Circulatory adequacy
- Concomitant soft-tissue injury
Thermal Burns

- Superficial burns
  - If patient is reached within the first hour, immerse the burn in cool water or apply cold compresses.
  - Transport the patient in a comfortable position.

Courtesy of Water-Jel® Technologies
Thermal Burns

- **Partial-thickness**
  - Cool burn with water or apply wet dressings.
  - Elevate extremities.
  - Establish IV fluids.
  - Administer pain medication.

- **Full-thickness**
  - Assess pain and administer pain medication.
  - Dry dressings are often used.
  - Begin fluid resuscitation.
Thermal Inhalation Burns

- Apply cool mist or aerosol therapy.
  - Apply ice pack to the throat if mister is not available.
- Aggressive airway management may be necessary.
Chemical Burns of the Skin

- Burn progresses as long as the substance remains in contact with the skin.
- Typical management: removal of chemical
  - Solutions require flushing with water.
  - Powders require brushing off before washing.
Chemical Burns of the Skin

The amount of damage depends on:

- Nature of the chemical
- Concentration and quality of the agent
- Chemical state or temperature of the agent
- Length of exposure
- Depth of penetration
Chemical Burns of the Skin

- Acid burns
  - Easy to neutralize
  - Cause destruction and coagulation of tissues

- Alkali burns
  - More difficult to neutralize
  - Effects are pronounced in burns of the eye.
Chemical Burns of the Skin

• Assessment
  - Ensure your own safety.
  - Follow with decontamination of the patient.
Chemical Burns of the Skin

- Management
  - Flush with copious amounts of water.
  - Rapidly remove the patient’s clothing.
  - Wash skin folds.
  - Once washing is complete, wash again.
Chemical Burns of the Skin

Management (cont’d)

- Dry lime
  - Remove clothing and brush as much as you can from the skin.
  - Flush copiously with a garden hose or shower.
- Sodium metals
  - Cover burn with oil.
Chemical Burns of the Skin

- Management (cont’d)
  - Hydrofluoric (HF) acid
    - Calcium chloride (CaCl) jelly may reduce injury.
  - Gasoline or diesel fuel
    - Remove with soap solution.
  - Hot tar
    - Immerse in cold water.
Inhalation Burns from Other Toxic Chemicals

- The solubility properties of the gas will often determine where it affects the airway.

<table>
<thead>
<tr>
<th>Table 6</th>
<th>Irritant Gases and Their Effects</th>
</tr>
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<tbody>
<tr>
<td><strong>Water Solubility</strong></td>
<td><strong>Examples of Substances</strong></td>
</tr>
<tr>
<td>Highly water soluble</td>
<td>Ammonia, Formaldehyde, Hydrogen chloride (HCl), Sulfur dioxide</td>
</tr>
<tr>
<td>Moderately water soluble</td>
<td>Chlorine</td>
</tr>
<tr>
<td>Slightly water soluble</td>
<td>Phosgene, Nitrogen dioxide</td>
</tr>
</tbody>
</table>
Inhalation Burns from Other Toxic Chemicals

- HF acid is a special case.
  - Aggressively binds with calcium ions
  - May require the administration of IV calcium
Inhalation Burns from Other Toxic Chemicals

- Assessment
  - Have a high index of suspicion for irritant gas exposure if the patient was involved in a:
    - Fire
    - Explosion
    - Contaminated environment situation
Inhalation Burns from Other Toxic Chemicals

- Assessment (cont’d)
  - Signs of upper airway swelling:
    - Stridor
  - Signs of lower airway involvement:
    - Wheezing and desaturation
    - Pulmonary edema
Inhalation Burns from Other Toxic Chemicals

- Management
  - Maintain an acceptable $O_2$ saturation level.
  - Monitor for signs of airway compromise.
  - Aerosolized beta-agonists are usually helpful.
Chemical Burns of the Eye

- Chemicals known to cause burns to the eyes include:
  - Acids
  - Alkalis
  - Dry chemicals
  - Phenols
Chemical Burns of the Eye

Assessment and management

- Flush with copious amounts of water.
- If the patient wears contact lenses, pause for removal.
- Patch the eyes with lightly applied dressings.
Chemical Burns of the Eye

• Assessment and management
  – The Morgan lens may make eye irrigation more comfortable and effective.

Courtesy of MorTan, Inc.
Electrical burns may produce internal injuries with little external evidence.

May result in two injury sites:
- Entrance wound
- Exit wound
Electrical Burns and Associated Injuries

• Degree of tissue injury is related to:
  − Resistance of the body tissues
  − Intensity of current
  − Duration of exposure
Electrical Burns and Associated Injuries

- Electricity can cause three types of burns:
  - True electrical injury
  - Arc-type or flash burn
  - Flame burn
Electrical burns have a strong possibility of severe internal injury.

- Two common causes of death from electrical injury are asphyxia and cardiac arrest.
- Electricity can disrupt the nervous system.
Electrical Burns and Associated Injuries

• Assessment
  - Once the hazard is neutralized, assess patient.
  - Start CPR, and identify ventricular fibrillation.
  - Open the airway.
  - Make note of consciousness; record vital signs.
  - Try to determine the path of the current.
Electrical Burns and Associated Injuries

Management

- Prioritize patient care.
- Administer early O$_2$ therapy.
- Manage for impending shock.
- Make transport decisions early.
Lightning-Related Injuries

• If an object is a better conductor of electricity than the air, it will “attract” lightning.

• A direct hit is not needed to be injured.
Lightning-Related Injuries

• The best treatment is prevention.
  – Don’t be the tallest conductor.
  – Don’t stand under or near the tallest conductor.
  – Take shelter in a substantial structure.
  – Avoid touching good conductors.
Lightning-Related Injuries

- Lightning carries enormous electrical power.
- Injuries tend to resemble blast injuries.
- Continued ventilatory support may be required.
Lightning-Related Injuries

Assessment

- Two special considerations:
  - Get patients and rescuers to a safe place.
  - Rapidly determine the number of patients.
- Start CPR when necessary.
Lightning-Related Injuries

Management

- Perform CPR as needed.
- Administer supplemental oxygen.
- Monitor cardiac rhythm.
- Insert a large-bore IV catheter.
- Cover burns with dry, sterile dressings.
- Splint fractures.
Radiation Burns

- Three types of ionizing radiation:
  - Alpha
  - Beta
  - Gamma

- Measured in:
  - Radiation equivalent in man (rem), or
  - Radiation absorbed dose (rad)
    - 100 rad = 1 gray (Gy)
Radiation Burns

• Acute radiation syndrome
  – Causes hematologic, central nervous system, and gastrointestinal changes
  – Unresponsive patients who vomit within 10 minutes of exposure will not survive.
Radiation Burns

• Radiation contact burns
  – Injury could resemble anything from superficial sunburn to a chemical burn.
  – Burns could appear within hours or days.
Radiation Burns

• Assessment
  - Determine if the scene is safe.
  - Determine what protective gear is needed.
  - Assess mental status and ABCs.
  - Prioritize the patient’s care.
Radiation Burns

• Management
  - Decontaminate patients before transport.
  - Gently irrigate open wounds.
  - Notify the ED as soon as possible.
  - Limit your duration of exposure.
  - Increase your distance from the source.
Management of Burns in Pediatric Patients

- Fluid resuscitation may be more challenging.
  - May require more fluid per kilogram than adults
  - May require dextrose-containing solutions earlier than adults
Management of Burns in Geriatric Patients

- Sensitive to respiratory injuries
- May have poor glycogen stores
  - Blood glucose levels should be checked.
- Cardiac monitoring should be implemented.
Long-Term Consequences of Burns

**Patient**
- Average of 1 day of inpatient treatment for each 1% of TBSA
- May be left with problems with:
  - Thermoregulation
  - Motor function
  - Sensory function

**Provider**
- Caring for patients with severe burn emergencies can be horrifying.
- Proper training, confidence, and courage can have a large impact.
You will encounter some serious burn injuries during your career.

The skin has four functions: to protect the underlying tissue, to regulate temperature, to prevent excessive loss of water, and to act as a sense organ.

Burns are diffuse soft-tissue injuries created from destructive energy transferred via thermal, electrical, or radiation energy.
Significant burn damage to the skin may make the body vulnerable to bacterial invasion, temperature instability, and major disturbances of fluid balance resulting in burn shock.

Thermal burns include flame, scald, contact, steam, and flash burns.

Burns can affect the cardiovascular, respiratory, renal, gastrointestinal, hematological, and endocrine systems.
Summary

- When burn shock occurs, the contents of the capillaries leak out of the circulation into the interstitial spaces. Adequate fluid resuscitation is needed.
- Burn wounds may be superficial, partial thickness, or full thickness.
- A superficial burn involves only the epidermis, and skin appears red and swollen.
Summary

- A partial-thickness burn involves the epidermis and part of the dermis.
- A full-thickness burn involves destruction of the epidermis, the dermis, and the basement membrane of the dermis.
- Inhalation burns may cause rapid airway compromise.
- Establishing scene safety should be your first priority in responding to a burn call.
• The many types of burns, coupled with the many possible presentations, can challenge your assessment skills.

• Once ABCs are addressed, assess the total body surface area (TBSA) burned.

• Three cornerstones of the emergency medical care of burns are airway management, fluid resuscitation, and pain management.
• Many burn patients will ultimately require intubation.
• Patients with more than 20% body surface area burns will need fluid resuscitation.
• The Consensus formula is an equation used to determine the amount of fluid a burned patient will need during the first 24 hours.
• Remember to assess the patient’s pain and provide aggressive pain management.
Summary

- Chemical burns may affect the skin, eyes, or airway.
- In cases of electrical burn, electric current is converted to heat as it travels through the body.
- Most radiation burns are caused by gamma radiation or x-rays.
Summary

- Pediatric patients can be more easily harmed by thermal injuries than other patients, and fluid resuscitation may be more challenging.
- Elderly patients are also particularly sensitive to respiratory insults. They may have poor glycogen stores.
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