Management of Burns

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Objectives

- To understand the methods for assessing area and depth of burns.
- To understand the methods for calculating rate and quantity of fluid to be given.
- Understand the pathogenesis of burn injury.
Objectives

At the end of this lecture, you will be able to:

- Identify types of burns and their causes.
- Describe the principles of managing a patient with burn.
- Explain proper wound management strategies.
Introduction

- Burns has a catastrophic influence on people in terms of:
  - Human life suffering
  - Disability
  - Financial loss.
THE UNLUCKY
Introduction

- **No one** is immune from Burn injury but victims usually belong to either:
  - The young (< 2 yrs)
  - The old ( > 65 yrs)
  - The unlucky
  - The careless
High Risk Groups

- The very young
- The very old
- The very unlucky (21% are bystanders)
- The very careless (\(\frac{3}{4}\)th from there own action)
THE VERY YOUNG
THE UNLUCKY
THE VERY CARELESS
Chronic Disease

- Psychological support
- Rehabilitation
  - Physical
  - Occupational
- Reconstructive surgeries
Skin

- Largest body organ

Functions

- Protection – (infection and trauma)
- Temperature regulation – (Hypothermia)
- Water tight seal – (Hypovolemia)
- Sensory perception

As ethics and physiological importance.
Epidemiology

- 45% of US admissions for the scald burn are in the children < 5 years of age
- **Flame** burn are the largest group of patients admitted to a burn unit
Causes

- **Thermal (88%)**
  - Scalds: Liquid spill or immersion, and steam (30%)
  - Contact burns (15%)
  - Fire: flash (10%) and direct flame (33%)
- **Electrical (5%)**
- Chemical
- Mechanical friction
- Radiation
- Frost Bite
SCOLD BURN
FLAME BURN
CHEMICAL BURN
CHEMICAL BURN
ELECTRICAL BURN
THE PATHOPHYSIOLOGY OF BURN INJURY

- Burns cause damage in a number of different ways, but by far the most common organ affected is the skin.

- Burns can also damage the airway and the lungs, with life-threatening consequences.
Dangers of smoke, hot gas or steam inhalation

- Inhaled hot gases can cause supraglottic airway burns and laryngeal oedema.
- Inhaled smoke particles cause chemical pneumonia and respiratory failure.
- Inhaled poisons, such as carbon monoxide, can cause metabolic poisoning.
- Full-thickness burns to the chest can cause mechanical blockage to rib movement.
Inhalation

Inhalational injury is caused by the minute particles within thick smoke, which, because of their small size, are not filtered by the upper airway, but carried down to lung parenchyma causes chemical pneumonitis and often gives rise to bacterial pneumonia.

Its presence or absence have very significance of any patient..
Inhalational injury

- Fires
- Closed space
- Singed nasal hair
- Carbonaceous material in nose & mouth
INHALATIONAL INJURY
Inhalational injury

- Direct thermal injury (upper airway)
- Chemical injury; products of combustion (lower airway)
- CO poisoning; systemic effect
Inhalation Injury

- Burn to the Respiratory Tree
  - Upper = Rapid = Obstructive
  - Lower = Delayed = Pneumonitis
- Increases mortality by 30-40%.
Intubation:

- Suspicion of inhalational injury
- Severe facial & neck burn

“easy early intubation will become difficult and impossible later on”
There are many poisonous gases that can be given off in a fire, the most common being carbon monoxide, a product of incomplete combustion that is often produced by fires in enclosed spaces.

This is the usual cause of a person being found with altered consciousness at the scene of a fire.
CO poisoning

- Toxic symptoms > 20%, death at 60%
- CO-Hb > 5% is indicative of inhalational injury but not severity
- 200 – 250 × greater affinity for Hb than oxygen
- Treatment: 100% O₂, hyperbaric oxygen
Diagnosis by

- Burn occurring in closed space
- Singed nasal hair
- Facial or oropharyngeal burn
- Carbonaceous sputum
- Strider, grunting or wheezing
- Maintain a high degree of suspicion, early intubation is mandatory
- Ventilation- Perfusion (V/Q) lung scan
- Fiberoptic bronchoscopy
Inflammation and circulatory changes

- The dangers to the airway and respiration described are readily apparent.
- Circulatory changes following a burn are more complex. Pain and the alteration of proteins by heat activate a web of inflammatory cascades.

On a cellular level, mast cells release inflammatory mediators such as histamine, primary cytokines (TNFalpha). These inflammatory factors alter the permeability of the blood vessels such that intravascular fluid escapes. And the gran molecular protein increases the oncotic pressure, more fluid escapes.
- The volume of fluid lost is directly proportional to the area of burn.

- Above 15% of surface area the loss of fluid produces shock.
Other complications of burns

- Infection from the burn site, lung, gut, lines and catheters.

- Malabsorption from the gut.

- Circumferential burns may compromise circulation to a limb.
Immediate care of the burn patient

- Prehospital care.
- Hospital care.
First Aid Scene

- Cool burn wound:
  - reduce direct thermal trauma & stabilize mast cells, reducing release of histamine and other inflammatory mediators
  - pain relief
  - running water (15 degree C.)
  - worth considering for up to 2 hours
Initial Evaluation

- **Burn = Trauma**

- **Systemic Evaluation:**
  - Prevent further burn
  - A - Airway
  - B – Breathing Ventilation
  - C - Circulation
  - Other concomitant *life threatening* injuries
  - Burn wounds

- A burn in multi injured patient will not rapidly cause the patient’s death but other injuries will.
Initial Management

- ABC
- Prevent Further Exposure
- Maintain Body Temperature
- Fluid Therapy
- Urinary catheter
- Nasogastric tube
- Feeding
- Tetanus immunization.
- H2 Blockers.
History

- When?
- What care has been given?
- What burned with?
- Burned in closed space?
- Loss of consciousness?
- Past medical history
AB - Airway and Breathing

- Assess for potential airway involvement
  - Soot or singing involving mouth, nose, hair, face, facial hair
  - Coughing, black sputum
  - Enclosed fire environment
- 100% oxygen
- Assist ventilations as needed
- Be prepared to intubate early if patient has inhalation injuries
C - Circulatory Status

- Burns do not cause rapid onset of hypovolemic shock
- If shock is present, look for other injuries
- Circumferential burns may cause decreased perfusion to extremity
- Start through burn if necessary
- Upper extremities
Examination

- Thorough inspection of the patient:
  - Blast injury
  - Fall injury
  - Airway compromise
  - Child abuse
Burn wound?

- Cell damage starts at 41 Deg Celsius
- Coagulation of Protein > 50 Deg Celsius
- Depth of wound: Temperature, Duration
- Chemicals: ph, strength
- Electricity: voltage, entry-exit points
Depth

- Epidermis
- Dermis
- Hypodermis
- Muscle

Burns can be classified based on depth:
- 1° (First-degree):
  - Epidermis only affected

- 2° (Second-degree):
  - Epidermis and Dermis affected

- 3° (Third-degree):
  - Epidermis, Dermis, and Hypodermis affected

- 4° (Fourth-degree):
  - Hypodermis and Muscle affected
Depth

Jackson’s classification

- Coagulation.
- Stasis.
- Hyperemia
Burn Wound Evaluation

- Depth
- Extent (%TBSA)
- Location
- Pre-injury Status
1<sup>st</sup> Degree Burn
(Sun Burn)

- Only Epidermis
- Flashes or sunburns.
- Red, Dry
- Very sensitive to touch
- Very painful
- No blisters
- Heals spontaneously
1st Degree Burn
2nd Degree Burn (Partial thickness burn)

- Epidermis + Dermis
- Red-white
- Wet-fibrinous exudate
- Sensitive to touch
- Painful
- Blisters
2nd Degree Burn
(Partial thickness burn)

1) Superficial partial thickness:
   - Epidermis and superficial dermis
   - Severe pain, moist, Red.
   - Thin walled fluid filled blisters.
   - Heals in 2-3 weeks
2nd Degree Burn (Partial thickness burn)

2) **Deep partial thickness burn.**

- Extends into the reticular dermis.
- Dark red, yellow-white
- Blisters are thick walled and commonly ruptured.
- Usually requires skin grafting.
Partial thickness deep

- Grey-white
- Dry
- Little to no pain
- Reepithelialization with copious scarring over weeks (extensive collagen deposition)
3rd Degree Burn (Full thickness burn)

- All Epidermis + Dermis
- Flame, immersion, scalds and electricity.
- White-Black, charred and leathery
- Pale, mistaken for normal skin
- Bright-red, hemoglobin in the sub-dermis
- Painless
- Underlying thrombosed vessels No blisters
- Excision and grafting.
Full thickness

- Dry
- No pain
- Clay like colour, white, charred
- Leathery
- No spontaneous wound closure possible
  (except very small wounds)
4th Degree Burn

- Deep tissues (fascia, muscle, bone, and other structure)
- Electrical Burns
- Needs Surgery
What is Important

- Determination of burn depth is of less significance on initial evaluation than the extent of the burn injury.

- There is underestimation of the burn depth initially and those termed first degree often are superficial second degree, sloughing the next day.
Extent of Burn Wounds

[Rule of 9's]

Anterior

Infant

Posterior

Palmar Method
(Patient’s palm)
Lund and Browder Charts

RELATIVE PERCENTAGE OF BODY SURFACE AREA AFFECTED BY GROWTH

<table>
<thead>
<tr>
<th>AREA</th>
<th>AGE 0</th>
<th>1</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>ADULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - ½ OF HEAD</td>
<td>9½</td>
<td>8½</td>
<td>6½</td>
<td>5½</td>
<td>4½</td>
<td>3½</td>
</tr>
<tr>
<td>B - ½ OF ONE THIGH</td>
<td>2¾</td>
<td>3¾</td>
<td>4</td>
<td>4½</td>
<td>4½</td>
<td>4½</td>
</tr>
<tr>
<td>C - ½ OF ONE LEG</td>
<td>2½</td>
<td>2½</td>
<td>2½</td>
<td>3</td>
<td>3½</td>
<td>3½</td>
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DEGREE OF BURN

<table>
<thead>
<tr>
<th>DEGREE</th>
<th>1st (Erythema)</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
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</thead>
<tbody>
<tr>
<td>HEAD</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
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<tr>
<td>Neck</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Ant. Trunk</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Post. Trunk</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Right Arm</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Left Arm</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
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<tr>
<td>Right Leg</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Left Leg</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Total Burn</td>
<td>12%</td>
<td>12%</td>
<td>12%</td>
<td>12%</td>
<td>12%</td>
<td>12%</td>
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</table>
3D Mapping

Solution: Three-Dimensional Mapping

mapping of patient burn regions from two-dimensional Lund-Browder diagram to three-dimensional finite element mesh

www.epri.com
Burn Severity

- Sever Burns – Burn Unit
- Moderate Burns – Admission
- Mild Burns - Outpatient
Large Burns (20 - 30%)

- Quantity of mediators is large
  : whole body oedema

- Hypovolaemic shock

- Fall in plasma volume

- Fall in cardiac output
Indications for admission to BU

- > 5% FT at any age
- > 10% PT in <10 yrs >50yrs
- > 20% PT in adults, between 10 and 50 yrs
- Special areas: face, perineum, hands, feet
- Electrical (including lightening)
- Chemical
- Inhalational injury
Sever Burn

- The American Burn Association guidelines
  - 2nd degree burns >10% TBSA in <10 or >50 years
  - 2nd degree burns > 20% TBSA in other age groups.
  - 3rd degree burns >5% TBSA in any age
  - Burn of the face, hands, feet, genitalia, perineum or the skin overlying major joints
  - Electrical injury including lightening injury
  - Chemical injury
  - Burn injuries with associated
    - Inhalation injury
    - Concomitant mechanical trauma
    - Significant preexisting medical disorders
# Fluid Therapy

- **Objective**
  - HR < 110/minute
  - Normal sensorium (awake, alert, oriented)
  - Urine output - 0.5-1 cc/kg/hr
- **Crystalloids in the first 24 hours (R/L)**

<table>
<thead>
<tr>
<th>Parkland Formula</th>
<th>Adults (R/L)</th>
<th>Children (G½S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Day</td>
<td>%TBSA x Wt x 4</td>
<td>%TBSA x Wt x 3 + Maintenance</td>
</tr>
<tr>
<td>2nd Day</td>
<td>%TBSA x Wt x 1</td>
<td>%TBSA x Wt x 1 + Maintenance</td>
</tr>
</tbody>
</table>
Colloids

- After 24 hours
- Protein
- 5% Albumin @ 0.5 ml/kg/% TBSA
Formula is a guideline

U.O.P. of 0.5 ml/kg/hr in adults
U.O.P. of 1 ml/kg/hr in children
Nutritional Considerations

- Hyper-metabolic state lasts until the wound is closed in some fashion
- Adequate nutrition is an important factor to maximize patients survival and minimize complications
Failure of Resuscitation

- Delayed resuscitation
- Consider other injuries
- Co-exist medical problems/medications
- Error in estimation of burn size & depth
- Inaccurate notes
- Inhalation injury
Extra Fluid is Required in

- Children
- Inhalation injury
- Electrical injury
- Delayed resuscitation
- Dehydration
  - Fire-fighters
  - Intoxicated patients
Monitoring Resuscitation

- Urinary output
- Heart rate
- Blood pressure
- Central invasive haemodynamic
- Electrolytes
- Blood gases
- pH (<7.39 - lactic acidosis ?)
Analgesia

- Never IM
- Best pain control is by Infusion
- Morphine Sulfate
  - 0.1 mg/kg
  - May require large but tolerable total doses
Escharotomy

- Chest: To allow respiratory movement
- Limb: To restore circulation in limb with excess swelling under rigid eschar
Limbs: Signs of Circulatory Obstruction

- Loss of distal circulation
  - pallor
  - coolness
  - absent pulse
  - loss capillary refill
  - decreased oxygen saturation
- Pain on passive extension
- Deep pain at rest
Escharotomy

- Circumferential burns and the leathery eschar that can cause a decrease in chest wall expansion or circulatory compromise in the limbs
- Non-circumferential burn does not rule out Escharotomy
Infection

- Major cause of death
- Burn wound sepsis
- Invasive devices
- Upper and lower respiratory tract infection
- Urinary Tract Infection
- Osteomyelitis
- Suppurative phlebitis
Antibiotics

- Prophylactic systemic antibiotics play no role in the management of acute burn wounds and provide no protection against microbial colonization of burn Eschar.
- In fact they increase the risk of developing opportunistic infections.
Assessment of burn wound

- Remove all clothes/ maintain warm temp.
- Remove all jewellery
- Check the back
- Estimate % BSA burn
- Estimate depth
- Recognize need for escharotomy
Burn Wound Care

- Adequate sedation and analgesia
- Mechanical debridement
- Use mild soap, tap water and cloth
- Shower tables preferred to hydrotherapy Tanks
- Managing blisters
- Apply moisture non-adherent dressing
- Topical antimicrobial agents
Burn Wound Care

- Topical antibiotics limit microbial proliferation in the burn wound until burned tissue can be surgically excised.
- Topical agents should ideally have broad spectrum coverage that minimize the colonization of the burn wound and do not necessarily need to deeply penetrate the burn eschar.
Topical Antimicrobial Agents

- Silver Sulphadiazine
  - Intermediate Penetration
  - Painless
  - Thin pseudo-eschar
  - Ineffective against Gram –ve
  - Neutropenia & Thrombocytopenia
Topical Antimicrobial Agents

- Nitrofurazone
  - Poor penetration
  - Painful
  - NO Silver
  - Superficial Burns
  - Up to once a week
Topical Antimicrobial Agents

- Silver Sulphadiazine with Cerium
  - Same as previous
  - Thicker pseudo-eschar
  - Prevents pain
  - Prevents water loss
  - Promotes healing
Topical Antimicrobial Agents

- Mefenide Acetate
  - Good penetration
  - Painful
  - Penetrates (ears and nose)
  - Broadest spectrum, pseudomonas
  - Strong carbonic anhydrase inhibitor causing hyperchloremic acidosis
Sulphadiazine with Cerium
Topical Antimicrobial Agents

- MEBO
  - Exposed Dressing
  - Painless
  - Superficial Burns
PRINCIPLES OF BURN RECONSTRUCTION

- Direct closure
- Adjacent tissue transfer
- Skin grafts; FTSG vs STSG
- Cultured epithelial autografts
- Flaps
- Tissue expansion
Surgery for the acute burn wound

- Any deep partial –thickness and full –thickness burns, except those which are less than 4cm need surgery.

- In deep dermal burns, the top layer of dead dermis is shaved off until bleeding is observed.

- Full-thickness burns require excision of the skin down to viable fat.

- Wherever possible, a skin graft should be applied immediately.

- Physiotherapy and splints are important in maintaining range of movement and reducing joint contracture.
Maximise Function and Appearance

1. Function - early reconstruction
2. Appearance - early reconstruction

(particularly face)
Surgical Therapy

- Sharp Debridement (tangential, epifascial)
- Split Thickness Skin Grafts
- Alternative Wound Coverage
Grafting

Early
- Preventing excessive fluid and electrolyte loss
- Prevents infection
- Decrease burn pain
- Decrease hospitalization
- Better psychological effect.

Late
- Patient more stable and enter in the anabolic phase.
- Less of blood loss.

Disadvantage:
- Loss of a lot of blood.
- Elongation of catabolic phase.
FINGERS CONTRACTURE!!!!!
FULL THICKNESS BURN
SIX MONTHS LATER
SIX MONTHS LATER
OUTCOME

PROGNOSIS

Sum of Age in years

Plus

Area of burn in % TBSA

< 80 good
80-100 life threatening
>100 bad
In 1993 the LA 50 (defined as burn size lethal to 50% of patients) in most burn units approached 75% total body surface area.

Between 1971 and 1991, deaths attributed to flames and hot liquids dropped an estimated 40% while deaths from smoke inhalation decreased only 12%.
OUTCOME

Causes of improvement

- Early and effective resuscitation
- Control of sepsis
- Improved management of inhalational injury, ventilation, ICU care.
- Early excision
- Development of alternative wound closure material
- Nutrition
- Team approach
Delayed reconstruction and scar management

- Is common for large full-thickness burns.
- Eyelids must be grafted before exposure keratitis arises.
- Burn alopecia is best treated with tissue expansion of the unburned hair-bearing skin.
- Z-plasty is useful in the situation in which there is a single band.
- Transposition flap is useful in wider bands of scarring.
- Hypertrophy of many scars will respond to pressure garments.
- In small area of scarring injection steroids is useful.
Integra™ Artificial Skin

- Bilayer skin replacement system
- Composed of 2 layers
  - Dermal regeneration layer
    - Cross-linked bovine collagen
    - Glycosaminoglycan (Chondroitin-6-sulfate)
  - Temporary epidermal layer
    - Silicone layer
FULL THICKNESS BURN
21 DAYS LATER
ONE YEAR LATER
Non-thermal burn injury

- Electrical injuries:
- Divided into - low- and high- voltage injuries , the threshold being 1000V.
  - **Low-voltage injuries** cause small, localized , deep burn.
  - Do not have enough energy to cause destruction to subcutaneous tissues when the current passes through the body , the resistance is too great.
  - The entry and exit points , normally in the fingers and these may cause underlying tendon and nerve damage.
  - They can cause cardiac arrest through pacing interruption with out significant direct myocardial damage.
- **High-voltage injuries:**
- Damage by flash (external burn) and conduction (internal burn)
- Myocardium may be directly damaged without pacing interruption.
- Limbs may need fasciotomies or amputation.
- Look for and treat acidosis and myoglobinuria.
Chemical burns

- There are over 70,000 different chemicals in regular use within industry.

- The more common burns are caused by either acids or alkalis.

- The initial management of any chemical burns is by copious lavage with water.

- Alkalis are usually the more destructive and are especially dangerous if they have come in contact with the eyes.

- The next step in management is to identify the chemical and assess the risks of absorption.
Complications

- Early
  - Sepsis
  - Renal Failure
  - GI Bleeding
  - DVT + PE
Complications

- Late
  - PUD
  - Chronic Renal Failure
  - For electrical burns: cataract, transverse myelitis
  - Scarring
Case

- 35 years old male
- 30 % TBSA Deep Burn
- pulse rate = 180/min

- 1st day
- 2nd day (with analgesia)
- 10th day