L3

Burn

The lecture ends at slide number 9. The rests are EXTRA

Objectives:

- Define Burn.
- Discuss the incidence of burn.
- Discuss the pathophysiology of burn.
- Recognize the calculation.
- List the types of burn.
- Explain the inhalation injury.
- Discuss the burn management:
  - Non-surgical: tetanus, analgesia, dressing, fluid, foley catheter.
  - Surgical: escharotomy, skin grafting.
- Identify the complication of burn.
- Explain the electrical burn.
- Explain the chemical burn.

Color index:

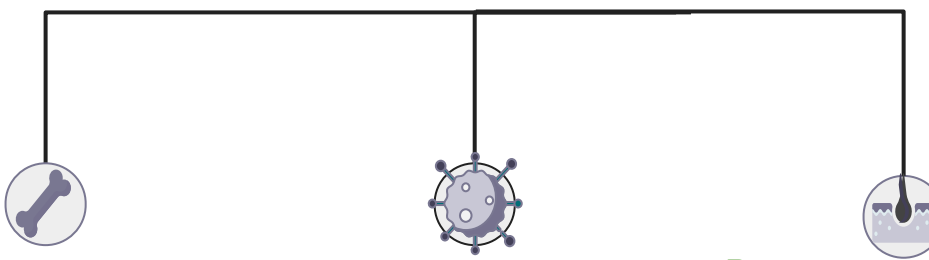
Main Text
Males slides
Females slides
42 Doctor notes
39 Doctor notes
Textbook
Important
Golden notes
Extra

Editing file

Skin Anatomy (overview)

Extra

Functions of the skin:

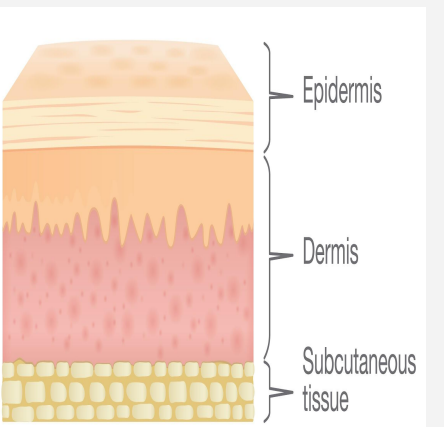


Protection of muscles, bones, ligament and organs.

Forms a barrier to infectious pathogens

Prevent water loss

Structure of the skin:

Epidermis	Dermis	Subcutaneous tissue (Hypodermis)
- The outer protective layer of the skin. - Composed of keratinised, stratified squamous epithelium through which three appendages (hair follicles, sweat glands and sebaceous glands) pass to subcutaneous tissue. -These appendages can escape destruction in partial-thickness burns and are therefore a source of new epidermal cells for reconstitution of the epidermis. -The basal layer of the epidermis generates keratin-producing cells (keratinocytes) and pigment cells (melanocytes) that produce melanin, which is passed to the keratinocytes and protects the basal layer from ultraviolet light and determines hair colour.	-Subclassified into two layers: 1- Papillary Dermis (upper part of the dermis). 2- Reticular Dermis (lower part of the dermis). Healing process happen here (by blood > healing by whatever left in the skin) -The Dermis, which is bound to the epidermis through a basement membrane, is composed of three cell types (fibroblasts,macrophages and adipocytes), collagen, elastic fibres and an extracellular gel-like matrix. -It supports the blood vessels, lymphatics, nerves and the epidermal appendages as well as pressure and temperature receptors.	- Made of fat and connective tissue. - It insulates & pads deeper tissue. - It anchors the skin to the muscle. 

Burn

Definition:

- Destruction of tissues caused by various etiologies including flames, and hot liquids, that ranges from trivial to life threatening which requires extensive treatment and rehabilitation with the chances of permanent dysfunction and distortion.
- Coagulative necrosis of the skin due to an insulting agent .

Incidence:

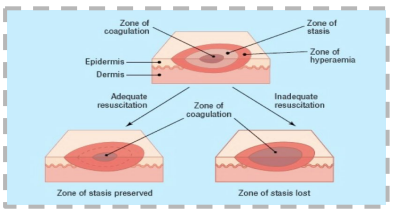
Extra

1. Estimated 2 million burns per year in the US.
2. 500K burns treated in the ER.
   70K burn hospital admissions.
   Third quarter of burns are managed at home .
3. Mortality is highest in the age groups: 2-4 years & 17-25 years .
   High mortality rate among younger groups .
4. Deep hand burns are a criteria for referral to burn center or hand specialist.The treatment depends on how deep and how much it penetrates the tissue.
5. Industrial accidents account for the majority of electrical and chemical burns.
   Alcohol and smoking are a common contributing factors in local burn injuries.
   Frost bites have the same physiology and the same presentation as burns but it has a completely different treatment as frost bites is limited on the skin and is non invasive (no systematic effect).

Burn

Types :

1. **Thermal :**
   - Scald "most common"
   - Friction
2. **Chemical :**
   - Alkali
   - Acids
3. **Electrical :**
   - Low voltage (<1000v) في البيت
   - High voltage (>1000v) مراكز ومحطات الكهرباء والميترو



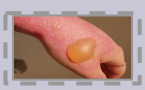
Pathophysiology of Burn:

1. **The local effects** are the result of tissue destruction and inflammatory response.vasodilation, increased capillary permeability, fluid loss into interstitial space.
2. **Systemic effects (>20% TBSA)** the inflammatory response (inflammatory cells will produce cytokines) to injury causes capillary dilation (manifested as erythema) in mild cases, or if there is capillary damage, that leads to protein leakage and edema.
3. Insensible fluid loss can cause severe hypovolemia which might progress to hypovolemic shock (when > 15% of the body surface area is burned) and decreased preload.
4. Destruction of the Epidermis causes impairment of the physical barriers and predispose to infections which can delay healing and increase energy demand.
   immunosuppression, catabolism, loss of protective layer of skin and gut, pulmonary edema
5. **Zones of the burn area :**
   1-Zone of Necrosis coagulations: a central area of irreversible coagulative necrosis, its extent is determined by the duration of contact with the heat source and the degree of heat transfer to the skin.
   2-Zone of stasis: an area of potential reversible cell damage surrounding the central zone (tissue is damaged with decreased perfusion but still viable). Its viability depends on aggressive fluid resuscitation.
   3-Zone of hyperemia: an area characterized by inflammation and increased blood flow surrounding the stasis zone.Viable

Assessment :

- **Depth**
  - 1st degree
  - 2nd degree
  - 3rd degree
  - 4th degree
  - superficial
  - superficial Partial Thickness
  - Deep Partial Thickness
  - Full Thickness
- **Body Surface Area**
  - **Rule of Nines**
  - **Palm Rule 1%**

Classification of Burns Based on the Depth of Skin Injury [1] (main clinical classification):

	Degree	Treatment
superficial burn (First Degree) 	- No interruption of epidermis. - Epidermal injury only - Painful - Clinically characterized by: **erythema only**. No fluid collection occur at this degree **- No blistering** - Most common presentation is kitchen burns and sunburns.	Heals within 3 days - 1 week Extra: - Symptomatic treatment: ○ Mild analgesics/NSAIDs pain is the commonest presentation Local wound care: ○ Daily cleansing. ○ Topical **antibiotics** (**silver sulfadiazine**)[2] if needed. -Elevation (raise patient's hand up to reduce edema) -Occupational therapy ○ Splints in functional position. ○ Early range of motion.[3]
Superficial partial thickness (Second Degree)  	- Injury to epidermal +/- dermal[4] layers. - pale pink - Clinically characterized by: Very painful because the nerve is affected partially **blisters** [4] (Hallmark of Second degree burns). less sensate - Blistering present - Skin is repopulated by viable germinal cells in follicles (has stratified squamous epithelium).[5]	Heals completely without scar in 1- 2 weeks Extra: -Similar to first degree burns. **-Leave blisters intact** they are the best natural dressing [7]. If debrided, cover with an occlusive dressing. -Compression garment after wound epithelialization.

Classification of Burns Based on the Depth of Skin Injury [1] (main clinical classification) cont..:

	Degree	Treatment
Deep Partial Thickness (Third Degree) [6] 	• Pink (more whiter → more deeper, if more plexuses are injured, the skin will appear whiter) • Less sensate • No blistering	• Heals with scar in 2 weeks • Infection could convert it to full thickness burn so resustasion is important • We clean the wound surgically until we reach healthy tissue then we remove a skin patch from one area of the body and transplant it to the burned area
Full thickness (Fourth Degree) 	• Leathery • Dry • Insensate	• Doesn't heal (unstable hypertrophic scar) • Usually happens in unconscious patients Treatment options: • Debridement and skin graft • Lap coverage with salvage procedures

1- In clinical practice, most burns are a mix of types. Any burn is surrounded by lighter zones eg: 2nd degree burns are surrounded by 1st degree burns and 3rd degree burns are surrounded by an engorge erythematous area (2nd degree burns). First site to come in contact with the burning agent is the deepest site of the burn. Retainment of sensations at the site of the burn suggest more superficial injury.

2-AKA: Flamazine is the **gold standard** in preventing infections due to its broad spectrum activity (covers both gram negative and gram positive bacteria).

3-Start early physical therapy if burns and edema are near a joint.

4-Blistering occur when the burn exceed the basement membrane of the epidermis going down to the dermis.The burn is painful due to the exposure of the nerve endings in the dermis. **the same note for 442.**

5-In partial thickness burns the epithelium lining the skin appendages is preserved and heals the wound by creating new epithelium in a process called (**epithelization**)so the burn has the ability to heal by it self, unlike full thickness burn where there's no remaining appendages to heal the skin eg: Deep 2nd degree burn > "the burn has exceeded reticular layer of the dermis" leading to delayed healing and scarring and surgical intervention is indicated.

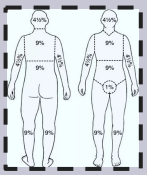
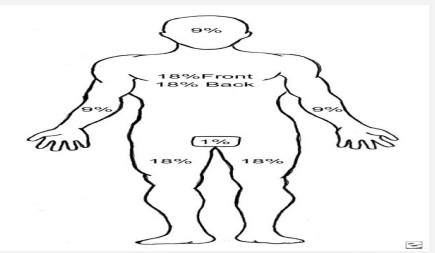
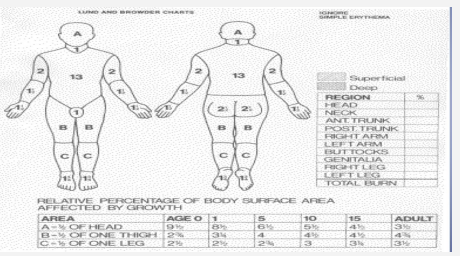
6-Whitish in color; Skin has 5 vascular plexuses, the most important are the Sub-dermal and Sub-epidermal plexuses, these Plexuses provide blood to the skin (give the reddish appearance of the skin).In 3rd ° burn These plexus are gone = no blood supply = skin looks white. **the same note for 442.**

white skin = no skin content to re-Heal = Surgery is required.

7- The closed intact blisters if kept in a dry & clean environment is better for wound healing except if the blister is infected then a certain medications that should be used for treating the infection and if there is open area or open wound you have to treat the infection.

Body Surface Area:

- Superficial burns don't count.

Palm Rule	❖ The size of the patient's hand is almost 1%. ❖ Palm without fingers = 1% **(Palmer method "rule of palm")** it's another way to estimate the size of a burn
Rule of Nine  Click here for a table	❖ Used to approximate burn size. ❖ Divides the body into areas that each represent approximately 9% of the total body surface area (TBSA) of an adult ❖ in children, the head size is relatively large (and the limbs are relatively small) It's less useful, so we use Lund and Browder chart ❖ Head in kids = 18% (9% in adults) ❖ Single leg in kids = 9% (18% in adults) ❖ **In summary:** give 2L IV line → adjust according to your measurements → adjust according to urine output.
Wallace Rule of Nine Click here to view the picture	
Lund and Browder Chart Click here to view the picture	

Burn Assessment cont..:

❖ **First : rule out inhalational injuries:** Click here for more info

- **Hints:** How to rule out inhalational injuries?

- Closed space fires
- Loss of consciousness
- Difficulty in breathing or stridor
- Facial burns
- Presence of singed nasal hair.
- presence of carbonaceous material in mouth or throat

Burn Assessment cont..

- **Second : rule out compartment syndrome** (when the capillary pressure exceeds 32mmhg, causing compression of the muscle, fascia, arteries, and nerves):

Click here for more info

- **6 Ps ;** How to rule out compartment syndrome?

Pain
Paresthesia
Pallor
Pulselessness
Poikilothermia
Paralysis

Treatment : **Escharotomy**

Hx	Px
❖ Time Since Injury ❖ Circumstances of the injury ❖ Closed space fire ❖ LOC ❖ Method of evacuation ❖ In chemical burns, the type and amount of the agent, duration of contact. ❖ In electrical burns, voltage and duration of intact. ❖ Associated injuries. ❖ Comorbidities.	❖ **ABCDE** ❖ General look ❖ Assessment of the consciousness ❖ Vital signs ❖ Local Exam (Size, site, depth, pulses, sensation).

Criteria for referral to Burn Center:

- Second-degree burns:
  - > 20% in adults.
  - > 10% in children and elderly.
- Any third-degree burns.
- Burns in the face, hands, feet, and genitalia.
- Inhalational injuries.
- Electrical burns · Chemical burns.
- Burns with comorbidities or pregnancy.
- Legal issues.
- Lack of trained personnel in burns.

Burn Center Referral Criteria

1. Partial-thickness and full-thickness burns totaling greater than 10% TBSA in patients under 10 or over 50 years of age.
2. Partial-thickness and full-thickness burns totaling greater than 20% TBSA in other age groups.
3. Partial-thickness and full-thickness burns involving the face, hands, feet, genitalia, perineum, or major joints.
4. Full-thickness burns greater than 5% TBSA in any age group.
5. Electrical burns, including lightning injury.
6. Chemical burns.
7. Burn injury in patients with preexisting medical disorders that could complicate management, prolong the recovery period, or affect mortality.
9. Any burn with concomitant trauma (e.g., fractures) in which the burn injury poses the greatest risk of morbidity or mortality. If the trauma poses the greater immediate risk, the patient may be treated initially in a trauma center until stable, before being transferred to a burn center. The physician's decisions should be made with the regional medical control plan and triage protocols in mind.
10. Burn injury in children admitted to a hospital without qualified personnel or equipment for pediatric care.
11. Burn injury in patients requiring special social, emotional, and/or long-term rehabilitative support, including cases involving suspected child abuse.

Management of Burn

- ABCDE
- Prophylactic intubation if signs of inhalational injury are present
- Fluids
- Analgesia
- Topical antibiotics
- Optimize caloric intake

Fluids Click here for more info	❖ The mainstay of burn treatment ❖ **Parkland's Formula:** 4 cc/kg/ % TBSA of LR. ½ the amount given over the first 8 hours (since the time of injury) The rest is given over the next 16 hours ❖ **The optimal way for monitoring the resuscitation is the urine output** > 0.5 cc/kg/hour in adults > 1 cc/kg/hour in children
Analgesia	Strong analgesia is required (the patient should be pain free).
Topical Antibiotics Click here for more info	❖ N.B. There is no role of systemic antibiotics in burns. ❖ The choice of local antibiotic depends on the site, presence of eschar, and the potential organism.

Antibiotic	Organism	Side effects
Silver sulfadiazine	Broad spectrum	Leukopenia
Mafenide acetate	Gram-positive	Metabolic acidosis
Silver nitrate	Pseudomonas	Electrolyte imbalance

Caloric intake:

Curreri Formula:
Adults : 25 kcal/kg + 40 kcal/ %TBSA
Children: 60 kcal/ kg
Protein intake:
1-2 gm/kg/ day

Prognosis & Follow Up

- Pneumonia is the most common cause of death in burn patients
- Sepsis is the second most common cause of death
- Prevent Curling's ulcer
- Wound complications
- Scar contracture
- Cosmetic appearance

Objectives of Treatment:

Extra

01 Prevention of Edema [1]

02 Prevention of contractures[5] due to poor positioning and prolonged immobilization

03 Prevention of infection

04 Preserve viable tissue

Calculations Related to the Management:

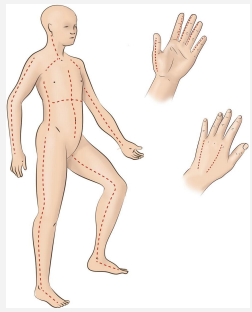
Mortality	Mortality = (body surface area % + age)/100
Parkland Formula	❖ Fluid volume of crystalloid administration during the first 24 hours of admission ❖ **Volume of lactated Ringer's = 4 mL × weight (kg) × TBSA%** ❖ 50% given in the first 8 hours ❖ 50% given in the next 16 hours ❖ Start counting the hours from the start of injury not from the time patient reach the hospital ❖ And check if he received any fluid before 24 hours starting from time of injure" ❖ Crystalloid is preferred because of the tendency to hyponatremia after the injury ❖ The parkland formula is used to calculate the loss of fluid but the maintenance fluid should also be calculated (given to unconscious patient) e.g. In case of trauma burns ,the patient is given 1 to 2 liters of fluid through 2 large bore IV lines 14 or 16 (larger than 18) so they can be given quickly .
4-2-1 Rule	❖ The "4-2-1 rule" for maintaining fluid :It is the calculation of hourly fluid need according to weight . ❖ (4 ml/kg/ hour for the first 10 kg , 2 ml/kg/ hour for the next 10 kg and 1 ml/kg/ hour for every kilogram after that.)

1-Edema usually happens within 24-48 hours after trauma and then comes down. It happens due to loss of capillary permeability which leads to a decrease in the oncotic pressure causing third spacing . The more the patient is given fluids the more the edema increases.
2- A condition of shortening and tightening of muscles, tendons or other tissues causing a deformity.

Management cont..:

Extra

Surgical	Non-surgical
❖ Escharotomy. ❖ Skin grafting.	❖ Tetanus prophylaxis[1] (lockjaw) ❖ Analgesia ❖ Dressing ❖ Nutrition ❖ Fluid ❖ Foley Catheter [2]

Escharotomy	❖ Indication: ◇ Poor tissue perfusion. ◇ Threat to perfusion after volume resuscitation. ◇ Deep Circumferential burns. ❖ Use mid-axial incisions.
Digital Escharotomy	❖ Use mid-axial incisions: ◇ Index, long → ulnar incision. ◇ Ring → radial or ulnar incision. ◇ Little → radial incision. ❖ Leave wounds open ❖ Consider carpal tunnel release. ❖ Consider intrinsic muscle release. 
Skin Grafting & Flap	❖ Skin grafting is a surgical procedure that involves removing skin from one area of the body and moving it, or transplanting it, to a different area of the body. ❖ **Grafts** are similar to first degree burns (First layer is removed and appendages are preserved in both of them so healing and epithelialization is possible) the difference is that grafts occur in a controlled environment unlike burns.

1. 1- An infection caused by Clostridium tetani. When the bacteria invade the body, they produce a toxin that causes painful muscle contractions.
2. 2-the urine output shows how well the patient resuscitated (feedback mechanism) . The minimum urine output for adults 1/2 ml per kg/hr.3- The most important indication of escharotomy is circumferential burn (which causes hypoperfusion due to edema).
3. -Circumferential burns :are seen in cases where full thickness burn affects the entire circumference of digit, extremity, or even the torso. which means it has a bad prognosis.

-As oedema forms the inelastic Eschar can cause a buildup of pressure and act like tourniquet (impairs blood flow). This pressure can lead to significant complications such as respiratory compromisation and loss of tissue perfusion requiring a surgical procedure known as an " escharotomy".

-An escharotomy performed by making an incision through the eschar to release the pressure

Management of Burns cont..:

Extra

Grafts	Flaps
❖ are thin sheet of skin (paper thin). ❖ used more with 3rd degree. ❖ do not contain blood vessels (the injury site needs to be well vascular e.g.above muscle or dermis).	❖ is a bulky tissue (e.g. muscle flap, subcutaneous tissue flap) ❖ used when there's a deep burn (4th degree burns) or when a deep reconstruction following cancer ablation is needed. ❖ Contain blood vessels (so they are used to cover deep structures like bones, tendon, or joints)

Antibiotics [1] Most cases will use antibiotics due to different types of burns involved in the same place.	❖ Intravenous or oral antibiotics should cover skin flora for initial treatment. ❖ Topical antibiotics [2] (silver sulfadiazine) for prevention of infection. **Topical antibiotic has 2 types :** • Cream-based: not oil based, used for minor wounds, increases the hydration to the wound (keep moist) , example : flamazine and silver (commonly used) • Ointment :oil-based, used for a longer duration (broad spectrum), makes an artificial surface for the wound so it locks it and provides a good environment , example: fusidic acid ❖ Topical application of (mafenide acetate) penetrates through eschar and may be effective against a wider variety of organisms.

Non- surgical Management	The first Priority would be **maintaining an adequate airway** and first Aid (ABCDE) especially in case of risk of inhalation injury, with continuous observation for signs of respiratory failure. ❖ **IV fluid resuscitation** if > 15% of BSA is affected (Parkland formula). ❖ **Analgesic** (eg: opioids). ❖ placing the patient in a warm room (to reduce energy expenditure) and **enteral feeding using nasogastric tube** with **vitamin** supplements and **iron** (Better to eat normally after 48 hours). **Prophylaxis against Tetanus** (eg: Clostridium Tetani) by Tetanus Immunoglobulins (TIG) ❖ Foley catheter to monitor urine output

Management of Burns cont..:

Extra

Non- surgical Management cont..	❖ **Dressings**, essential to protect from contamination and for promotion of healing Types: - Evaporative dressings: eg: paraffin, gauze - Semi occlusive and occlusive: eg: hydrogel, hydrocolloid ❖ **Topical antibiotics**, like Silver Sulfadiazine (Flamazine) and Povidone Iodine (Betadine) (Not advised in the first 48 hours as they can make the determination of the depth more difficult). ● special Cases - preexisting Renal disease or Impaired renal function → diuretics. - Only in positive blood culture and septicemia → Systemic antibiotics. - Proton pump inhibitors (PPI) eg: Omeprazole → prophylaxis for curling's ulcer.

Types of Burns According To the Causative Agent:

Thermal Burns	❖ Caused by heat, **e.g.** scalding by hot water. ❖ **Heat is classified into 2 types:** 1-Dry heat e.g. oven heat 2-Moist heat e.g. Hot coffee/kitchen oil. ❖ Extent and depth of the injury is proportional to intensity and duration of heat applied. For that: the first thing to do is to remove clothes if something hot was spilled on it, otherwise the burn will go deeper and deeper.

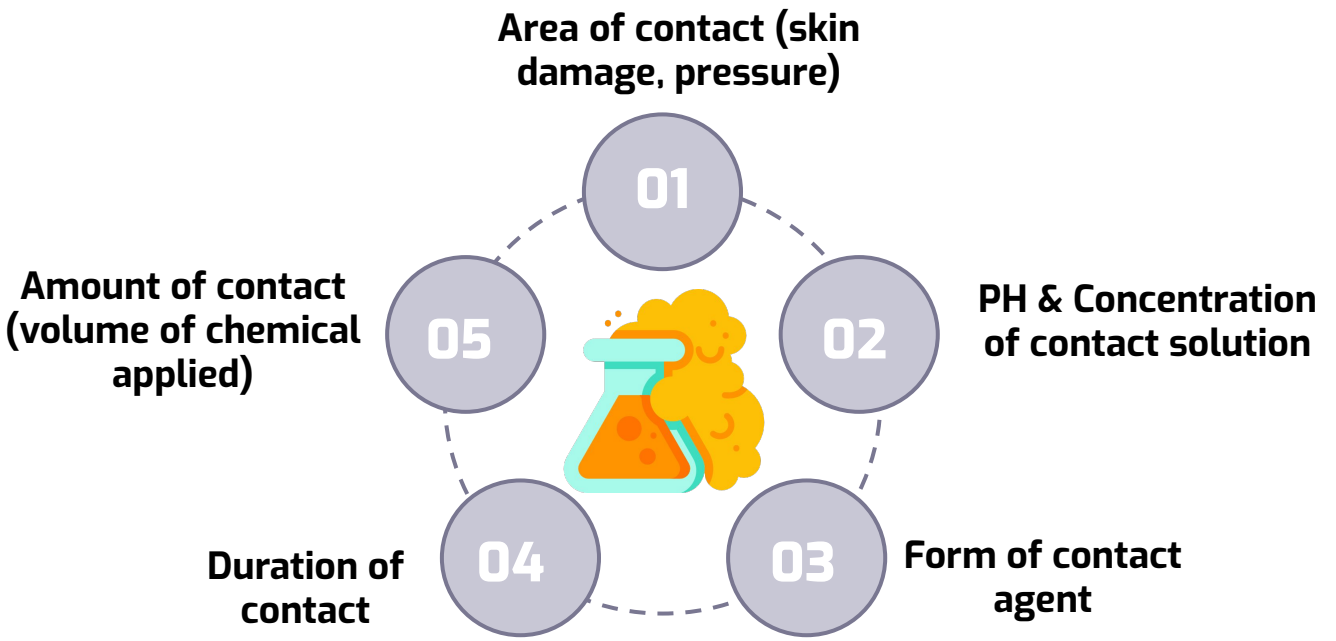
Thermal Response:	
Edema	❖ Inflammatory phase. ❖ Hand edema produces joint fibrosis and contractures. ❖ Edema may indirectly reduce blood flow by fluid accumulation (will compress blood vessels). ❖ When we give IV fluids we worry about (third-spacing) which might lead to edema eventually. ❖ If someone get burned in joint areas ex;hand or leg. Make sure to extent it to its maximum (each part has its own level) because if not , joint will get edema and gonna be so difficult to open it later (compartment syndrome).

Thermal Response cont..:	
Ischemia	❖ **Systemic factors:** ❖ Hypovolemia from evaporation and increased capillary permeability. ❖ Fluid resuscitation if there is fluid loss , or 2nd degree burn (in 1st degree blood vessels are intact > no inflammation > no exudate) is required for significant burns. **Parkland formula:** **LR volume= 4cc x kg x %burn** (It's extremely important to understand parkland formula ❖ Example: If a burn is estimated to cover 10% Body surface of a child weighing 7kg the amount of fluid need to be replaced is equals to 4 x 10 x 7 = 280mL). **Local factors:** ❖ Unyielding eschar/compartment. ❖ Ischemia leads to loss of injured/viable tissue.
Infection[1]	❖ Multiple factors contribute to development of the infection: ◇ Systemic factors: impaired immune response. ◇ Local factors: as bacterial counts increase, invasion of bacteria into the dermis occurs. ❖ Infection can convert burns from a partial to a full thickness injury (because infections cause further reduction in blood supply). ❖ Prior to antibiotic use, Streptococcus species was most common organism. Still seen with burn cellulitis (nowadays Staph are more common than Strept) ❖ Pseudomonas species is most common cause of systemic sepsis. (It is a gram negative that could be acquired for the hospital) so use **silver based antibiotic.**

1-Infection happens due to loss of outer layer of the skin.In case of infection suspicion, the amount of bacteria that determines that the wound is infected is bacteria > 10^5 at the wound sight.

- Burn wound sepsis is the number one cause of morbidity in burns (common complication).

Chemical Burns	❖ Chemical burns don't simply end with removing the burning agent like thermal burns; because chemical agents react with the body's tissue and the injury extends deeper. ❖ Acid → The most common cause of chemical burns, they cause fast tissue necrosis (Acids burns are most commonly seen in those working in Gas stations or Chemical laboratories). One of the worst types is sewer plugs (sulfuric acid drain cleaner) ❖ Base → The most dangerous cause of chemical burns. ❖ Acids and bases keep burning even after removal till neutralization of the acid or base happens (some of them have antidotes). ❖ Acute vs chronic ❖ Short acting Vs. long acting ❖ Superficial Vs. deep ❖ **Factors which worsen the burn:**



Chemical Burns:

Extra

"We don't usually ask about these tables." :)

Acids		Bases	Pathophysiology
Batteries: Sulfuric acid/lithium	Acetic acid	Ammonia Tile cleaners: Ammonium chloride	**Bases:** ❖ Proton acceptor (OH^-). ❖ Higher pH is stronger on logarithmic scale. ❖ Liquefaction necrosis. ❖ Protein denaturation. ❖ Lipid saponification (exothermic = heat producing). ❖ Eschar can't form and base penetrates deeper than acid (continuous action). **Acids:** ❖ Proton donor (H^+). ❖ Lower pH is stronger on logarithmic scale. ❖ Necrosis by protein denaturation. ❖ Forms eschar which limits penetration.
Rust removers: Hydrofluoric acid ^{2}/chromic acid	Trichloroacetic acid	Drain cleaners: Sodium hypochlorite (lye), Sodium hydroxide	
Pool cleaner: Hydrochloric acid	Chloroacetic acid	Potassium hydroxide	
Phosphoric acid	Chemical peels: Phenol (Carbolic acid)	Cement: Calcium hydroxide/oxide (lye), Alkali. Calcium hypochlorite	
Nitric acid	Cresols	SIlicates, Phosphates, Lithium hydride	
Formic acid	Toilet bowl cleaners/cement removers: Muriatic acid	Petroleum solvents: organics. Air bag deployment: Alkali. Bleaches/household cleaners: oxidizers.	

Chemical Burns cont..:

Extra

"We don't usually ask about these tables." :)

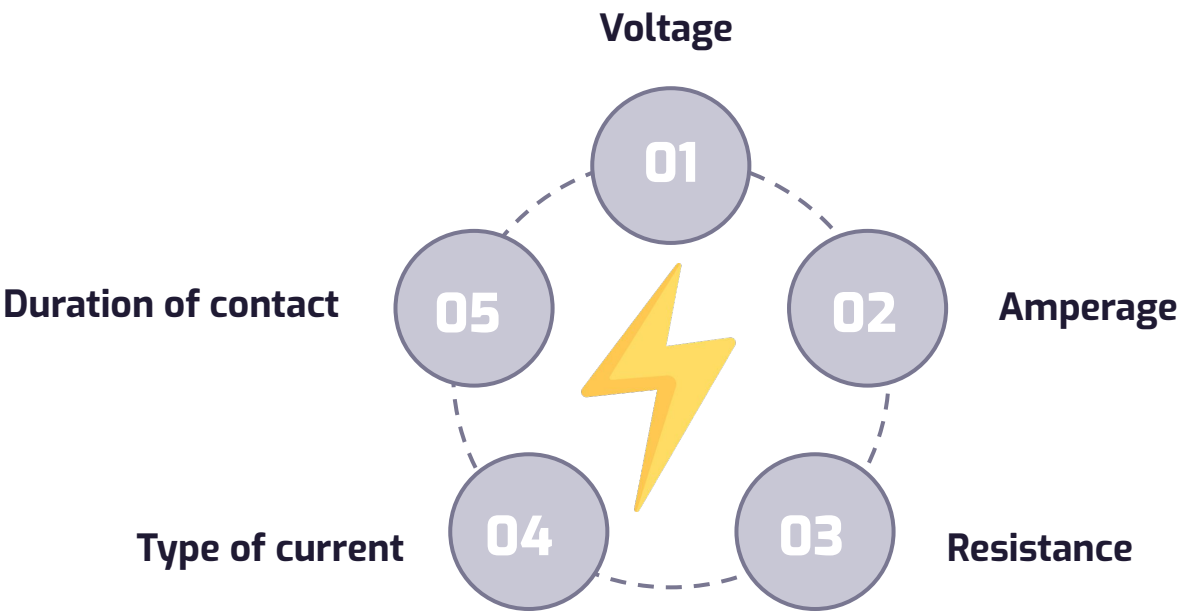
Special categories	
Oxidants	❖ Bleaches, peroxides, chromates, manganates ❖ Neutralize with milk/egg white/starch before water irrigation
Reduction reactions	❖ Binds free electrons and thus denatures proteins. ❖ Neutralize first with soda lime, soap,magnesium before water irrigation
Corrosives	❖ White phosphorus (military), metals, aqueous ammonia, phenol. ❖ Remove particles, copper sulfate solution
Desiccants	❖ Sulfuric acid, muriatic acid ❖ Dehydrates tissue ❖ Exothermic: heat producing ❖ Neutralize with lime water, soap,magnesium.
Vesicants	❖ Chemical warfare (phosgene, mustard, etc) ❖ Blisters, edema, ischemic necrosis ❖ Special antidotes ❖ Chemotherapy agents
Protoplasmic proteins	❖ Hydrofluoric acid, acetic acid, tungstic acid, tannic acid. ❖ Forms salts and bind proteins/calcium or ions.
Hydrofluoric acid	❖ After initial lavage for 30 minutes to treat the H^+ ion, treat fluoride ion. ❖ 10% Calcium gluconate gel topically: ◇ May need to remove nails to get contact. ◇ May combine with 50% DMSO (dimethyl sulphoxide). ❖ Consider injection (not with digits). ❖ Consider intra-arterial injection.

1-History should give you a hint about the type of burn which is important because they are managed differently (eg. Gas station explosion, chemistry lab fire, household chemical cleaners acids/bases...etc).

2-Causes Hypocalcemia

If you don't know the type of the chemical agent just dilute it with water to minimize its effect "The solution of pollution is dilution"

Electrical Burns **e.g** Electricity station burns , or in airport generators.	❖ Pathophysiology ◇ Current burns can be described as burning from inside out from deeper organs till it arrives to skin, patients who experience electric shock may have no external injuries. ◇ History of electrical shock (voltage, current type and source of electricity) should give you a hint if there's any muscle(lead to renal failure later) or bone damage and doesn't exclude electrical injury as a differential ◇ **Severity of an electrical injury depends upon:**

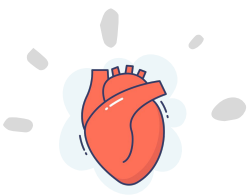


- ❖ Tissue resistance:
  - ◇ Bone > Fat > Tendon > Skin > Muscle > Vessel > Nerve
- ❖ Path of current:
  - ◇ Low voltage follows least resistance (The worst type).
  - ◇ High voltage direct flow.

Types of Burns According To the Causative Agent cont..:

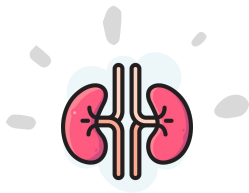
Extra

Electrical Burns **e.g** Electricity station burns , or in airport generators.	❖ Systemic injury: if a current entered from one hand and exits from the other it means that it went through the heart and can cause arrhythmia so the initial management should be cardiac monitoring.



Cardiac arrhythmias [1]

sepsis



Renal failure

Due to muscle necrosis and failure of hydration

PNS injury

Elevation	Treatment
❖ Extent of necrosis is hard to asses ❖ Red, swollen extremity ❖ Entry and exit wound ❖ Skeletal injury possible secondary to a fall or being thrown ❖ Compartment syndrome [2] ◇ Low threshold for fasciotomy	❖ Fasciotomy [3]: ◇ Within 4-6h ◇ Nerve decompression ◇ as needed ❖ Debridement of devitalized tissue ❖ Second look procedure ◇ 48-72h ◇ Expect additional necrosis from vascular thrombosis ❖ Definitive treatment: ◇ Amputation and/or flap coverage

1. Common worries in high voltage electrical burns (e.g. metro stations and electrical companies)include arrhythmia,muscle injury (compartment syndrome), rhabdomyolysis, internal edema and renal failure .
2. Compartment syndrome results from the combination of increased interstitial tissue pressure (tissue pressure exceeds the perfusion pressure) and the noncompliant nature of the fascia and osseous structures that make up a fascial compartment resulting in edema(causes an increase in capillary and venous pressure leading to muscle necrosis) and swelling of the deep compartments (muscles or bones). Compartment syndrome is associated with electrical burns.
3. **Fasciotomy** has the same principle as **Escharotomy** but much deeper. A fasciotomy consists of one or more fascial incisions and remains the only effective way to treat acute compartment syndrome.

Inhalation Injuries:

Extra

- Common in house fires and caused by inhalation of smoke from burning objects eg:plastic.
- Usually fatal.
- Carbon monoxide displaces oxygen and binds to hemoglobin forming (Carboxyhemoglobin)
- The patient can be saved if he was put on 100% O2 for 75 min or for 4-6 hours in a room with clean air.
- Cyanide inhalation is also common and can be fatal
- Damage to lung parenchyma due to inhalation of chemicals or heated smoke can happen.

Complication of Burns:

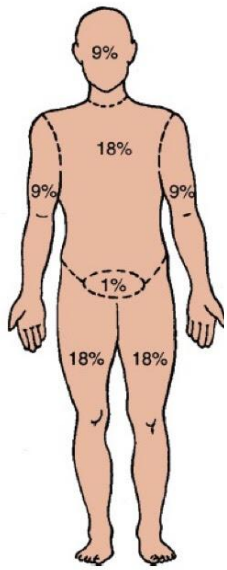
1	2	3
Early Consequences	**Short- Term Consequences**	**Long- Term Consequences**
❖ Hypovolemic shock. ❖ Electrolytes imbalance ❖ (hyponatremia followed by hypernatremia, and hyperkalemia followed by hypokalemia). ❖ Sepsis. ❖ Hemolysis . ❖ Hypothermia.	❖ Nutritional depletion and weight loss ❖ Respiratory failure and ARDS ❖ Renal failure (due to hypovolemia) ❖ Venous thrombosis ❖ Curling's ulcer (acute duodenal ulcer) and erosive gastritis (due to ischemia of the Gut from water loss)	❖ Permanent disfigurement ❖ Prolonged hospitalization ❖ Psychological disturbance ❖ Impaired mental and physical function

Recall Summary

Q1: How do superficial burns present?
Painful, dry, red areas that do not form blisters (think of sunburn)

Q2: How do partial-thickness burns present?
Painful, hypersensitive, swollen, mottled areas with blisters and open weeping surfaces

Q3: How do full-thickness burns present?
Painless, insensate, swollen, dry, mottled white, and charred areas; often described as dried leather



Q4: Define STSG?
Split-Thickness Skin Graft

Q5: What is an autograft STSG?
STSG from the patient's own skin

Q6: What is an allograft STSG?
STSG from a cadaver (temporary coverage)

Q7: What prophylaxis should a Burn patient receive?
Tetanus

Q8: What principles guide the initial assessment and resuscitation of the burn patient?
ABCDEs, then urine output; check for eschar and compartment syndromes

Q9 :What are the signs of smoke inhalation?
Smoke and soot in sputum/mouth/nose, nasal/facial hair burns, throat/mouth erythema, history of loss of consciousness/explosion/fire in small enclosed area, dyspnea, low O2 saturation, confusion, headache, coma

Q10 :What diagnostic imaging is used for smoke inhalation?
Bronchoscopy

Q11: What lab value assesses smoke inhalation?
Carboxyhemoglobin level (carboxyhemoglobin level >60% is associated with a 50% mortality); treat with 100% O2 and time

Q12:H ow should the airway be managed in the burn patient with an inhalational injury?
With a low threshold for intubation; oropharyngeal swelling may occlude the airway so that intubation is impossible; 100% oxygen should be administered immediately and continued until significant carboxyhemoglobin is ruled out

Q13 :What burns qualify for the Parkland formula?
≥20% TBSA partial- and full-thickness burns only

Q14 :What is the Brooke formula for burn resuscitation?
Replace 2 cc for the 4 cc in the Parkland formula

Q15: What is the rule of 10's?
For determining hourly IVF rate: TBSA × 10 (patients 40 to 80 kg)

Q16: How is the crystalloid given?
Through two large-bore peripheral venous catheters

Q17: Can you place an IV or central line through burned skin?
YES

Q18: Why is glucose-containing IVF contraindicated in burn patients in the first 24 hours postburn?
Patient's serum glucose will be elevated on its own because of the stress response

Q19: What fluid is used after the first 24 hours postburn?
Colloid; use D5W and 5% albumin at 0.5 cc/kg/% burn surface area

Q20: Why should D5W IV be administered after 24 hours postburn?
Because of the massive sodium load in the first 24 hours of LR infusion and because of the massive evaporation of H2O from the burn injury, the patient will need free water; after 24 hours, the capillaries begin to work and then the patient can usually benefit from albumin and D5W

Summary

Q21: What is the minimal urine output for burn patients?
Adults 30 cc; children 1 to 2 cc/kg/hr

Q22: Why do most severely burned patients require nasogastric decompression?
Patients with >20% TBSA burns usually develop a paralytic ileus → vomiting→ aspiration risk → pneumonia

Q23: What stress prophylaxis must be given to the burn patient?
PPI to prevent burn stress ulcer (Curling's ulcer)

Q24:What are the signs of burn wound infection?
Increased WBC with left shift, discoloration of burn eschar (most common sign), green pigment, necrotic skin lesion in unburned skin, edema, ecchymosis tissue below eschar, partial-thickness burns that turn into full-thickness burns,hypotension

Q25:Why are systemic IV antibiotics contraindicated in fresh burns?
Bacteria live in the eschar, which is avascular (the systemic antibiotic will not be delivered to the eschar); thus, apply topical antimicrobial agents

Q26:Circumferential, full-thickness burns to the extremities are at risk for what complication?
Distal neurovascular impairment

Q27:How is it treated?
Escharotomy: full-thickness longitudinal incision through the eschar with scalpel or electrocautery

Q28:How is carbon monoxide inhalation overdose treated?
100% O2 (± hyperbaric O2)

Q29:Which electrolyte must be closely followed acutely after a burn?
Na+ (sodium)

Q30:What is the name of the gastric/duodenal ulcer associated with burn injury?
Curling's ulcer (Think: CURLING iron burn = CURLING's burn ulcer)

Q31:What is the "rule of the palm"?
Surface area of the patient's palm is ≈1% of the TBSA used for estimating size of small burns

Q32:What is the "rule of nines"?
In an adult, the total body surface area that is burned can be estimated by the following:Each upper limb = 9%/
Each lower limb = 18% / Anterior and posterior trunk = 18% each / Head and neck = 9% / Perineum and genitalia = 1%

Summary

Classification of Burn	Superficial 1st degree	Superficial partial thickness 2nd degree	Deep partial thickness 2nd degree	Full thickness 3rd degree	Full thickness 4rd degree
Zone involved	Epidermis	Epidermis and upper dermis	Epidermis and most of dermis	Epidermis and total dermis including epidermal appendages and subdermal fat	Extends to underlying structure ; muscle, fascia, bone
Description	Painful + Edema + erythema	Painful +Pink **blister**	-	Dry, inelastic, waxy appearing scar	-
Management	Mild analgesics Daily cleansing +/- topical antibiotic	Daily dressing Heal within 2 wks	Debridement	Debridement and meshed split thickness skin grafting	Amputation or flap coverage with salvage procedure

Quiz!

Q1: A 44-year-old man is brought to the emergency department by a coworker 2 hours after accidentally burning his foot on an electric grill that he keeps next to his bed because he likes to wake up to the smell of bacon. He initially decided to go to work despite his injury but felt like it was “too serious to ignore.” He is the regional manager of a paper company. His vital signs are within normal limits. Examination of his right foot shows erythematous skin with multiple blisters, some of which have ruptured. The affected skin is tender to light touch. Which of the following best describes this patient's skin findings?

1. Superficial burn
2. Superficial partial-thickness burn
3. Deep partial-thickness burn
4. Full-thickness burn

Q2: A 35-year-old man is brought to the emergency department 40 minutes after spilling hot oil on himself in a kitchen accident. Examination shows multiple tense blisters over the abdomen, anterior chest, and entire right leg. Deroofing of the blisters reveals tender and mottled underlying skin that does not blanch with pressure. Examination of the left thigh shows tender and erythematous skin with quick capillary refill after blanching with pressure. Which of the following is the closest estimate of total body surface area affected by second-degree burns in this patient?

1. 9%
2. 18%
3. 45%
4. 36%

Q3:which of the following is surgical management of burns?

1. Skin grafting
2. Tetanus prophylaxis
3. Analgesia
4. Dressing

Q4: which of the following is the most common cause of systemic sepsis?

1. E.coli
2. Pseudomonas species
3. Klebsiella pneumonia
4. None of them

Q1)**2**| Q2)**4**| Q3)**1**| Q4) **2**

Quiz!

Q5: What are the main causes of death among people who initially survive a severe burn?

1. fever
2. bacterial infections
3. severe dehydration
4. 2 & 3

Q6: Which of these population groups has the highest risk for burns?

1. 60 to 65 yo
2. 18 to 35 yo
3. 24 months or younger
4. All of the above

Q7: Burns are classified by degrees from first to third. Which of these describes a third-degree burn?

1. Burned area is larger than 5 inch across
2. Burned area is on the face
3. Burned area covers 10% of the body
4. Burned extends through all the skin layers and tissue

Q8: To treat a first degree burn you should

1. Apply a constricting band between the burn and the heart
2. Clean the are thoroughly with hot tomorrow soapy water
3. Apply cold running water until there is little or no remaining pain
4. Apply a good quality burn cream or ointment

Q5) **4** */ Q6)* **2** */ Q7)* **4** */ Q8)* **3**

القادة

رزان المهنا

في الدوسري

محمد الغامدي

نوف الضلعان

وعد أبو نخاع

الأعضاء

شهد الجري

موضي السبيعي

هيفاء العمري

حسبي الله لا إله إلا هو عليه توكلت وهو رب العرش العظيم.
اللهم إني أستودعك ما قرأت وما حفظت وما تعلمت فرده لي عند حاجتي إليه إنك على كل شيء قدير.

SURGERY442@GMAIL.COM