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Burns: Evaluation and Treatment

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Objectives

1) List at least three types of burns and identify the severity of burns.
2) Identify two classification systems for determining burn size.
3) Describe what hypertrophic scarring is and why it occurs.
4) List at least three psychosocial aspects of caring for burn patients.
5) Identify at least two medical treatments and two therapy interventions for burns.
Definition of Thermal Injuries/Burns

- An acute wound caused by exposure to thermal extremes, caustic chemicals, electricity or radiation
- The degrees of tissue damage depends on the strength of the source and duration of contact or exposure
- High morbidity and mortality rate

Burns

- Skin no longer provides barrier and allows body heat and water to escape and bacteria to enter
- Loss of sensation, sweating, sebum secretion and skin elasticity occur
- Large amount of fluid loss
Risk Factors and Populations

• Everyone is at risk for burns; however, most are not severe
• Estimated over a million burn injuries per year. Of these, 486,000 require medical attention and 40,000 require hospitalization
  • 3,275 deaths from fire/smoke inhalation
• Kitchen spills, contact injuries, electric burns, and occupational hazards account for majority of burns

American Burn Association, 2016

Thermal Burns

• Most common type of burn
  • Scalds: Hot liquids
    • Typically seen in children who pull a hot pan off the stove or in abuse situations
  • Flame: Typically see inhalation damage with this type
  • Contact: Heating pad, radiator

• Results from any misuse or mishandling of fire or a combustible product.

• Frostbite is also a thermal burn obviously caused by extreme cold
Thermal burns

Frostbite
Electrical

• Results from contact with flowing electrical current, i.e. household current, high-voltage transmission lines and lightning

• Minimal external damage noted but significant internal injury can occur
  • Can affect all internal organs/functions
    – Cardiovascular: Cause an arrhythmia or cardiac arrest; Aneurysm, tissue ischemia; Will need close monitoring
    – Respiratory: Cause respiratory arrest
    – Neurological: Loss of consciousness, neuropathy, spinal cord injury
    – Musculoskeletal: Fractures, dislocations, compartment syndrome
    – Kidney: Renal failure if extensive muscle necrosis

• Commonly see an entrance and an exit wound
  http://www.dermnetnz.org/topics/electrical-burns/
Electrical

Chemical

- Most commonly results from contact (skin contact or inhalation) with a caustic agent

- Usually deep as it continues to burn tissues until it is completely removed or washed away
  - May need to remove clothes and shower patient

- Sometimes evidence of abuse with attacker throwing caustic agents at victim

- Alkaline chemicals tend to burn more than acidic ones
  - Example of alkaline chemical is cement
Chemical

Radiation

- Sunburn
- Result of radiation treatment or radioactive material exposure
  - Often called radiation dermatitis
Radiation

Classification and Characteristics of Burn Injuries

- Classified by level of tissue involvement and amount of surface area affected
  - Determine size
  - Determine depth
  - Determine severity
  - All of these may take 3-4 days to fully assess given evolution of wound and presence of eschar
Determine the size

- Small, superficial burns are measured like any other wound
  - Length x width x depth

- Larger burns are expressed as a percentage of total body surface area (BSA)
  - Several classification systems are used

Three classification systems

- Lund & Browder
  - Used more frequently for children and infants because the Rule of Nine’s is inaccurate for their body shapes and hence, their BSA
  - Classification changes based on age of child

- Rule of Nine’s
  - Quantifies BSA in multiples of 9’s
    - Anterior Body: Each leg is 9%, trunk is 18%, each arm is 4.5%, head is 4.5% and genital area is 1%
    - Posterior Body: Each leg is 9%, trunk is 18%, each arm is 4.5% and head is 4.5%
    - Totaling 100%

- Palmar Method:
  - Uses palm of hand to determine burn size
Lund and Browder Charts

Rule of Nine’s
Palmar Method

Depth of Burn Injuries

- Can define by thickness
  - Partial thickness burn involves epidermis and part of dermis
  - Full thickness burn involves epidermis, dermis and subcutaneous tissue

- Can also define by degree
  - First
  - Second
  - Third
  - Damage usually involves several depths and degrees

- Consider viewing Burns 101 Assessment for more info
  https://www.youtube.com/watch?v=DBE01Cq25Z4
Superficial/1\textsuperscript{st} Degree

- Damage is limited to epidermis, causing erythema and pain
- Skin will peel in several days
- No treatment necessary typically
- Sun burn or minor flash burn

Superficial/1\textsuperscript{st} Degree Burn

[Image of superficial burn]

www.nlm.nih.gov
Superficial/1\textsuperscript{st} Degree Burn

Superficial Partial-Thickness/2\textsuperscript{nd} Degree

- The epidermis and part of the dermis are damaged
- Produces blisters, mild-to-moderate edema and pain
- Healing occurs within 2 weeks
- No scar
Superficial Partial-Thickness/2\textsuperscript{nd} Degree Burn

![Image of 2nd degree burn]

www.nlm.nih.gov

Superficial Partial Thickness/2\textsuperscript{nd} Degree Burn

![Image of burn wound]

www.islamicmedicine.org
2\textsuperscript{nd} Degree Burn

Schraga et al, Emergent Management of Thermal Burns.

Deep Partial Thickness

- The epidermis and dermis are damaged
- No blisters appear but white, brown or black leathery tissue and thrombosed vessels are visible
- Leaves hair follicles and dermal appendages intact so epidermal cells can be produced
Full-Thickness/3\textsuperscript{rd} Degree

- Damage extends through deeply charred subcutaneous tissue to muscle and bone
- No pain
- Heals like a full thickness wound with granulation, epithelialization and wound contraction

Full Thickness/3\textsuperscript{rd} Degree Burn

[Image: health.yahoo.com]
Full-Thickness/3rd Degree Burn

www.roanoke.k12.va.us

Full Thickness/3rd Degree

Schraga et al, Emergent Management of Thermal Burns.
Subdermal

- Destruction beyond dermis and into fat, muscle, tendon and/or bone. Typically due to electrical injuries, prolonged thermal contact or exposure to strong injuries
Determining the Severity

- Severity of a burn is determined by both its size and depth
- **Major**: Meets 1 or more of these criteria
  - 3rd degree burns on more than 10% of BSA
  - 2nd degree burns on more than 25% of BSA in adults; more than 20% in children
  - Burns on the hands, face, feet or genitalia
  - Electrical burns
  - Any burn in a high-risk patient
- **Moderate**: Meets 1 or more of these criteria
  - 3rd degree burns on 2-10% of BSA
  - 2nd degree burns on 15-25% of BSA in adults, 10-20% of BSA in children
- **Minor**: Meets 1 or more of these criteria
  - 3rd degree burns on less than 2% of BSA
  - 2nd degree burns on less than 15% of BSA in adults, less than 10% of BSA in children

Initial assessment of Burn Patient (ABCDE)

- **Airway**: Assess airway and remove any obstruction
- **Breathing**: Observe patient’s breathing rate, depth and character
- **Circulation**: Palpate pulses; Loss of distal pulse may indicate shock or constriction of an extremity
- **Disability**: Assess patient’s level of consciousness and ability to function
- **Expose**: Remove burned clothing and examine the skin underneath.
Airway management

• 3 types of inhalation injuries:
  • Patients with carbon monoxide poisoning
  • Upper airway thermal burns
  • Inhalation of combustible materials

• It is very important to maintain airway and this will be done with intubation
  • May combine with percussion, prone positioning, use of steroids

Acute Changes

• Physiologic:
  • **Fluid volume:** Input via IV fluids greater than output as edema increases

  • **Body weight:** Need accurate dry weight to measure amount of resuscitation

  • **Body temperature:** May be elevated

  • **Electrocardiographic status:** May see dysrhythmias
Acute Changes

• Biochemical and Hematologic:
  • Serum creatinine and blood urea nitrogen: Ensure kidney function is normal
  • Hemocrit & Hemoglobin: May decrease after surgical interventions
  • White Blood Cell Count: May increase or decrease depending on amount of fluid resuscitation
  • Blood glucose: May see hyperglycemia
  • Electrolytes: Imbalance can be avoided with lactated Ringer’s
  • Plasma protein and myoglobin levels: May see elevated myoglobin levels
  • Prothrombin time, partial thromboplastin time and platelet count: Expect to be normal except in patients with preexisting disease

Special Assessment Considerations

• Pay particular attention to these factors that affect healing and treatment:
  • Burn location: Burns on face, hands, feet and genitalia are most serious due to possible loss of function
  • Burn configuration: Edema due to circumferential burn can slow or stop circulation to extremity; Burns on neck can obstruct airway; Burns on chest can interfere with normal respiration
  • Pre-existing conditions
  • Other injuries sustained at time of burn
  • Patient age: Patients under 4 or over 60 are at higher risk of complications
  • Pulmonary injury: Inhaled smoke or super-heated air damages lung tissue
Burn Interventions

• Care of burns depends on type and severity of burn, the patient’s general health prior to injury, and whether there are concurrent injuries

• In general, treatment seeks to:
  • Reduce pain
  • Remove dirt, debris and dead tissue
  • Provide a dressing that promotes healing and possible skin grafting

• American Burn Association has developed criteria for when to transfer to burn center

When to refer to a Burn Unit

• Any partial-thickness burn larger than 20% of total body surface area (TBSA) in a patient of any age or larger than 10% of TBSA in children younger than 10 years or adults older than 50 years

• Third-degree burns covering more than 5% of TBSA

• Second-degree or third-degree burns involving critical areas (e.g., hands, feet, face, perineum, genitalia, or major joints)

• Burns with associated inhalation injury

Schraga et al, Emergent Management of Thermal Burns.46
When to refer to a Burn Unit

• Electrical or lightning burns
• Severe burns complicated by coexisting trauma - If traumatic injuries pose a higher risk to the patient than the burn injuries, the patient may have to be sent first to a trauma center
• Preexisting disease that could complicate management of the burn injury
• Chemical burns with threat of cosmetic or functional compromise
• Circumferential burns on the extremities or the chest

Schraga et al, Emergent Management of Thermal Burns.

Criteria for Outpatient Management of Burn Patients

• Appropriate
  • Patients with small burns who have demonstrated understanding of wound care, pain control and therapy

-Mosier & Gibran, 2010
Criteria for Outpatient Management of Burn Patients

- Inappropriate: These patients need special care and consideration
  - Abused patients
    - Even signs of self-induced injury
  - Demented patients
  - Intoxicated patients
  - Homeless patients
  - Patients with comorbid conditions
  - Patients with a language barrier

-Mosier & Gibran, 2010

Minor to Moderate Burns

- 1st step is to stop the burning process and relieve pain
  - Never use hydrogen peroxide or povidone-iodine because they can cause further tissue damage
- After devitalized tissue is debrided, cover wound with antimicrobial ointment and non-adhesive dressing
Moderate to Major Burns

- Same initial treatment as with mild to moderate burns
- Also begin IV therapy to replace lost fluids, so as to prevent hypovolemic shock and help maintain cardiac output
- Careful monitoring of input and output is needed

Medical Management

- Intravenous lines to replace fluid lost
- Nutritional support
- Elevate room temperature
- May require intubation
Debridement and Cleansing

- May involve whirlpool
- Also includes sharp debridement that can be done by PTs
- Can also include use of a contact ultrasound such as Sonic One by Misonix or Arobella Qoustic system
- Debate over whether intact blisters should be left alone or ruptured; However, widely accepted that ruptured blisters and necrotic tissue should be removed
  - Current World Health Organization recommendation is to "debridement of all bullae and excision of all adherent necrotic tissue" (Jenkins, 2013)
  - [https://www.youtube.com/watch?v=FPC186EaKug](https://www.youtube.com/watch?v=FPC186EaKug)
Debridement and Cleansing

- May need surgical debridement
  - Circumferential full-thickness burns involving the chest or extremities may require escharotomy
  - The necrotic tissue, or eschar, becomes rigid and acts like a tourniquet
  - Escharotomy is done via a linear and lengthwise incision
    - This “allows return of [blood] flow and prevents further ischemic injury” (Jenkins, 2013)
Escharotomy

Example of escharotomy:  
https://www.youtube.com/watch?v=G6DGB024njQ

Debridement and Cleansing

• Several misconceptions in regards to cleansing of burns  
  • Must use sterile saline  
  • Burns must be scrubbed to debride superficial exudate  
• Instead burns can be washed with regular non-scented soap and tap water during daily shower or bath and can be simply wiped with a soapy washcloth to help remove any topical agents and exudate

Mosier & Girban, 2010
Skin Grafting

• May be necessary to repair defects caused by burns
• May be from patient’s own intact skin or from cadavers or pigs or from skin equivalents
• Surgeon may choose skin grafting if:
  • Primary closure is not possible or cosmetically acceptable
  • Primary closure would interfere with function
  • Wound is on a weight-bearing surface of the body

Skin grafting

• 3 types
  • Split-thickness grafts: Consist of epidermis and a small portion of the dermis
  • Full-thickness grafts: Include the epidermis and all of the dermis
  • Composite grafts include epidermis, dermis and underlying tissues such as muscle, bone or cartilage
Graft taken from patient's healthy skin

Skin is meshed to cover a large wound

Watch on your own:
https://www.youtube.com/watch?v=31OaRPgmEZc
Appearance of Donor Site

Healed Skin Grafts
Topical Agents

- Silver sulfadiazine (Silvadene) typically used for acute burns
  - Topical antibiotic cream
- Antibiotic ointments
- Santyl
  - Enzymatic debridement ointment that is effective on necrotic tissue
Dressings

- To be used to prevent infection, contain drainage, for pain management
- Types of dressings include:
  - Non-adherents such as Adaptic or Xeroform
  - Alginate or hydrofibers such as Aquacel Ag to absorb drainage and prevent infection
  - Silicon dressings that gently stick to wound to protect it but easily comes off without causing trauma to wound or surrounding skin
    - Also useful for scar management
Dressings

Basic Tenets of Rehab for the Burn Patient

- Maintenance of function of affected areas
- Restoration of physical abilities
- Control of scarring and wound contractures
- Return to preburn level of functional activities
- An acceptance of the psychological impact of a changed self-image and body image
Physical Therapist’s Role

- Besides wound care, PTs will be very involved in ensuring patients maintain and/or regain as much function as possible.

- Must look out for contractures
  - Position of comfort = position of contracture
  - Typically a flexed position
  - See next slide for proper positioning

- Mobility and strength training important during recovery

- Respiratory status must also be closely monitored

- Very old video but still relevant:
  [https://www.youtube.com/watch?v=kcQOLTaeRzk](https://www.youtube.com/watch?v=kcQOLTaeRzk)

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**Proper Positioning**

<table>
<thead>
<tr>
<th>Area Affected</th>
<th>Position to Prevent Contracture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior neck</td>
<td>10-15 degrees extension</td>
</tr>
<tr>
<td>Anterior axilla</td>
<td>90 degrees Shoulder abduction</td>
</tr>
<tr>
<td>Posterior axilla</td>
<td>Shoulder flexion</td>
</tr>
<tr>
<td>Elbow/forearm</td>
<td>Extension/forearm neutral</td>
</tr>
<tr>
<td>Wrists</td>
<td>15-20 degrees extension</td>
</tr>
<tr>
<td>Hands</td>
<td></td>
</tr>
<tr>
<td>MCP’s</td>
<td>70-90 degrees flexion</td>
</tr>
<tr>
<td>IP’s</td>
<td>Full extension</td>
</tr>
<tr>
<td>Thumb</td>
<td>Palmar abducted and opposed</td>
</tr>
<tr>
<td>Palmer</td>
<td>All joints full extension/thumb radially abducted</td>
</tr>
<tr>
<td>Hips</td>
<td>Extension, 10 degrees abduction, neutral rotation</td>
</tr>
<tr>
<td>Knees</td>
<td>Extension</td>
</tr>
<tr>
<td>Ankles</td>
<td>90 degrees dorsiflexion</td>
</tr>
</tbody>
</table>
Early Mobilization

- Very important to encourage OOB and ambulation quickly after injury
  - Even if patient is still on a ventilator
  - Goal is OOB within 24 hours of admission

Exercise

- Range of motion:
  - Watch for pain at end ranges where skin is being stretched
  - Can be active, active assistive, or passive
- Strengthening: Needed to avoid loss of lean body mass
- Cardiovascular: Maintain or improve function; May be ambulation or even just a tilt table to avoid orthostatic hypotension; Avoid overheating the patient if sweat glands were involved
Range of Motion

Strengthening
Splinting

- Use of pre-fabricated and/or custom-made thermoplastic splint
  - When positioning and exercise fail to treat impairments
  - Skin is becoming more inelastic
  - Swelling or pressure ulcers are worsening
  - Skin grafting
  - Exposed tendon or joint

What can happen if splinting is not done?

Schraga et al, Emergent Management of Thermal Burns®
Treatment with Splint

- Thermoplastic splints
  - Low temperature plastic
  - Custom made requiring frequent modifications due to dressing changes and/or edema
- Wearing schedule based on:
  - Wound status
  - Range of motion limitations
  - Patient compliance

Splinting
Post Acute Phase of Injury

• Wound Closure until Scar Maturity
  • Rehab Goals
    • To control hypertrophic scar tissue formation
      – Collagen fibers are unorganized and lead to increased scarring
    • To maximize the cosmetic result of the healed/grafted area
    • To decrease the need for and extent of reconstructive surgery
    • To support the patient through his adjustment to the injury

Principles of Hypertrophic Scarring

• 1\textsuperscript{st} and superficial 2\textsuperscript{nd} degree burns usually do not scar
• Deep 2\textsuperscript{nd} and 3\textsuperscript{rd} degree burns scar the most
• Early healing/grafting decreases scarring
• Children scar more than elderly
• Difficult to predict severity of scarring by race of patient
Principles of Hypertrophic Scarring

• Clinical signs of hypertrophic scar formation
  • Occurs a few months after injury
  • Erythema
  • Elevated skin level surface
  • Blanching upon stretch
  • Stays within area of injury
  • If across a joint, can cause contractures
Principles of Hypertrophic Scarring

• Stages of Hypertrophic Scarring
  • Three R’s vs. Three P’s

<table>
<thead>
<tr>
<th>Immature:</th>
<th>Mature:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Pale</td>
</tr>
<tr>
<td>Raised</td>
<td>Planar</td>
</tr>
<tr>
<td>Rigid</td>
<td>Pliable</td>
</tr>
</tbody>
</table>

Semi-mature: Pink, raised, Rigid

Immature Scars
Mature Scars

Before & After
Before & After

Before & After
Principles of Hypertrophic Scarring

• Rehabilitation Considerations
  • Rehab treatment is only effective on immature and semi-mature scars. A mature scar will not respond to treatment.
  • Hypertrophic scar tissue will bridge a joint and continue to contract until it meets an opposing force

Positive Pressure Therapy

• Treatment of Scars
• Provides constant and controlled pressure
  • ~Capillary pressure: 23mm Hg
• Decreases vascularity, which in turn decreases myofibroblast activity and therefore, collagen synthesis
• Encourages better orientation of collagen during scarring phase
Positive Pressure Therapy

- Pressure is applied 24 hours per day for approximately 1 year until the scars are mature
- Begins when the wounds are healed/closed
- Garment should fit tightly
- Patients should have 2 sets of garments, one to wash and one to wear

Positive Pressure Therapy

- Methods of providing pressure:
  - Ace bandages in the acute phase
  - Custom made pressure garments
  - Prefabricated pressure garments
  - Self-adhesive wraps (Coban, Cowrap)
  - Inserts
  - Splints
  - Transparent Face Masks: Heavy plastic fabricated from a mold or computer scan of the patient’s face
Custom Pressure Garments

Transparent Face Mask
Physical Therapy in the Post Acute Phase

- Should focus on
  - Stretching contracted skin
  - ROM of joints
  - Swelling
  - Strength
  - Flexibility
  - Sensation
  - Function in ADL
  - Balance

Modalities

- Modalities can used throughout the continuum of healing for different reasons from wound healing to pain control and ROM
  - Electrical stimulation
    - Can be used in open burns to help decrease bacterial load and increase wound healing
  - Ultrasound
    - Non-thermal ultrasound helps with collagen synthesis and scar maturation
    - Low-frequency, noncontact ultrasound (MIST therapy) can be used for wound healing but also assists with scar maturation
      - [https://www.youtube.com/watch?v=Hb0cKwPUcgw](https://www.youtube.com/watch?v=Hb0cKwPUcgw)
  - Massage
  - Compression
Psychosocial Aspects

- Unlike other injuries that are not always visible to others, most burns are visible and can cause self-esteem issues in patients with burns
- Other signs of emotional disturbance include anxiety, fear, anger, agitation, and depression (Boswick, 1987)
- Patients with burns often go through several phases prior truly being able to accept their injury

Psychosocial Aspects

- Psychological Phases of the Burn patient
  1. **Critical**: Pre-occupation with own somatic disorders, may experience nightmares and depression
  2. **Stabilization**: More confident of survival, depression persists, anxiety regression more evident, patients are usually more demanding
  3. **Recovery**: Behavior reflects patient’s true personality, patients are more involved in their own treatment and welfare of others
  4. **Pre-discharge**: Ambivalence about discharge, separation anxiety, bouts of depression and euphoria
Psychosocial Aspects

• Psychological considerations of the burn patient
  • Fear of death
  • Mutilation and disfigurement
  • Pain
  • Separation from family
  • Disruption of lifestyle
  • Dependence vs. Independence
  • Prolonged hospitalization and follow-up care
  • Financial impact of injury

Psychosocial Aspects

• Emotional responses to acute injury
  • Grieving
  • Guilt
  • Anger
  • Anxiety/fear
  • Depression
  • Relief to be alive
Psychosocial Aspects

• Guidelines for effective relationships with patients
  • Set short term achievable goals
  • Allow the patient to make decisions and choices when possible
  • Honor the patient's requests when legitimate
  • Acknowledge the patient's feelings
  • Encourage discussions of feelings
  • Carry out your end of the “contract”
  • Use a consistent, positive approach

Psychosocial Aspects

• Establish a contract with the patient
  • Purpose: To eliminate inconsistencies, inequality, and many of the unfavorable aspects of being a patient
Conclusion

- Burns are a very specialized aspect of physical therapy
- Must have a good understanding of the severity of the burns to be able to guide your treatment plan
  - Mobility and scar management are key
- It is important to have the patient be highly involved in their care and give them the ability to set their own goals and guide their treatment

References


References


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References


