OBJECTIVES

1. Learn the nomenclature of burns.
2. Understand the expected rate of healing.
5. Acute burn management in the field.
6. Acute burn management in the trauma center.
7. Indications for transfer to a pediatric burn center.
8. Long-term management of pediatric burns.

DISCLOSURES

Consultant to Mimedx
Grant recipient from Medline
**ANATOMY OF THE SKIN**

**NORMAL HEALTHY SKIN**

- Epidermis
- Dermis
- Subcutaneous tissue

**1ST DEGREE BURN**

Affects only the first layer of skin
- Mildest type of burn
- Often referred to as a "superficial burn"
- Can be very painful
- May require medical help

**2ND DEGREE BURN**

Results in damage extending beyond the top layer of skin
- The skin will blister and become extremely red and sore
- Should be assessed by a doctor for risk of infection
- If over-the-counter pain relief is not sufficient, a prescription medication may be required

**3RD DEGREE BURN**

Affects all layers of skin
- Severe burn
- Requires medical attention immediately
**3RD DEGREE BURN**

Burn extends through every level of skin
One of the most severe burns
If extensive nerve damage has occurred, there may not be any pain
Common signs of a third-degree burn include:
- Bleeding
- Appearing a bit black
- Skin appearing dry or leathery
- May looks little bit black, or skin appears dry or leathery

**4TH DEGREE BURN**

This is the most severe type of burn
Fourth degree burns penetrate deeply beneath the skin
There is potential for nerve damage and injury to deeper tissues including muscles, tendons, and bones
Due to nerve damage, there may not be any pain
Burns may appear white, brown, yellow, or blackened
Seek emergency medical care immediately

**PATHOPHYSIOLOGY OF BURNS**

- Inflammatory reaction leading to rapid edema formation.
- Increased microvascular permeability.
- Vasodilatation and increased extravascular osmotic activity.
  - Direct heat effect on the microvasculature releases chemical mediators of inflammation.
  - Increased venous permeability caused by histamine release.
PATHOPHYSIOLOGY OF BURN INJURY

- Damage to the cell membranes partly caused by oxygen-free radicals released from polymorphonuclear leukocytes.
- Activates the enzymes catalyzing the hydroxylation of prostaglandin precursor (arachidonic acid) with rapid formation of prostaglandins.
- Enzymes catalyzing the hydroxylation of prostaglandin precursor (arachidonic acid) with rapid formation of prostaglandins.
- Prostaglandins inhibit the release of norepinephrine and may thus be of importance in modulating the adrenergic nervous system which is activated in response to thermal injury.
- Thermal increases in the numbers of vacuoles and many open endothelial intercellular junctions in the blood/lymph barrier.
- Continuous loss of fluid from the blood circulation within the thermally damaged tissue causes hypotension with decreased cardiac output and hypoperfusion on the cellular level.

PATHOPHYSIOLOGY: TREATMENT STRATEGIES

- If the fluids are not adequately restored burn shock develops.
- Burn wound provides a vast area of entry of surface infection with a high risk of septic shock.
- Hypermetabolic state

STRATEGY OF BURN MANAGEMENT

Prehospital goals
- Remove from threat in environment
- ABCs
- Remove burned clothing
- Cover with dry dressing
- Transport to nearest burn or trauma center

Hospital goals
- Accurate diagnosis of TBSA
- Accurate diagnosis of depth of burn
- Precise fluid resuscitation
STAGES OF WOUND HEALING

PHASES OF WOUND HEALING

METHODS OF WOUND CLOSURE

- Most wound healing: Hydrogel
- Antibacterial ointment: Bacitracin, Silvadene
- Calcium Alginate
- Mepilex / AG
- Suprathel
- Amnion
- Fish skin
- Cadaveric skin
- Autografts: meshed and full thickness
- Cell biopsy and culture
IDEAL PEDIATRIC GRAFT FOR SKIN SUBSTITUTE

- Protective barrier.
- Biocompatible.
- Available widely with long shelf life.
- Demonstrated clinical and scientific data.
- Flexible to the depth and contour of the wound.
- Easy to apply and secure.

STSG
Lacks antigenicity - biocompatible.
May not be available if burn volume large.
Costly in pain and suffering to child.
% take variable related to wound, infection.
Meshed grafts flexible.
Scarring and contracture rate high.
Securing grafts in hands, face, feet, genitalia can be challenging.

STSG ALTERNATIVES

Biologic grafts
- Porcine or cadaveric skin (potential physiologic rejection).
- Placental derived allografts.
- Fish skin

Synthetic materials
- Hydrocolloids or hydrogels (moist wound healing).

Biosynthetic
- Suprathel, Integra® (requires graft), Apligraf® (short shelf life), Dermagraft® (foreskin)

Image Above: Micrograph of Hematoxylin and Eosin (H&E) stained cross section of dehydrated Human Amnion/Chorion Membrane (dHACM), with cell nuclei.
EXPECTED RATES OF WOUND HEALING: 1ST AND 2ND DEGREE BURNS

- Hydrogels
- Antibacterial ointments
- 7-14 day expected wound closure

EXPECTED RATE OF WOUND HEALING: >14 DAYS

Standard of care
Skin grafts
Split thickness
Full thickness
Skin bx and culture

DHACM FOR TREATMENT OF PEDIATRIC BURNS

- Authors: Natasha Ahuja, Richard Jin, Colin Powers, Alexandria Billi, and Kathryn Bass
- Publication: Adv Wound Care, 2019.
- Retrospective study
SUMMARY OF OUTCOMES

dHACM - time to closure accelerated – 15-21 days\(^1\)

STSG average time to closure greater – >21 days\(^1\)

dHACM scar and contracture 20.8\(^\%\)\(^2\)

STSG scar and contracture as high as 57\(^\%\) to 64\(^\%\)\(^2,3\)

Excellent cosmesis\(^1\)

Low infection rate – one late fungal rash.\(^1\)

\(^1\) Ahuja et al., Adv Wound Care, 2019. \(^2\) Cubison et al., Burns 2006;32:992–999. \(^3\) Rotatori et al., Burns 2019;45:1066–1074.

SYSTEMS OF CARE

Prehospital
  - ground crews
  - air transport: helicopter, fixed wing

Trauma Centers
  - Level 1, Level 2, Level 3

Burn Centers
  - >10\(^\%\) TBSA burns, special considerations (hands, face, feet, genitalia)

Wound Care Centers
  - small and moderate burns, special considerations with advanced wound care.

CDC FIELD TRIAGE CRITERIA

Step Four

- Fever
- Severe adult°: Risk of injury death or severe injury age >10 years
- Obstetric\(\text{Triage Level 1}\):
  - Trauma
  - Emergency medical evacuation
  - Transport to trauma center
  - Fetal distress
  - Critical care
  - Inpatient care
- Pregnancy >19 weeks
- GESTATION (gestation >19 weeks)
PREHOSPITAL CARE

Ground transport
Air transport
  * Remove from environment and remove affected clothing.
  * ABGs
  * Airway considerations
  * Oxygen
  * IV access for fluid bolus
  * Wound coverage - dry and clean
  * Attention to body temp regulation

PARKLAND BURN FORMULA - PEDIATRIC CARE

Charles R. Baxter, MD, (d. 2005)
  * Director of the emergency department at Parkland Memorial Hospital in Dallas, TX
  * Founded the Parkland Hospital Burn Unit and was an active researcher, making advances in the treatment of burn victims and trauma procedures.
  * Dr. Baxter was also one of the physicians who unsuccessfully tried to save John F. Kennedy after he was shot in 1963.

PARKLAND BURN FORMULA

- For use in pediatric patients with acute burns.
- Used as a guide.
- Patient physiology guides titration of fluids: Mental status, HR, BP, urine output.
- Fluid creep - excessive fluid resuscitation is detrimental to patient outcomes.
- Inhalation burns may require less fluid - the lung will leak fluid and impair gas exchange via the alveolus.
- Electrical burns may require more fluid - deep space injury will increase the risk for compartment syndrome in the extremities.
- The Parkland Burn Formula was designed for children - to rapidly restore intravascular volume, avoid hypotensive shock, optimally preserve cell mass.
PARKLAND BURN FORMULA

- Use 4ml of LR solution.
- Estimate or weigh the body mass in kg.
- Estimate percent body surface area of burn - *exclude 1st degree burns.

24 hour fluid requirement (ml) = 4 ml (LR) x Wt (kg) x TBSA %

Give the first half of the total volume calculated in the first 8 hours.

Give the second half of total volume during the remaining 16 hours.

RULE OF NINES ADULTS

Each Arm : 9 %
Each Leg : 18 %
Head : 9%
Front Torso : 18 %
Back Torso : 18 %

RULE OF NINES CHILDREN

Each Arm : 9 %
Each Leg : 14 %
Head : 18%
Front Torso : 18 %
Back Torso : 18 %
1% TBSA MEASUREMENT

TRAUMA CENTER

Resuscitation
ATLS protocol
primary survey - calculate %TBSA
start fluid resuscitation - 24 hour volume = 4ml L/H/kg/hr
1st half volume in first 8 hours.
2nd half volume in remaining 16 hours.

Admission
to the general surgery ward / IMCU for pain control, fluid management,
to the PICU for critical monitoring, airway control, fluid monitoring.

BURN SEVERITY

First Degree (Partial Thickness)
Superficial, red, sometimes painful.

Second Degree (Partial Thickness)
Skin may be red, blistered, swollen. Very painful.

Third Degree (Full Thickness)
Whitish, charred or translucent, no pin prick sensation in burned area.
SEVERITY?

INDICATIONS FOR TRANSFER TO BURN CENTER
INDICATIONS FOR TRANSFER TO A BURN CENTER

1. Partial thickness burns greater than 10% total body surface area (TBSA).
2. Burns that involve the face, head, hands, feet, perineum, perineum, or major joints.
3. Third degree burns in any age group.
4. Electrical burns, including lightning injury.
5. Chemical burns.
6. Inhalation injury.
7. Burn injury in patients with accompanying medical disorders that could complicate management, prolong recovery, or affect mortality.
8. Any patient with burns and concomitant injuries (such as fractures) in which the burn injury poses the greatest risk of morbidity or mortality to such patient. If the burn poses the greater immediate risk, the patient may be initially stabilized in a trauma center before being transferred to a burn unit. The treating physician will be necessary in such situations, and should be in concert with the regional medical control plan and triage protocols.
9. Burn injury in patients who will require special social, emotional, or rehabilitative intervention.
10. Burn injury in patients who will require special social, emotional, or rehabilitative intervention.

BENEFITS: LOCALIZED SITE OF SERVICE

- No separation of child from family.
- No hardship for parents to travel.
- Less loss of time from other family members.
- More time in home community for work.
- Better access to other social supports in home community.
- Eliminates healthcare costs of transfer.

LONG TERM OUTCOMES: VANCOUVER SCAR SCALE

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