



Approach to wound healing & Burn case scenario



Objectives

Approach to wound healing The students should be able to:

- List and explain the phases of Normal Wound Healing
 - The hemostatic phase, The inflammatory phase, The proliferative phase, The remodeling (maturing) phase
- List and describe the types of Wound Healing
 - Healing by primary intention (first intention), Healing by secondary intention, Healing by tertiary intention (delayed primary closure)
- Identify and differentiate between the factors Affecting Wound Healing
 - Local factors: Wound site, Wound contamination, Infection, Mechanism of wounding, Tissue loss, Hematoma formation in the wound, Vascular insufficiency, Previous radiation of wounded area, A pressure in the wounded area
 - Systemic Factors: Malnutrition, Uncontrolled diabetes, Medications, Chronic diseases, Immunosuppression, Smoking
- List and discuss the types of wounds
 - Acute Wound
 - Chronic
- Classify Wounds According to the Mechanism of Wounding
 - Clean. Avulsion, Abrasion, Puncture, Crushing
- Explain the Management plan of Acute Wound
- Explain the Management plan of Chronic Wound

- Explain the mechanism of Compartment Syndrome
- Describe Degloving Injury
- Demonstrate the following points regarding leg ulcer:
 - List the different types of leg ulcer including: Venous Ulcer, Ischemic Ulcer, Traumatic Ulcer, Chronic Infection, Neoplastic Ulcer, Pressure ulcer, Venous ulcer, Ischemic ulcer, Diabetic Ulcers
 - List and explain the Risk factors, and the prevention mechanisms of Different Leg Ulcer
- Abnormal scars:
 - Explain how scars are formed
 - Explain the different abnormal scars and how they are formed
 - Atrophic scar, Hypertrophic scar, Keloid scar, Contracture scar
 - Explain the Management plan of abnormal scar

Burn- case scenario

- The student is expected to describe and perform the following:
- Calculation
- Management
 - Surgical options
 - Non surgical options

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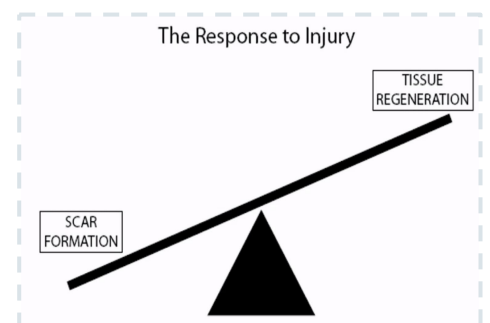
Wound healing

> Definitions

- **Wound:** disruption of normal anatomical structure and function and epithelial integrity of the skin or internal organ.
 - **Acute wound:** proceeds through an orderly and timely reparative process to restore function and anatomical integrity (3-4 wk).
 - **Chronic wound:** proceed through a reparative process without establishing a sustained anatomic and functional result (beyond 6 wk)
- **Wounds can be classified according to the mechanism of injury:**
 - **Incised wounds:** A sharp instrument causes these; if there is associated tearing of tissues, the wound is said to be lacerated
 - **Abrasions:** These result from friction damage and are characterized by superficial bruising and loss of a varying thickness of skin and underlying tissue.
 - **Degloving injuries:** These result from shearing forces that cause parallel tissue planes to move against each other: for example, when a hand is caught between rollers or in moving machinery. And others, Crush injuries, burns and gunshot wounds
- **Wound healing:** is restoration of integrity and continuity of injured tissue to reestablish homeostasis of that tissue and to stabilize the entire organism's physiology , **OR** a response of an organism to a physical disruption in an organ or a tissue to repair a defect.
- Wound healing requires the coordinated completion of a variety of cellular activities, including **phagocytosis, chemotaxis, mitogenesis, synthesis of collagen** and **extracellular matrix** components.
- If the disruption happened in the epithelial integrity of mucous membranes we call it **ulcer**
- Loss of integrity of the bone called **fracture**

> Scar formation VS regeneration:

- **Scar formation:** substitution of a different cellular matrix as a patch to immediately re-establish both a physical and a physiological continuity of the injured organ. **Will not behave like normal tissue**
- **Regeneration:** recreating the original organ by the developmental process which created it.
- **The more the tissue regeneration the better the function of the organ**



Classification of wounds cont.

> According to Etiology :



Iatrogenic wounds:

like surgical wound (you inflict the injury to the tissue)



Traumatic wounds:

(Laceration / sharp clear cut of the wounds edges or Aberration it just multiple superficial laceration as a result friction between the skin and agent



Pathological wounds:

Wounds that arise in the bed of other comorbidity like DM wounds , wounds arising from varicose veins , Chronic inflammatory condition of the skin like Dermatomyositis or skin rash and malignant tumor.

> According to the mechanism of wounding:

1

Clean

New wound (<12 hours), minimal contamination, may need debridement, usually closed primarily, the edges approximated with an appropriate method.

2

Avulsion

Shearing force causing such wound, with skin flap or total skin loss, and exposure of underneath structures. Management includes several debridement sessions, cleaning, with a pressure dressing to prevent accumulation of blood and serum under the skin flap of sometimes a skin graft or flap os required when there is significant blood loss.

3

Abrasion

These result from friction damage and are characterized by superficial bruising and superficial loss of epithelial cells and portions of the dermis with intact deep structures. Management includes cleaning to prevent traumatic tattoo and and to allow the wound to heal by regeneration of epithelial cells.

4

Puncture

Such wound does not need closure, but assessment for deep structures injury or deep foreign bodies by imaging and clinical follow up to detect the development of infection is required.

5

Crushing

This injury is associated with significant loss of tissues including different structures that may initially appear viable. Non-viable tissues need debridement, cleaning of the wound, closure with a skin graft or myocutaneous flap depending on the exposed underlying structures.

6

Incised wounds

A sharp instrument causes these; if there is associated tearing of tissues, the wound is said to be lacerated

7

Degloving injuries

These result from shearing forces that cause parallel tissue planes to move against each other: for example, when a hand is caught between rollers or in moving machinery. And others, Crush injuries, burns and gunshot wounds

Wound healing

Wound contraction:

- Active, normal & essential part of healing, that starts from the proliferative phase.
- This is beneficial especially in bigger or chronic wounds where the contracture will bring the cells together at a faster rate which will accelerate the healing process.
- Rate depends on the number of myofibroblasts
 - Myofibroblasts resemble fibroblasts but contain smooth muscle Actin.
 - Responsible for wound contraction.
- From end to end
- Contracture: an undesirable result of healing due to excessive contraction and fibrosis.

Classification of Healing:

By type:

01

1. **Primary 1°:**
proximation of the edges and migrations of cells from edge to edge (horizontal).
2. **Delayed primary:**
we wait for 2-4 days then we approximate by primary healing.
3. **Secondary 2°:**
Horizontal contraction by myofibroblast and epithelization.
4. **Partial-thickness:**
No contraction, only vertical epithelization.

By timing:

02

1. **Acute** (First week)
2. **Subacute** (Lasts for 1-6 weeks)
3. **Chronic** (Lasts for >6 weeks)

By abnormal healing:

03

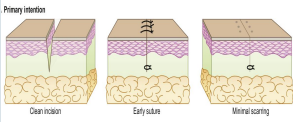
1. **Overgrowth:**
Due to increased collagen production. (Hypertrophic vs. Keloid).
2. **Undergrowth:**
(Wide, thin, chronic unstable wound E.g. pressure sore, and diabetic wounds.).
3. **Abnormal pigmentation.**
(hypo/hyper)
Whenever there is injury in the skin the melanin production can be over or under produced
4. **Contour abnormality.**

Wound healing



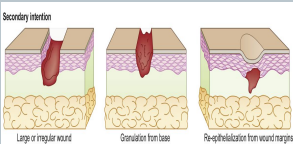
Classification of Wound Closure:

Primary healing (1° intention)



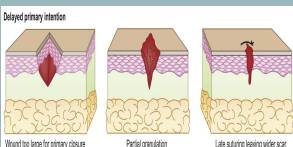
- Primary closure by suturing the edges together.
- Within hours of repairing full-thickness surgical incision.
- Results in mortality of minimal number of cellular constituents.
- Usually done In the first 24 hours
- E.g. surgical wounds
- ★ **Never try to close wound by 1° intention if :** more than 24h passed since the injury , if it's from humans ¹ or animals ² bite , any chronic ³ wound

Secondary healing (2° intention)



- Wound left open to heal by processes of **granulation**, **contraction** of myosin and actin → results in edge to edge (**horizontal**) **repair**. and **epithelialization** of dermis and epidermis → results in **vertical repair**.
- You keep the wound open, clean and moist with minimal bacterial load less than 1000 bacteria Per gram of fascia, just Dress the wound with no suturing and clean the extra exudate.
- Usually takes longer than primary healing.
- Results in more intense inflammatory response.
- Larger quantity of granulation tissue with pronounced contraction of wounds.
- E.g. Perineal abscess & Diabetic foot and wounds with poor vascularity, if we treat by 1° intention it may lead to Cellulitis and ulcers.

Tertiary healing (3° intention)



- **Tertiary healing** is a combination of 1° healing and 2° healing. Clean the contaminated wound, wait for about 3 days → and then re-approximate it by suturing.
- Delayed primary closure (24-48h)
- Desired for contaminated wounds (infected wounds)
- Phagocytosis of contaminated tissues well underway by 4th day.
- Foreign materials walled off by macrophages.
- 3° intention healing describes the situation where a wound healing by 2nd intention (neglected traumatic wound/burn) is treated by excising its margins and then opposing them or covering the area with a skin graft.
- The final cosmetic result may be better than if the wound had been left to heal by 2° intention
- E.g. face , forehead , malar and cheek wounds and if >24 h passed , leave it to heal by itself and after 3 week you can excised it and close it up

- ★1- human bites are worst due to a higher bacterial load in their mouth.
- ★2- Cat bites are dangerous , superficially you can only see the bite marks with surrounding redness and may appear not infected BUT deep there where the tip of its teeth was there will be an abscess, you should go and explore them w/ excision of the wound and the whole tissue out in the OR.
- 3- Chronic wounds are difficult to close because of the heavy contamination of the wound

Wound healing

> Epithelial Repair:

- Epithelial continuity is reestablished across a wound: Multiple events happen during the healing process. The cells (from the two edges of the wound) mobilize & migrate to the middle and get in proximity then duplicate by mitosis and differentiate to different cells.

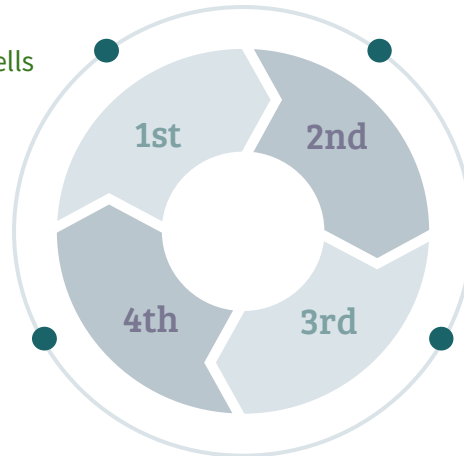
Mobilization of cells

Migration from edge to edge

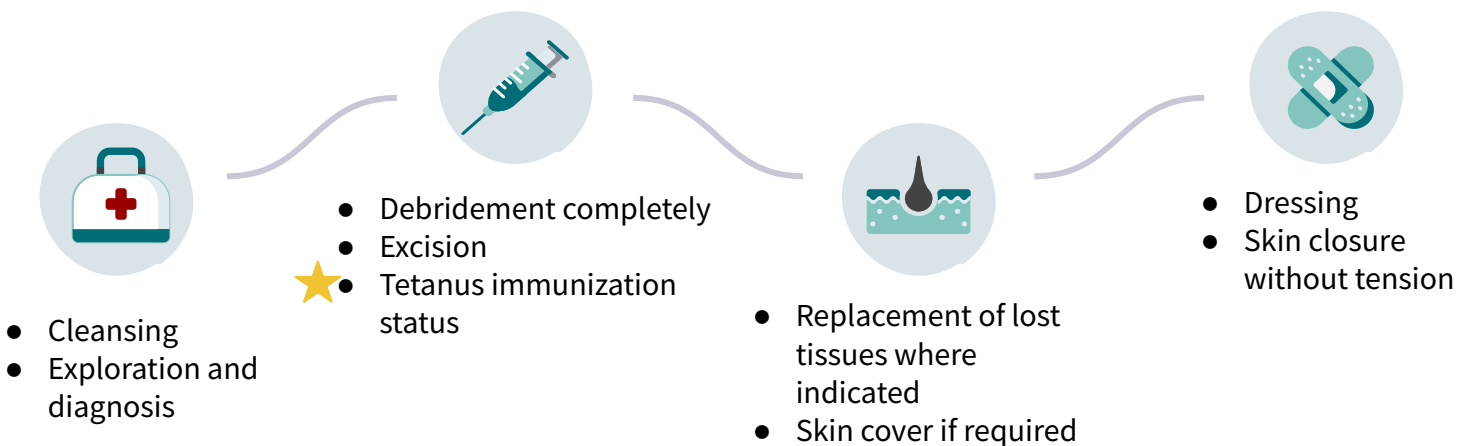
(stimulus is loss of contact inhibition)

Cellular differentiation

Mitosis



> Wound Management:



Note

Do we need to give the patient antibiotics?

If the wound is fresh and clean, → it is not preferred to give prophylactic Abx

If dirty → always start with oral antibiotics (IV requires admission)

- Never choose to admit the patient with mild wound for IV antibiotic the **first choice** is treating him as outpatient with oral antibiotic unless it's a very severe case

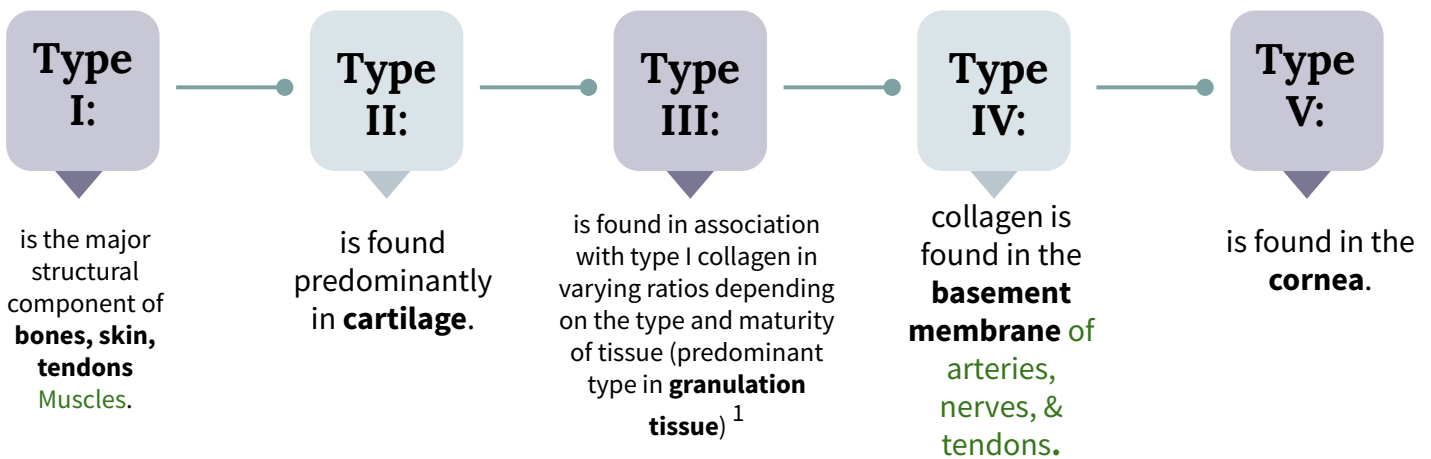
If a patient presents with a clean wound, always ask about Tetanus status:

- Major wound:
 - Give vaccine if the last booster was more than 5 years ago
 - If immunization is unknown, Give vaccine and immunoglobulins
- Minor wound:
 - Give vaccine if the last booster is older than 10 years
 - Unknown → give Vaccine
- If a child is not immunized or missed a dose in childhood or unknown → give passive and active immunizations (vaccine and immunoglobulins)

Collagen

- Left handed helix involving 3 polypeptides.
- Most abundant family of proteins in the human body (30%).
- Over 19 types of collagen have been identified

Types of collagen:



- Wound Strength is 80% of original after remodelling. (Healing)
- **The main step in collagen synthesis** → Lysine and proline hydroxylation required for cross linkage.
- **Collagen synthesis events:** procollagen gets converted to collagen by proline and lysine hydroxylation (essential component to have complete collagen synthesis), catalyzed by Vit.C and Fe.
- Differs in relative composition of hydroxylysine and hydroxyproline and cross-linking
- **Type I** ≅ **90% of all collagen in body**
- Normal skin ratio - **Type I:Type III = 4:1**
- Hypertrophic / immature scar 2:1 ratio
- **Formation inhibited by:** Colchicine, penicillamine, steroid, Vit.C deficiency and Fe deficiency.
- ★ They activate collagenase which degrades collagen synthesis and inhibits cross linkage hydroxylation of lysine and proline.

1. E.g. in traumatic wounded skin (associated with healing). Can also be found in newborns.

Phases of Wound Healing

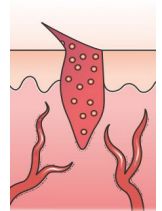
01

Haemostasis (5-10/15 min)



Main cells in this phase: platelets

- Considered as phase zero or part of the inflammatory phase. This phase is delayed by bleeding disorders.
- **Initial** response to injury = **constriction** followed by dilation (vasoconstriction is to reduce blood loss and aggregate the platelets)
- Platelet plug forms after adherence to exposed subendothelial collagen via vWF
- Platelets degranulate releasing: ADP, thromboxane-A₂, bradykinin, and 5-HT → further vasoconstriction and platelet aggregation.
- Platelets stimulated to release :



platelet derived growth factor (PDGF)

- made by macrophages, endothelial cells, fibroblasts
- chemotaxis, fibroblast stimulation



transforming growth factor β (TGF β)²

- made by macrophages, platelets, fibroblasts
- fibrinogenesis, angiogenesis, chemotaxis, immune suppression
- It has a major role in wound healing.



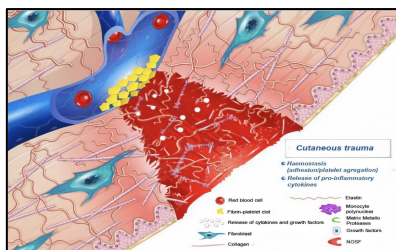
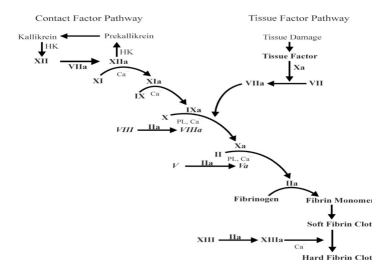
The main source for the production of TGF β is the **Alpha granules** of platelets.

Excess production of TGF- β isoforms causes abnormal scars (Hypertrophic and Keloid scars).



fibroblast growth factor

- made by macrophages and endothelial cells
- angiogenesis and chemotaxis



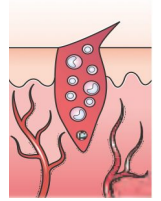
- Form the platelet plug
- Degranulation of platelets (release of cytokines and growth factors)
- Activation and recruitment of neutrophils

Phases of Wound Healing

02

Inflammatory/Migratory "lag" phase (1-4 Days)

- Typically starts immediately after hemostasis (24-48 h)
- ★ - **Main cells in the inflammatory phase:** in the first 24 hours → **PMNs (neutrophils)**
 - Neutrophil importance is doubted in the inflammatory phase since patients with neutropenia don't have wound healing issues
- ★ - After 24 hours → **Macrophages** are more important.
- Characterized by an inflammatory response to injury, through an increased capillary permeability, proliferation of capillaries at wound edges and accumulation of protein-rich exudate preceding collagen synthesis



Classically represented by:

01 Rubor (redness) caused by:

- vasodilation
- primarily result of prostacyclin (PGI_2) and histamine, also caused by prostaglandin A, D, E (PGA, PGD, PGE)

02 Tumour (swelling):

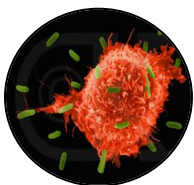
- caused by leakage of plasma proteins through gaps in vascular endothelium
- edema potentiated by PGE_2 , prostaglandin $\text{F}_{2\alpha}$ ($\text{PGF}_{2\alpha}$)

03 Calour (heat)

Increased local temperature secondary to both:

- Increased blood flow
- Elevated metabolic rates

04 Dolour (pain)



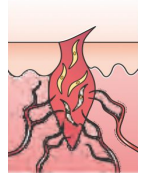
Macrophages :

- Phagocytosis
- Wound debridement
- activation of fibroblast
- Angiogenesis
- Matrix synthesis (granulation tissue formation) regulation

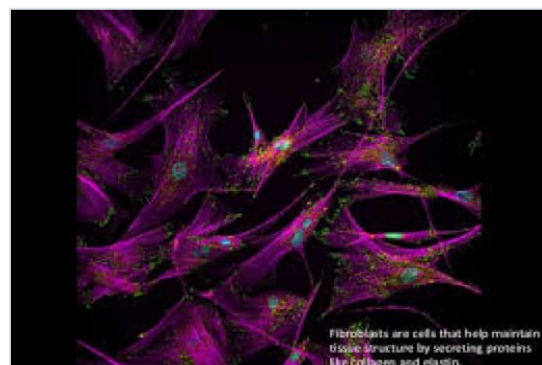
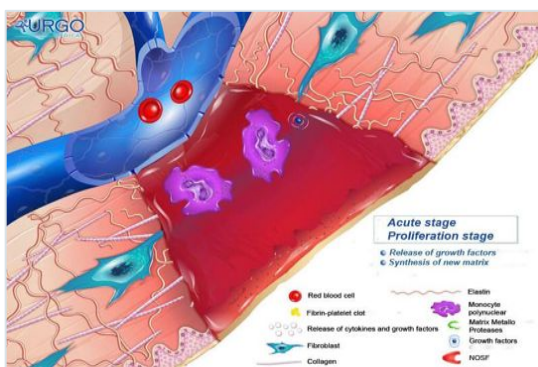
Phases of Wound Healing

03

Proliferative/Fibroplasia “incremental” (3 days - (3 weeks)



- Begins 2-3 days after wounding (48h-3w)
- In this phase there is progressive collagen synthesis by fibroblasts and a corresponding increase in tensile strength with increased collagen turnover. This phase is delayed by: Microvascular diseases (Diabetes), Macrovascular (Atherosclerosis).
- In this phase, the scar changed from red to pale
- Signalled by arrival of **fibroblasts**
(Main cells in the proliferative phase, they play a role in collagen synthesis).
 - Driven by macrophage-derived **bFGF**, **TGFβ**, **PDGF** to proliferate and synthesize glycosaminoglycans (**GAGs**) and **proteoglycans** (building blocks of new extracellular matrix of granulation tissue and collagen).
 - Also produce **bFGF**, **TGFβ**, **PDGF**, **keratinocyte growth factor**, **insulin-like growth factors-1**.
 - Dominant cell type peaking at 7-14 days.
- Collagen synthesis (net production for next 3-6 weeks).
 - ★ ○ Arterial oxygen tension (**PaO₂**) is a **key determinant of the rate of collagen synthesis**.
- ↑ Keratinocyte mitosis, ↑ Endothelial cells and ↑ Angiogenesis (from vessels at wound margins).
- Lasts 2-4 weeks depending on site and size of wound with slowing of fibroblast migration and proliferation.
- Different cells differentiate into different types and new blood vessels are formed (angiogenesis).

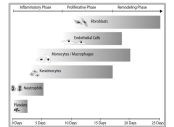
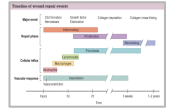
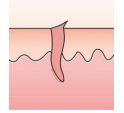


Phases of Wound Healing

04

Remodeling /Maturation (3 weeks - one year)

- Begins approx. 3 weeks after injury (lasts 8m)
- **The major event in the remodeling phase:** Collagen synthesis and degradation are accelerated but in equilibrium with collagen breakdown (**no net increase in collagen content**)
- Collagen deposition peaks by 3rd week
- Large capillaries growing into wound regress/disappear
- Indurated, raised, pruritic scar becomes mature scar
- Collagen fibers become organized
- **Type III collagen replaced by type I collagen**
- **re-establishing normal 4:1 ration (I:III):**
Duration depends on age, genetics, type of wound, location (1-2 years).
In abnormal wound healing (such as in hypertrophic scars and keloids) we have a higher ratio that could reach up to 1:30 so you'll have high collagen type 3 compared to the normal ratio, and you'll have abnormal scarring.
- Type three collagen is the main collagen present in the wound healing process.
- Tensile strength increases to 80% of pre-injured skin
 - Especially in healing tendons, muscles, and blood vessels. For example for tendons it reaches up to 60-80%, but for normal wounds it usually reaches 100%.
- **Don't not operate on scars or wounds that are in remodeling phases , wait until it's done.**



Factors Affecting Wound Healing: ★

Mnemonic

DID NOT HEAL

General (patient):

1. **N**utrition¹
2. **D**rugs/**T**oxins²
3. **A**ge³
4. **D**M
5. **S**moking⁴
6. Vascular disease
7. **O**besity
8. Systemic diseases
9. **I**diopathic
10. Inherited diseases
11. **S**urgical technique⁵



Local (wound):

1. **O**xygen (**H**ypoxia)
2. **I**nfection
3. **A**cidity
4. **R**adiation⁶
5. **L**oss of growth factors
6. **D**enervation (**i**n diabetics)
7. **I**atrogenic
8. **E**dema
9. **C**ancer⁹
10. **F**oreign body

1. Patients with pressure sore are usually malnourished therefore the healing process is usually delayed in such patients, Malnutrition has to be severe before healing is affected. Protein availability is most important, and wound dehiscence and infection are common when the serum albumin is low. Healing problems should be anticipated if recent weight loss exceeds 20%. **Vitamin C** is essential for proline hydroxylation and collagen synthesis.

2. E.g. penicillin, steroids, cortisol and chemotherapy.

3. Elderly patients are more prone to have chronic wounds, they heal poorly because of impaired blood supply, poor nutritional status or intercurrent disease. however, they still form 'good' scars.

4. Vasoconstriction → reduced oxygen delivery, by shifting oxygen hemoglobin dissociation curve to the left

5. Dead spaces must be avoided, as the accumulation of blood and exudate encourage infection. Correct suturing of the deeper layers avoids dead space and often allows the skin edges to fall together without tension. 5/0 or 6/0 sutures are appropriate for the face, stronger ones (3/0 or 4/0) are needed for incisions near joints and still stronger ones for the abdominal wall

6. Chemo and radiotherapy lead to **fibrosis** of the skin as well as stenosis of the arteries.

Wound healing

➤ Factors affecting wound healing cont. : ★

The aim of wound care is to achieve healing by primary intention and thereby reduce the proliferative and inflammatory phases, by correcting any abnormality that can retard or slow the wound healing. Several local and systemic factors can influence the wound healing, that can result in delay or abnormal healing process which will lead to a poor cosmetic outcome and delay recovery of the function of the wounded part.

These factors should be addressed and controlled by the treating clinician.



Local factors

1

Blood supply

- Decreased tissue perfusion results in decreased wound oxygenation.
- Fibroblasts are oxygen-sensitive and their function is reduced in hypoxic states.
- Poor blood supply also leads to decreased nutrients delivery which will retard the wound healing.

2

Radiation

- Causes endothelial cell, capillary and arteriole damage.
- Irritated fibroblasts secrete less collagen and extracellular matrix.
- Lymphatics are destroyed resulting in edema and risk of infection.
- Previous radiation of wounded area also results in vasculitis with local hypoxia, ischemia, reducing the amount of oxygen and nutrition to the wound site.

3

Infection

- Wounds with over 10⁵ organisms per gram of tissue are considered infected and are unlikely to heal without further treatment with debridement and Abx.
- It reduces the rate of wound healing, granulation tissue formation, oxygen and nutrient delivery. the use of debriding agent to clean the wound and appropriate prophylactic antibiotics is important in preventing wound infection.

Wound healing



Local factors

4

Wound site

The presence of persistent pressure or recurrent trauma at wound site may compromise the healing of the wound.

5

Wound contamination

Such wound require debridement, removal of all dead tissues and foreign bodies, and cleaning.

6

Hematoma formation in the wound

Bleeding must be controlled because hematoma formation in the wound predisposes to wound infection and it separates the wound edges and prevents wound healing.

7

Mechanism of wounding

Incisional wounds will follow the normal phases of wound healing, whereas crushing or avulsion wounds may not heal in normal process and may have a prolonged healing process.

8

Tissue loss

This will delay the slow wound healing and predispose to infection.

9

Pressure in the wound area

Pressure in the wound will reduce the blood supply, which causes hypoxia, ischemia, and retarded wound healing.

In addition to **Nerve supply, trauma, hydration** and **temperature**.



Systemic factors

Congenital

Acquired

- Pseudoxanthoma elasticum
 - Autosomal dominant
 - Problem with collagen cross linkage → weakness and failure of healing
- Ehler-Danlos syndrome
 - AD, defect in synthesis, structure and cross linkage of collagen
- Cutis laxa
- Progeria
- Werner syndrome
- Epidermolysis bullosa
 - Similar to a burn

Table 1-2 Diseases and Conditions

	Defect	Characteristics	Surgical Intervention
Ehlers-Danlos syndrome	Abnormal collagen structure, production of processing	Hyperflexible joints Stretchy, fragile skin Easy bruising Vascular aneurysms	Not recommended
Progeria	Mutation in <i>LMNA</i> gene	Limited growth Full body alopecia Wrinkled skin Atherosclerosis Large head, narrow face, beaked nose	Not recommended
Werner syndrome	Mutation in <i>WRN</i> gene	Graying of hair Hoarse voice Thickened skin Diabetes mellitus Atherosclerosis Cataracts	Not recommended, but reported for temporary improvements
Pseudoxanthoma elasticum	Fragmentation and mineralization of elastic fibers	Cutaneous laxity Yellow skin papules Vision loss	Redundant skin folds can be treated with surgical excision
Cutis laxa	Mutation in elastic fibers	Loose, wrinkled skin Hypermobility joints	Surgical excision of redundant skin produces temporary benefit but patients do not have wound healing problems

> Factors affecting wound healing cont. :



Systemic factors

Congenital

Acquired



Malnutrition:

Nutrition is extremely important for protein and collagen synthesis, and metabolic energy for wound healing.

Folic acid is important for the synthesis of collagen.
Magnesium is required for the synthesis of protein.

Vitamin K is essential for the process of carboxylation in the synthesis of coagulation factors II, VII, IX, and X. deficiency of vitamin K will cause coagulopathy and hematoma formation in the wound that retards the wound healing.

Vitamin A → formation of the extracellular matrix

Deficiency delays wound healing. Because it's part of the structure of collagen fibers

25,000 IU po OD increases tensile strength.

200,000 IU topical Q8 increases epithelialization.

Increases collagen synthesis, inflammatory response, and recruitment of macrophages into the wound.

Vitamin C

Collagen synthesis, has a role in the cross-linkage.

Scurvy: Immature fibroblasts, deficient collagen synthesis, capillary hemorrhage, decreased tensile strength.

Vitamin E → formation of the extracellular matrix

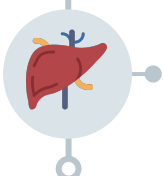
Antioxidant and a membrane stabilizer.

Large doses may inhibit healing but unproven to reduce scarring.

Too much Vit E will negatively affect wound healing

Zinc is an essential cofactor for many enzymes and the synthesis of RNA and DNA. Deficiency causes impaired epithelial and fibroblast proliferation.

Deficiency of zinc can also affect migration and mobilization.



Chronic diseases

Diseases such as liver disease, jaundice, malignancy, uremia, will dispose to malnutrition, wound infection, and delay wound healing.

➤ Factors affecting wound healing cont. :



Systemic factors

Congenital

Acquired

Pharmacological

- Steroids decrease inflammation and subsequent wound healing.
- NSAIDs decrease collagen synthesis and inhibit platelet aggregation.
- Antineoplastic agents decrease fibroblasts proliferation and wound contraction.
 - Few or no adverse reaction of administered 10-14 days after wound closure.

(Endocrine abnormalities) Uncontrolled diabetes

- Diabetics often have delayed wound healing.
- Neuropathy rather than small vessel occlusive disease may be responsible for delayed healing.
- Hyperglycemia will inhibit fibroblast proliferation, alter collagen formation, and retard wound healing. Hyperglycemia predisposes to wound infection by making good media for bacteria growth, and suppression of phagocytic function of neutrophils.

Smoking

- Nicotine causes vasoconstriction decreasing perfusion. **Decreasing cell production**
- CO shifts the oxygen dissociation curve **to the left** and reduces tissue oxygenation.
- It also reduces collagen formation in the wound.

Age

- Rate of cell multiplication decreases with age.
- All stages of healing are protracted in elderly.
- Healed wounds have less tensile strength in elderly.
Thus their wounds break easily and no problem with hypertrophic scars and keloids

Immunosuppression

Immunosuppression status due to some conditions (leukemia, post-transplant, immunosuppressive drugs, chemotherapy, and AIDS) will predispose to wound infection, reduce the inflammatory response, and retard wound healing.

Decreased oxygen delivery to tissue reduce:

- Collagen formation
- Extracellular matrix deposition
- Angiogenesis
- Epithelialization

Classification of contamination in Surgical wounds (WHO classification of wound)¹

1

Clean: (class I)

- nontraumatic, non infected wounds & no breach of Resp, GI, or GU tract.
- No spillage of the content of the tract itself.
- ★ **E.g.** Elective procedures, thyroid and breast surgeries.
 - with no local infection nor interruption of the epithelial continuity.
- No need for antibiotics.
- Infection rate should be less than 1%.
- Use of Ab prophylaxis isn't recommended.

2

Clean-contaminated: (class II)

- Small breach in protocol; Resp/GI/GU tract are entered with minimal contamination.
- Very minor spillage of the content.
- Minimal entry of GI, respa, GU tract.
- ★ **E.g.** cholecystectomy, uncomplicated appendicitis, intestinal resection ONLY if there was no spillage, small breach in the Mucosa of the mouth or Mucosa of the Anus
- Infection rates in excess of 5% may suggest a breakdown in wards.

3

Contaminated "Dirty": (class III)

- Fresh traumatic wounds; major break in sterile technique, **nonpurulent inflammation**; in or near contaminated skin.
- Major spillage e.g. stool. Presence of dirty material.
- **E.g.** hemicolecotomy or resection of the intestine with spillage, any perforated bowel, emergency surgery for perforated diverticular disease, or drainage of a subphrenic abscess.

4

Infected: (class IV)

- **Purulent infection.** Traumatic & severe wounds.
- Clear purulent discharge or clinical sign for infection like, erythema, swelling etc.
- Fever (>38°), pus, positive culture and require triple broad spectrum antibiotics.
- ★ **E.g.** traumatic open bone fracture, and purulent pyogenic perforated appendicitis.
- Must go to specialized OR

Classification of wounds

Wounds can be classified into:

1. **Acute** wounds such as clean incised, avulsion, abrasion puncture and crushing.
2. **Chronic** wounds such as venous, ischemic, pressure and diabetic ulcers.



Acute wounds <24 hours

Tidy

- Incised, clean wound in healthy tissue without tissue loss such as a wound from a clean sharp object.
- Can be closed immediately.
- Heals by primary intention.



VS

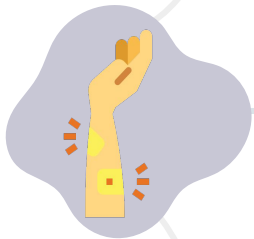
Untidy

- Crushed or avulsed tissues with contamination, devitalized tissues and tissue loss, such as wounds caused by explosion, missile or bullet injury.
- Requires debridement, excision of devitalized tissues, and cleaning several times before definitive repair is performed
- Usually heals by secondary or tertiary intention.



Acute wounds cont.

➤ Compartment syndrome



1

This occurs due to increased pressure in the muscles compartment after trauma. It occurs most commonly after closed trauma (crushing injury).

2

The typical clinical feature is severe pain in the affected compartment particularly with passive muscles movement, distal sensory deficit, and the late sign is absent distal pulses.

3

A catheter can be inserted in the muscles compartment and using a pressure monitor to measure the intra-compartmental pressure. Presence of clinical features with persistent pressure of 30 mmHg or higher is an indication for fasciotomy.

fasciotomy

Fasciotomy is performed by skin incisions in specific locations depending on the area involved that includes skin, fat and fascia to decompress the muscle compartments and relieve the pressure.

Late fasciotomy in the presence of dead muscles may lead to a sudden release of a large amount of myoglobin to the bloodstream which may cause myoglobinuria, blockage of glomeruli, and precipitate acute renal failure.

Therefore, severely traumatized limb with extensive dead tissues better to be amputated.

➤ Degloving injury

- This occurs when the skin and subcutaneous tissue are avulsed from the underlying fascia with exposed neurovascular structures, bones, and tendons.
- It can be an open or closed injury.



- The treatment includes antibiotics prophylaxis, saline irrigation, removal of foreign bodies, resection of nonviable skin and subcutaneous tissue with adequate debridement, followed by skin flap or grafting.
- The trial of replantation or revascularization is extremely challenging.



Acute wounds cont.

Management of acute wounds:



- Management of the patient should follow the acute trauma life support (ATLS) principles.
- The patient should be examined completely and a stab wound in the wound should not be missed.
- The wound should be examined, taking into consideration the site and the possible damaged structures including vascular structures.

1

2

- Assess the severity of the pain and motor and sensation function.
- Tetanus therapy should be assessed and appropriate treatment given.



- Pressure pad or tourniquet should be applied over the bleeding wound. Clamps should not be applied blindly to a bleeding wound because it may cause nerve damage and cause further damage to the vessels which rendered vascular anastomosis impossible.

3

4

- Adequate anesthesia (local, regional or general) is sometimes required to facilitate the examination. The toxic level of local anesthesia should not be exceeded.



- Prophylactic antibiotics for anaerobic bacteria are required in certain cases and wounds in a certain location. The tourniquet should be used in limb injuries in order to facilitate examination and visualization of all structures. During tourniquet application, care should be taken to avoid uneven pressure and the tourniquet time must be noted.

5

6

- An x-ray may be required to rule out deep foreign bodies.
- After complete assessment, a thorough debridement of the wound should be performed. All dead or devitalized tissue should be excised and foreign bodies should be removed. copious irrigation of the wound with saline is helpful. Debridement should be carried out until bleeding occurs. Avoid injuries to the nerves, vessels, and tendons.



- Muscle viability is judged by the color, bleeding pattern, and contractility.
- Repair of damaged structures (nerves, vessels, and tendons) maybe attempted in a tidy wound.
- Large hematoma may require evacuation by incision or aspiration. If the large hematoma is not evacuated, it calcifies with htime, and cause symptoms include local lump or mass.

7

8

- Skin cover by graft or flap may be required if there is skin loss, as skin closure should always be without tension.
- Needle stick injuries should be managed according to the protocols of hepatitis and HIV risks.

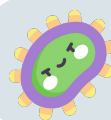


Preparation of the wound by cleansing and debridement before closure is important. All wounds are contaminated, even the wounds that considered to be clean contain bacterial inoculum. Therefore, lavage and adequate debridement are essential steps in wound care. The decision to close the wound primarily depends on the extent of contamination. for example, the incised clean wound can be closed primarily, but crush wounds, human bite or farm injury should be managed as open wound till the appropriate condition of closure is reached. Delayed closure give time for further debridement, cleaning and reduction of bacterial count in the wound.

9

10

- The dressing of the wound to provide important issues including complete wound cover, protect the wound, immobilize, compress the wounded area evenly, and absorb any secretion. The wound might need to be checked frequently to avoid infections.



- Infection of the closed wound clinically evidenced after few days with pain, redness, swelling, tenderness, and hotness with or without discharge. Such wound should be opened with the evacuation of any collection, lavage, debridement, and left open with daily dressing.

11

12

- The sutures or clips should be removed under sterile condition after they have done the job for which they placed.



Chronic wounds



01

- Chronic wounds develop when the normal wound healing process fails to repair the tissue injury, Arise chronically and gradually so you don't see a wound immediately. E.g. **varicose vein**, they don't arise immediately so it's not an acute wound , it's a wound that arises as result of disturbed vascularity of the skin or like the pressure sore. **Or** there is a distraction in the arterial supply of the skin because of the Peripheral neuropathy the patient will have gradual onset of wound.

02

- Debridement, cleaning, daily dressing changes, and negative pressure devices have been the main method to enhance the healing process in chronic wounds.

03

- Several local and systemic factors are well known to retard the healing process, and results in a chronic wound.
- Judicious intervention is essential in countering these factors to enhance the normal wound healing. E.g, debridement can change the wound to an acute state or condition that will accelerate normal healing.



Leg ulcer

- An ulcer is a break in the epithelial continuity.
- The persistent inflammatory phase of wound healing results in overgrowth of the granulation tissues and attempt of wound healing by scarring with fibrotic ulcer margin.
- Necrotic tissue in the ulcer floor is called "Eschar" whereas yellowish soft material are called "Slough".

• Etiologies of leg ulcers:

Venous ulcer

The usual site is above the medial malleolus. It results from venous hypertension due to varicose veins or deep vein thrombosis.

Ischemic ulcer

This is due to arterial insufficiency or vasculitis. it occurs commonly at the tip of the toes or in the shin area of the leg. blood supply insufficiency is obvious, and the ulcer is dry with minimal granulation tissue.

Traumatic ulcer

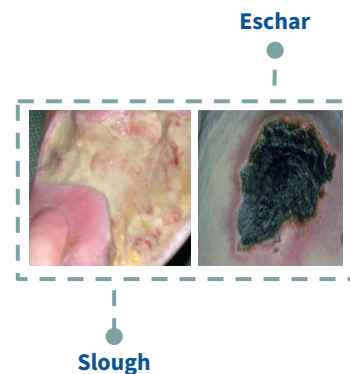
This is due to repeated trauma and can be self-inflicted.

Infective ulcer

This is due to Tuberculosis or Syphilis

Neoplastic ulcer

- It could be squamous or basal cell carcinoma or sarcoma.
- Biopsy should be obtained from any chronic ulcer which is persistent and unresponsive to appropriate wound care to rule out malignant changes (squamous cell carcinoma called "Marjolin's ulcer").
- It usually affects the area with chronic or prolonged scar (chronic burn), and it has poor prognosis.
- Treatment of chronic leg ulcer includes treatment of underlying cause, appropriate wound care, but skin graft is required in some cases.



Chronic wounds

> Ischemic ulcer



This ulcer results from atherosclerosis of the main lower limb arteries or due to thromboembolic occlusion of these arteries



Ischemic ulcer contains little granulation tissue, indicating impairment of healing process with exposure of deep structures such as bones, tendons, and joints with black mummified (dry gangrene) or black suppurative (wet gangrene) tissues.



Ischemic ulcer most commonly involves the toes but any part of the leg or foot can be affected.



Peripheral pulses (dorsalis pedis and posterior tibial) will be absent, but the evaluation with doppler ultrasound is more accurate.



Ischemia is the harbinger of limb loss due to infection when associated with diabetic ulcers.



Treatment:

1



2

- Intervention is very important to save the limb and prevent major amputation.

Endovascular balloon angioplasty or stenting is the appropriate intervention for focused obstruction or stenosis

long segment arterial obstruction or stenosis require **bypass surgery with the autologous saphenous vein or synthetic graft.**

- This is to improve tissue perfusion and enhance ulcer healing. Most ischemic ulcer will not improve without revascularization.

- After intervention and improvement of blood supply, wounds debridement, cleaning, excision of all dead tissues, local antibiotics and amputation of dead parts (e.g toes) are essential.

- Systemic antibiotics are required in the presence of infection.
- Incompletely healed clean ulcers with the favorable condition may require skin flap or graft fore coverage.

Chronic wounds



Pressure ulcer

- Localized tissue damage usually over bony prominences, as a result of prolonged pressure and consequently reduced blood supply to local tissue
- Other terms are **pressure sore**, bed sore, and decubitus ulcer.

01

- It occurs most commonly in bedridden, paraplegic or severely ill patients in the intensive care unit.

02



- When the pressure on the skin exceeds the capillary pressure, it causes tissue hypoxia, necrosis, and ulceration.

03

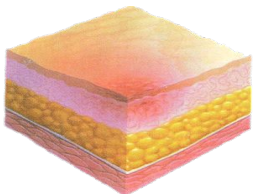
- The most commonly affected sites in the body are **sacrum**, greater **trochanter**, heel, **ischium**, **occiput**, and lateral malleolus.

04

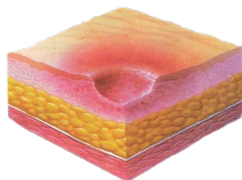
Staging of pressure ulcers

- **Stage 1.** Nonblanchable (**erythema**) of Intact dermis, no open wounds. The skin may painful, but appears reddened and does not blanch and feel either softer or firmer than the skin area around it (30 min - 1 hr).
- **Stage 2.** (**Partial dermal loss**) Partial thickness skin loss, with breaks, forms an ulcer which is tender and painful (2 - 6 hrs).
- **Stage 3.** (**Complete dermal loss ,with Muscle fascia**) Full thickness skin loss and the wound extends into the tissues beneath the skin, but not through the underlying fascia.
- **Stage 4.** (**Reaching the bone with infection**) Full thickness skin loss, with very deep pressure sore, reaching into muscle and bone and causing extensive damage to deeper tissues, such as tendons, and joints.

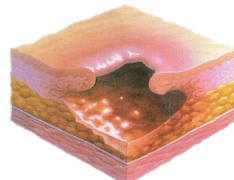
Stage I



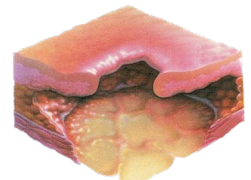
Stage II



Stage III



Stage IV



- develops if the patient doesn't move while sleeping for 2 hours (bed sore).
- **mainly involves the epidermis.**
- produces erythema, avoided by changing the position every 30 min.

Involves the **epidermis and the upper dermis.**

Involves the **epidermis, dermis and upper fascia.**

Involves the fascia and can reach to the **muscle, tendons and bones** and they usually develop osteomyelitis.

Chronic wounds



Pressure ulcer cont. :



Management:

Stage 1,2 = Change position and medical treatment

Stage 3,4 = Surgical and IV antibiotics for 6 weeks



Prevention

- Skin care
- Address spasticity
- Pressure dispersion (kosiak's principle)
- Support surface (at least 4 inches)
- Special pressure relief mattresses or dispersion cushions (e.g air-fluidized beds) to minimize pressure.
- The bedridden patient should be turned at least every 2 hours.



Medical

- Relief pressure
- Control infection
- Control extrinsic factors
- Dressing
- Drainage of any collection.
- Adequate debridement and excision of devitalized tissues and sloughs.
- Fecal diversion stoma is indicated when the ulcer is recurrently contaminated by fecal materials.
- Large skin flap with intact blood supply and sensation is the best cover when the ulcer is clean and ready for grafting.



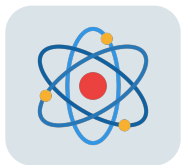
Surgical

- make sure patient is optimal(nutrition and smoking status, contamination)
- Debridement
- VAC Therapy Negative pressure vacuum-assisted closure (VAC) may enhance the closure of the ulcer (porous sponge packed into the wound connected to negative pressure). The negative pressure will stimulate wound closure, promote drainage, and provide a moist wound environment which is favorable for the growth of granulation tissue.
- Wound coverage

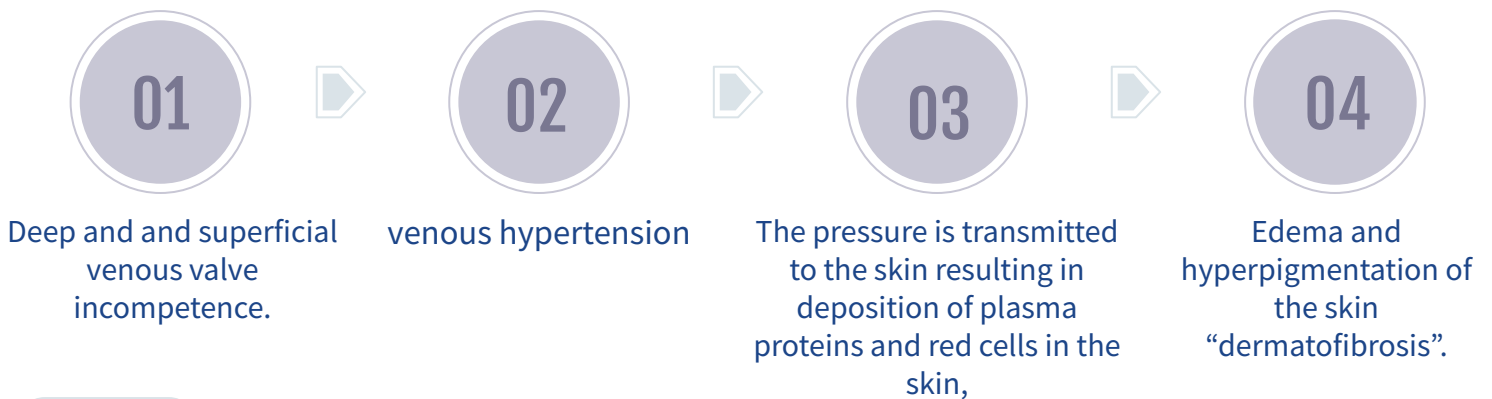
Chronic wounds

> Venous ulcer

- This is due to venous valvular incompetence of the lower limb, resulting in venous insufficiency.
- the patient usually develops discomfort in the leg, heaviness, and edema.
- Ulceration may develop in the anteromedial aspect of the leg “gaiter zone”, ulcers are generally superficial.



Pathophysiology:



Treatment:

-
- Debridement of the ulcer with excision if all dead tissues. 1
 - Sterile moist dressing. 2
 - Weekly or biweekly application of compression with paste bandages or multiple layer dry bandages. 3
 - Antibiotic therapy when infection is present. 4
 - Teaching the patient to elevate the limb most of the time. 5
 - Most venous ulcers will heal with compression within a few months, but some refractory ulcer may need surgery for ablation of normal perforator veins and skin grafting of the ulcer. 6

Chronic wounds

Diabetic ulcer

Diabetic patients are at risk of skin ulcer for the following reasons:



Neuropathy

Diabetic patient develop polyneuropathy of the nerves supplying the lower extremities.

- Motor neuropathy results in atrophy of the small intrinsic muscles of the foot with derangement of the bony structures with the collapse of the midfoot and plantar subluxation (Charcot's foot). This will result in excessive weight bearing in area at the risk of ulceration.
- Sensory neuropathy will result in loss of sensation and protective reflexes.

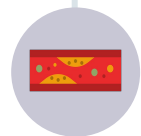


Charcot's foot Deformity



Hyperglycemia

Uncontrolled blood sugar will impair the leukocytes response to infection, create good media for bacterial growth, and retard the wound healing.



Arterial disease

Deficiency of blood supply will cause ischemic ulceration. Poor oxygen and nutrients delivery will retard the wound healing.

The commonest sites of diabetic ulcers are found at the plantar surface of the metatarsal, heels and dorsum of foot but it can occur anywhere in the foot or leg. It can be superficial, clean ulcer or even deep penetrating the deep structures with sloughs, purulent discharge with a limb or even life-threatening sepsis.



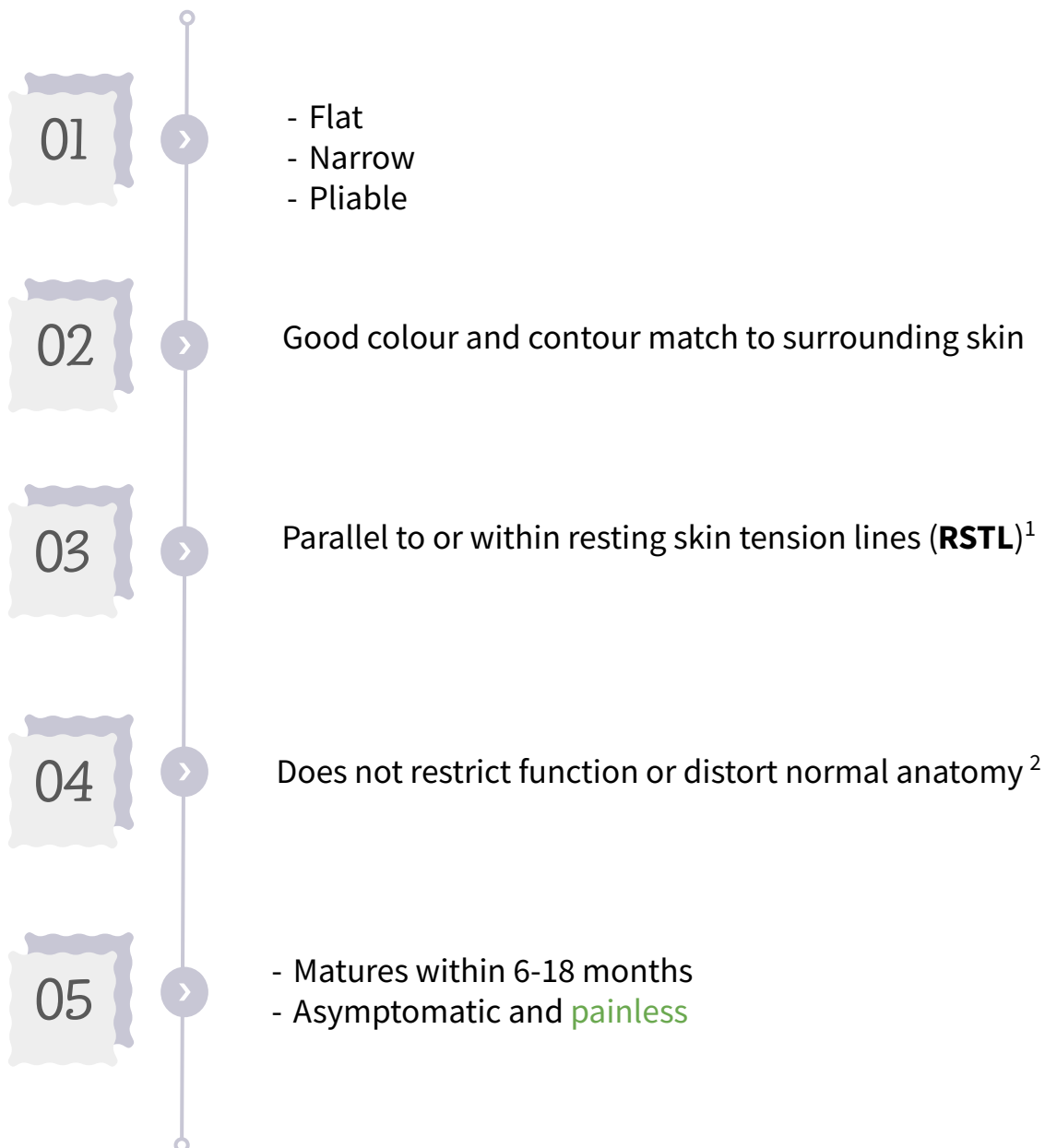
Treatment:

- Tight control of blood sugar.
- Antibiotics therapy covering aerobic and anaerobic bacteria..
- Plain x-ray to look for osteomyelitis.
- Adequate debridement, drainage of any collection, excision of dead tissues.
- Daily sterile dressing.
- The negative pressure vacuum-assisted closure may enhance the wound healing and closure when the wound is clean and granulating.
- Minor amputation is required for dead or severely infected toes.
- Major amputation is required for limb-threatening or life-threatening infected diabetic foot or in the presence of extensive osteomyelitis.
- Arterial surgery or endovascular intervention may be required when the ischemia is a prominent factor.

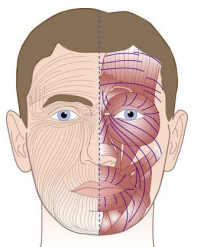
Scar formation

- Scars form in the maturation phase of wound healing, and over a year or more the immature scar becomes a mature scar.
- The collagen matures and becomes aligned along the stress lines of the skin and their strength increased.
- Although the tensile strength of the wound continues to increase, it would not exceed 80% of the normal skin.

➤ Ideal Scar:



1. For example when you operate on the forehead (frontalis muscle), RSTL are perpendicular to the muscle fibers, therefore you should do the scar horizontally rather than vertically to decrease the tension, create less visible scars & decrease the risk of hypertrophic scar.
2. Wounds that cross a joint (hands, fingers, etc) are at high risk for causing functional defects due to contracture (myofibroblasts).

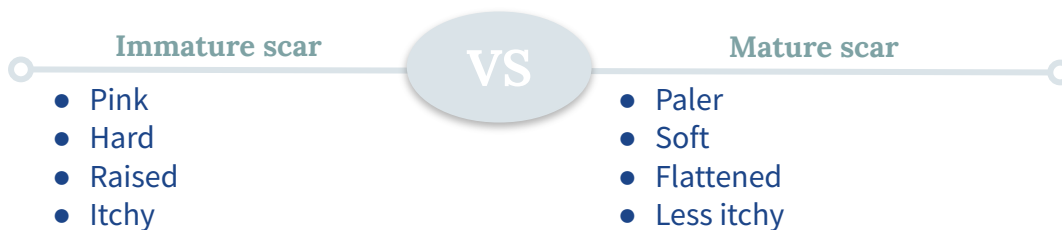


Scar formation

➤ Abnormal scar formation

How can it prevented?

- If acute wound managed correctly, most of the abnormalities in scar formation will be prevented.
- Proper scrubbing and cleansing of the wound with the proper alignment of all deep structures and good apposition of the wound edges are important in preventing the formation of an abnormal scar.
- Suture marks can be prevented by the use of fine (5-6/0) monofilaments suture under less tension and can be removed as early as 3-5 days in certain area and replaced by sticky strips, but subcuticular suture will result in a much better cosmetic scar
- When the size of suture increases, it leaves obvious marks with the less cosmetic outcome.



➤ Types of abnormal scars

Atrophic scar

- This is a flat, pale and stretched in appearance.
- It can be traumatized easily as the epidermis and dermis are thinned.
- Excision and resuturing may improve such scar.

Contracture scar

- This is when the scar form across a joint or flexion or extension skin creases.
- It may cause restriction of the movement at the joint , flexion or extension deformity.
- Contracture can be prevented be postoperative splints and intensive physiotherapy.
- Treatment include multiple Z-plasty or skin graft or flap.



Abnormal Scars :

Hypertrophic scar

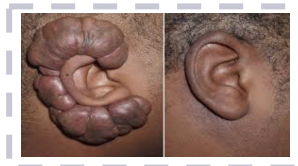
- This is an excessive scar tissue that **does not extend beyond the original wound boundaries**.
- It results from the prolongation of the inflammatory phase of wound healing and from inappropriate scar sitting such as wound across the lines of skin tension.



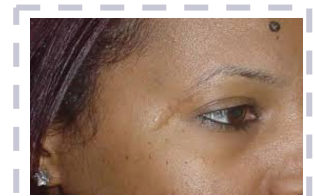
Hypertrophic scars
These scars should not be excised.

Keloid scar

- **Overproduction of collagen and fibroblasts**
- This is an excessive scar tissue that extends beyond the original wound boundaries.
- The etiology of keloid scar is unknown, but it is associated with deeply pigmented skin and inherited tendency.
- It is more common in the body triangle between the point of each shoulder tip, xiphisternum, ear, and chin of the tibia.
- Hypertrophic scars improve with time spontaneously, while keloid scars do not. All excisions have **high rates of recurrence**.



Keloid scar
excision can be done as an alternative.



Wide scar
Caused by traumatic wounds that are not closed properly.



Important to remember this table

Features	Hypertrophic scar	Keloid scar ¹
Genetic	Not familial	May be familial
Race	Not race related	Black > White
Sex	Female = Male	Female > Male
Age	Children	10-30 years
Borders	Remains within wound	Outgrows wound area
Natural history	Subsides with time	Rarely subsides
Site	Flexor surfaces	Sternum, shoulder, face, earlobe
Aetiology	Related to tension	Unknown (genetics?)

1. Classical presentation: 20 year old African American female, with a scar in the earlobe.
- Keloid scars have high recurrence rate.



Vancouver Scale:

Scar characteristic	Description
Pigmentation	
0	Normal color that closely resembles the color over the rest of one's body
1	Hypopigmentation
2	Hyperpigmentation
Vascularity	
0	Normal color that closely resembles the color over the rest of one's body
1	Pink
2	Red
3	Purple
Pliability	
0	Normal
1	Supple: flexible with minimal resistance
2	Yielding: giving way to pressure
3	Firm: inflexible, not easily moved, resistant to manual pressure
4	Banding: rope-like tissue that blanches with extension of the scar
5	Contracture: permanent shortening of scar producing deformity or distortion
Height	
0	Normal: flat
1	<2 mm
2	<5 mm
3	>5 mm

438's Doctor's questions

- What is the cell that peaks in wound healing at 3 weeks
- What's the main cell in the inflammatory phase
- Medications
- Clinical case will be given during OSCE about keloid and hypertrophic scars
- When to do primary/secondary/tertiary closure



Treatment of hypertrophic scar and keloid ¹:



Prevention by: (in surgical wounds)

- No tension closure
- Minimal undermining of skin
- Adequate hemostasis



Non surgical:

- Pressure: compression garment.
- Silicone sheets or gels.

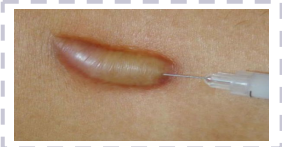
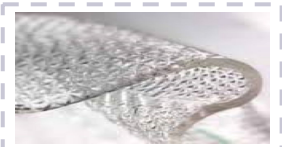


Medical ²:

- 5-FU (Fluorouracil is a chemotherapy).
- Intralesional Steroids ³ (first-line therapy).



- Laser
- Radiation
- Surgery



1. We should take measures to prevent it from occurring in the first place. You prevent HTS, by avoiding tension in creating a scar parallel to the RSTL, minimal undermining (raising the skin and going underneath it), minimal electrocauter (leads to seroma formation → high tension) closing layer, no strangulation (put spaces between each suture).
 - Keloid: combination of (steroid and silicone) or (surgery and radio)
2. How does radiation and chemotherapy heal HTS if it leads to reduced wound healing? the unit of given radiation therapy is the guide. Patients that receive radiation therapy for cancer receive high amounts of radiation compared to HTS. The second thing is that HTS has abnormal collagen synthesis (high turnover of collagen) and radiation stops this by causing fibrosis and less formation of collagen.
 - There's still a 10% chance of recurrence after treatment.
3. Steroids injection increases collagenase → digest collagen → less scar

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.



> Epidemiology:

1

- Males > Females

2

- 2 peaks at : 0 - 5yrs and 25 - 35yrs

3

- 80% of burns are less than 20%TBSA

4

- **Pediatrics:** Scald Burns >80% , Account for 45% of Hospital Admission , 33% due to child abuse

5

- **Elderly:** Impaired mobility, poor coordination, decrease awareness to pain , Abuse/neglect.

6

- **Factors that increases mortality:** Age greater than 60 , Greater than 40% TBS , Inhalation injury

7

- Alcohol and smoking are a common contributing factors in local burn injuries.
- Industrial accidents account for the majority of electrical and chemical burns.
- 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

Pathophysiology of burn:

01

The local effects are the result of tissue destruction and inflammatory response.

02

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.

03

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.

04

Destruction of the Epidermis causes impairment of the physical barriers and predispose to infections which can delay healing and increase energy demand.

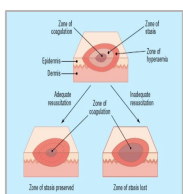
05

Burns have 3 zones :

1-Zone of 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.

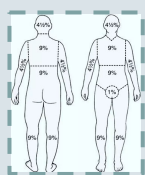
2-Zone of stasis: an area of potential reversible cell damage surrounding the central zone (tissue is damaged with decreased perfusion but still viable).

3-Zone of hyperemia: an area characterized by inflammation and increased blood flow surrounding the stasis zone.



Calculations:

★ Rule of nines



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
- less useful in children because of the relatively large head size (and the relatively small limbs).
- ★ Palm without fingers = 1% (**Palmer method "rule of palm"**) it's another way to estimate the size of a burn
- ★ 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.

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 injury"**
- 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.)

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



438 Note for OSCE: in the exam, they will bring a picture and ask you to estimate the degree of burn.

Note

- Time of contact and the intensity of the agent determine the severity
- In clinical practice, most burns are a mix of types. Any burn is surrounded by lighter zone.
- E.g. : 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.

	Degree	Treatment
<p>First Degree (superficial burn)</p> 	<ul style="list-style-type: none"> • Epidermal injury only. • Clinically characterized by: edema, erythema and pain • No fluid collection occur at this degree (no blister). • Most common presentation is kitchen burns and sunburns. 	<ul style="list-style-type: none"> • Heal within 7 days • Symptomatic treatment: <ul style="list-style-type: none"> ◦ Mild analgesics/NSAIDs pain is the commonest presentation • Local wound care: <ul style="list-style-type: none"> ◦ Daily cleansing. ◦ Topical antibiotics (silver sulfadiazine) if needed. ◦ aka: Flamazine is the gold standard in preventing infections due to its broad spectrum activity (covers both gram negative and gram positive bacteria). • Elevation (raise patient's hand up to reduce edema) • Occupational (Physical) therapy <ul style="list-style-type: none"> ◦ Splints in functional position. ◦ Start early range of motion, if burns and edema are near a joint.
<p>Second Degree (superficial/deep partial thickness)</p> 	<ul style="list-style-type: none"> • Injury to epidermal +/- dermal layers. • Clinically characterized by: painful because the nerve is affected partially and its endings are exposed. • blisters (Hallmark of Second degree burns), occur when the burn exceed the basement membrane of the epidermis going down to the dermis. • Skin is repopulated by viable germinal cells in follicles (has stratified squamous epithelium). • 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 e.g: Deep 2nd degree burn → "the burn has exceeded reticular layer of the dermis" leading to delayed healing and scarring and surgical intervention is indicated. 	<ul style="list-style-type: none"> • Heal within 14 days • Similar to first degree burns. • Leave blisters intact, they are the best natural dressing. If debrided, cover with an occlusive dressing. • 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 should be used for treating the infection and if there is open area or open wound you have to treat the infection. • Compression garment after wound epithelialization.

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

	Degree	Treatment
<p>Third Degree (full thickness)</p> 	<ul style="list-style-type: none"> Entire dermal layer and subdermal fat injury the entire content of the skin+nerve endings are completely burnt here(less painful)so covering the burn is better to prevent infections . Clinically characterized by: dry, inelastic and waxy appearing scar skin is similar to commercial leather. Whitish in color (pale) Skin has five 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 major systemic effect in second and third degree burns is decrease venous return. 	<ul style="list-style-type: none"> They form blisters and heal by hypertrophic scars. You must do skin grafting Early tangential skin excision and meshed split thickness skin grafting (within 7 days). We have to surgically debride and skin graft. We remove the eschar (the white patch) we clean the wound until we reach healthy tissue then we remove a skin patch from one area of the body and transplant it to the burned area.
<p>Fourth Degree (full thickness)</p> 	<ul style="list-style-type: none"> Dermis and deep tissue injury. Clinically characterized by: injury to all skin layers, and injury to tendon, nerve, bone and joint In addition to Muscles and subcutaneous fat . basically injury to vital structures underneath the skin . Caused when the patient is unable to move away from the burning agent eg: unconscious patients/disabled patients/infants, car accident . It's rare but has a bad outcome . 	<ul style="list-style-type: none"> Very deep, doesn't hurt and doesn't heal Skin grafts not adequate for exposed deep structures. <p>Treatment options:</p> <ul style="list-style-type: none"> Amputation. Flap coverage with salvage procedures.

➤ Classification of Burns Based on the cause of Skin Injury :

thermal

- Friction burn
- Scald burn: the most common type of burns among children.

Chemical

- **Alkaline** (more dangerous due to infiltration and liquefactive necrosis).
- **Acidic** (hydrofluoric acid can cause 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

- **Systemic injury: cardiac arrhythmia** (if a current entered from one hand and exits from the other it means that it went through the heart), **sepsis, renal failure** (due to necrosis), **PNS**

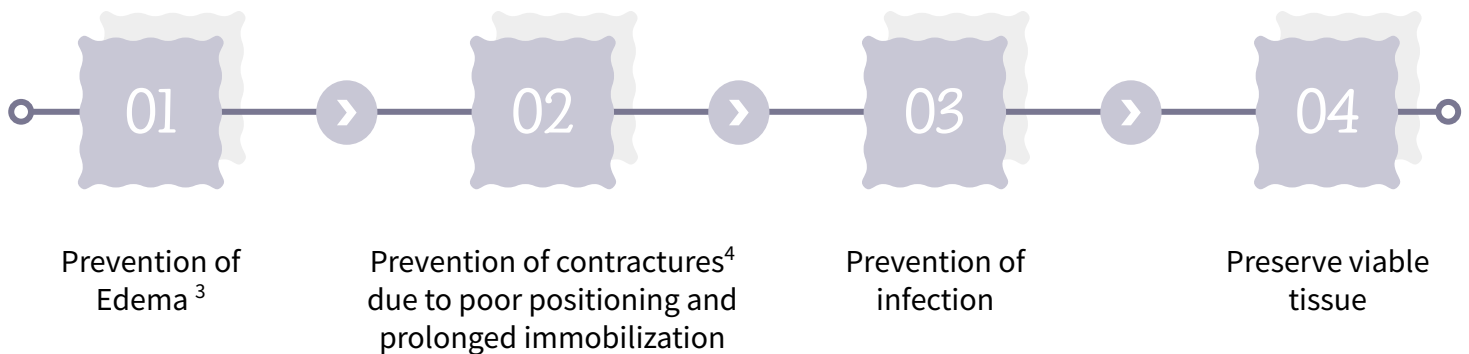
Sunburns

Burn

➤ Burn Healing :

- **First** degree and **superficial second** degree burns:
 - Local wound care only.
 - Has the ability to heal by themselves because the blood vessels and skin appendages are still intact .
- **Deep second**¹ degree burns:
 - Controversial.
 - Functional results worse than superficial second degree burns.
 - Consider excision and skin grafting if hand burns will take 14 days to “close”.²

➤ Objectives of treatment :



➤ When to transfer to a burn center (transfer criteria) : ★

- >25% body surface area (BSA).
- >20% BSA in children.
- High voltage burns.
- Inhalation injuries.⁵
- Burns in the genital area, face, neck, feet and hands in addition to full thickness burns.
- Chemical burns.
- Circumferential burn

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.
8. 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.
9. Burn injury in children admitted to a hospital without qualified personnel or equipment for pediatric care.
10. Burn injury in patients requiring special social, emotional, and/or long-term rehabilitative support, including cases involving suspected child abuse.

1- Grey zone !

we don't know whether the burn will heal by itself or not so we wait for 14 days, if it didn't heal we use grafts. During these 14 days we maximize resuscitation and give topical antibiotics

2-They are deeper so more skin appendages will be affected , causing less epithelization making it harder to heal as the number of skin appendages left are less .

3-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.

4- A condition of shortening and tightening of muscles, tendons or other tissues causing a deformity.

5-Should be incubated before the manifestation of signs of acute hypoxia due to occluded airway by edema and before an emergency tracheotomy is needed.

Management of Burns:



Surgical

- Escharotomy
- Skin grafting



Non surgical

- Tetanus prophylaxis¹ (lockjaw)
- Analgesia
- Dressing
- Nutrition
- Fluid
- Foley Catheter²

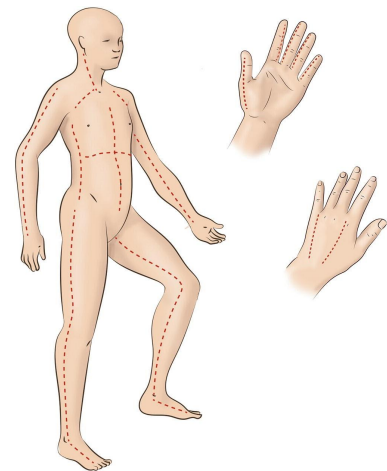
01

Escharotomy³:

- 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.

Grafts

- 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)
- **2 types:**
 - **Split thickness graft:** epidermis and part of dermis. High risk of hypertrophic scar(contraction)
 - **Full thickness graft:** epidermis and entire dermis. Less hypertrophic scar (less contraction) need to close it

VS

Flaps

- 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)

1- An infection caused by Clostridium tetani. When the bacteria invade the body, they produce a toxin that causes painful muscle contractions.

2-the urine output shows how well the patient resuscitated (feedback mechanism) . The minimum urine output for adults ½ ml per kg/hr.

3- The most important indication of escharotomy is circumferential, superficial burn (which causes hypoperfusion due to edema).

-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 compromise 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

02

Antibiotics¹:

- Intravenous or oral antibiotics should cover skin flora for initial treatment.
- Topical antibiotics ² (silver sulfadiazine) for prevention of infection.
- Topical application of (mafenide acetate) penetrates through eschar and may be effective against a wider variety of organisms.

03

Non-Surgical Management:

- The first step is removing the object especially in chemical burns
- ★ 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).
- Normal Urine output: 1 cc/kg/hour. Pediatric, Electrical and inhalation aim for: 2cc/kg/hour
- **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
 - **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.

1. Need documented culture. Most cases will use antibiotics due to different types of burns involved in the same place.

2. **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

Inhalation injury

- **The mechanisms of inhalation injury can be divided into three broad areas**
 - Inhalation of products of combustion
 - Carbon monoxide inhalation
 - Direct thermal injury to the upper aero-digestive tract (**inhaling hot air**)
- **Features of inhalation injury (physical/mechanical components)**
 - Flame burn in a closed space
 - Singed (burned) nasal hair
 - Facial or oropharyngeal burns
 - Expectoration of carbonaceous (blackish) sputum
 - **Changed voice and inability to breathe**
 - **Loss of facial hair (nasal, eyebrows, mustache..etc)**
 - **On intraoral examination: burns on the soft and hard palate, blisters in the mouth or throat.**
 - **Does Not occur with burns caused by hot water**
- Acutely the patient is fine, the problems begins when the patient starts receiving fluids. This fluid will go to third spacing (interstitial edema) and compromises the airway. Patient will start developing signs of upper respiratory obstruction—such as crowing, dyspnoea, cough, stridor, or air hunger.
- Intubating in this stage is semi-impossible due to swelling of the vocal cords and trachea, tracheostomy or cricothyroidotomy which is not always feasible, that's why you should intubate the patient as soon possible until this phase passes. **You have to INTUBATE prophylactically** (don't miss inhalation component)

An Area for your notes

➤ Carbon monoxide (chemical component of inhalation injuries)

Why is it bad?

- Odourless, tasteless gas
- Impairs tissue oxygenation by preferentially binding to Hgb
- Affinity 240 times that of oxygen
- shifts the Hb dissociation curve to the left decreasing O2 delivery

Signs

- Headache
- cherry red lips
- arrhythmias
- acidosis
- seizures
- LOC

CO level	Symptoms
0-5	Normal Value <small>Normal people don't have any carbon monoxide</small>
15-20	Headache, Confusion
20-40	Disorientation, Fatigue, Nausea< Visual Changes
40-60	Hallucinations, Coma< Shock
60 or above	Mortality >50%

Not done routinely, you have to call the lab and ask for it with the regular Arterial Blood Gas analysis (ABG)



Treatment:

- 100 % O2 +/- intubation and ventilation
- t1/2 of CO is 5 to 6 hours on R/A
- 45 min on 100% O2
- 27 min HBO @ 3 atm



Indications for hyperbaric oxygen therapy HBO

- Coma
- LOC
- ischemic ECG changes
- focal neurological deficits
- +/- CO Hb >40%



Questions /cases from the doctors

1

A 29 years old male, sustained a burn 1 hour ago, cam to the ER with these features.

What will be your main concern?

Inhalation injury

What are the features of this injury?

Calculation of inhalation burns

Add 25% to TBSA

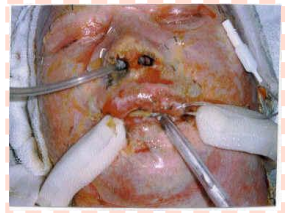
In this case the patient is suffering burns on his head,neck and right arm =18%

$18+25= 43\%$

If we only calculate the external TBSA the patient will be under resuscitated.

Most common cause of morbidity and mortality in burn patients acutely is under resuscitation

Most common cause of morbidity and mortality in burn patients a week after the injury is infection



2

What is the degree of the burn?

First degree

What is diagnostic feature?

Erythema

Only requires analgesia because it only affects the epidermis



3

What is the degree of the burn?

Second degree

Why?

Presence of blisters, there is loss of fluid underneath the skin and the burn extends to the dermis

Second degree burns are divided into

- Superficial partial thickness (upper layer of the dermis)
- Deep partial thickness (middle layer of the dermis) facial burns heal on their on because the face has a big blood supply



4

What is the degree?

Third degree burns involve the whole dermis

What is the diagnostic feature ?

The presence of an eschar

Fourth degree burns are rare and require surgery and skin grafts



Questions /cases from the doctors

5

A patient presents to the ER suffering from a cut wound in the right hand, the wound has been 2 hours and is superficial , how would you approach this pt ?

- Hx & Px
- **Ask about Tetanus Vaccine** [\(for more details\)](#)
- **Do you need to give ABx ? if the wound dirty and old > YES**
- **Start with oral ABx > after 48h , progression of clinical infection ? shift to IV**

6

Patient sustained a burn at 4 o'clock, presented to ER at 8 , when would you give the first half amount ?

You estimate time from the time of injury NOT admission

7

History:

CC: Difficulty breathing; Machine (in wheat house--closed area) exploded in face

Comments:

This patient most likely have inhalation injury, so ask yourself:

- Can the patient see?
- Can the patient hear?

Since its a burn bare in mind the following:

- Vaccination and degree of pain
- Was the patient wearing clothes or not?
- If so, did the clothes burn or not?
- Covered after removal of clothes?—to avoid dehydration and hypothermia. —in case of continuous contact
- Assess breathing, assess mucosal lining,
- Transfers to burn unit (more than 30% and inhalation injury)
- The burn will demarcate after 3-5 days

Management:

- Maintain Airway, breathing and circulation (make sure patient is stable)
- Make sure patient is pain free and the wound is covered
- if chemical then irrigate with NS or water
- Decide on surgery after 3-5 days
- If circumstantial burn → escharotomy
- If compartment → fasciotomy



Questions /cases from the doctors

8

History

Personal: Khalid , 65 yo from SA, retired policemen - no allergies

CC: Came to ER

- large wound with **pain** in right upper buttocks and **scarring** X 2 years ago
- Wound has discharge now (note: Painful wound on Right lower buttocks for two years. With discharge so ask about: color, smell, how many times do you change dressing (continuous or not), amount)
- Assos.: fever, loss of weight, redness around wound



PMx:

- Admitted 5 times to hospital 5/7 past years for this issue, improved with AxB
- Paraplegic for the last 10 years due to RTA
- Diabetic since long time and takes insulin and glucophage
- HTN, dyslipidemia
- Recurrent UTI (note:can't control bowel and urine output so ask: is there a need for a catheter? Colostomy?)

PSx:

- Peripheral vascular disease with clopidogrel (Plavix) for stent

Sx:

- Smokes 10 cigs for 20 years

Clinical exam:

(inspect: site, size, depth of floor, granulation tissue of unhealthy tissue

Palpate: Discharge (pus, yellow, green, blood) and (continuous-then its a sinus continuously draining), Around the wound (raised edges, laceration (with an M), muscle wasting, frail skin, redness), Pulses (Femoral, popliteal, dorsalis pedis) incase its vascular or hematoma, Percuss (around for abscess))

- Site: On the right ischium
- Single wound
- Measure size
- Irregular edges
- With areas of necrosis
- Redness in surrounding skin
- The edges are darker
- Purulent discharge
- Measure depth of wound
- Assess base
- Palpate for tenderness and
- Asses temperature of surrounds area and floor
- Check for disagree or bleeding
- Percuss around loculated abscess

- Random comment: Usually the cause of sepsis is urosepsis

Questions /cases from the doctors

9



- **If a patient came for a follow up 3 weeks post-op and asked for scar revision , when should you assess?**

you should not assess until the scar is completed 1 year, then you can assess

- **When to allow a patient to go back to normal activity?**

6 to 8 weeks post-op because tensile strength should be around 80% of normal skin at the time

Patient with a clean wound in ER.

10

1. Ask about tetanus vaccination status
2. Debride the wound completely - Excision of abnormal tissue from a healthy tissue to a healthy tissue in Depths on site.
3. Give oral antibiotic , if it's very severe then IV

439 Quiz

Q1: Which of the following statements about the process of wound healing are true?

- A) The inflammatory phase begins 2–3 days after the injury.
- B) The proliferative phase lasts from 3 days to 3 weeks following the injury.
- C) The remodelling phase involves fibroblast activity and production of collagen and ground substance.
- D) Fibroblasts require vitamin C to produce collagen.
- E) The white cells stick to the damaged endothelium and release adenosine diphosphate (ADP) and cytokines.

Q2: Which of the following are useful in the treatment of keloids?

- A) Elasticated garments
- B) Silicone gel sheeting
- C) Excision and steroid injection
- D) Excision and radiotherapy
- E) Vitamin D preparations.

Q3: Which of the following statements are true?

- A) Scars continue maturing for 3 months.
- B) Keloids contain an excess of type B collagen.
- C) Suture marks can be reduced by using polyfilament sutures.
- D) The tensile strength of the scar never reaches that of the normal skin
- E) A hypertrophied scar extends beyond the boundaries of the previous incision.

Q4: Which of the following statements regarding burns in children in the UK are true?

- A) The majority are electrical or chemical.
- B) The majority are most commonly scalds.
- C) Hot water thermostat setting at 60°C helps to improve safety in homes.
- D) Intravenous (IV) resuscitation in children is required for burns greater than 5 per cent of total body surface area (TBSA) and less than 10 per cent.
- E) Non-accidental injury is common in children's burns.

Q5: A patient is admitted following a house fire. He has extensive partial and full thickness burns over his arms, upper torso and neck. You note black carbon deposits around his nostrils and oropharynx. Which of the following is the immediate priority?

- A) Adequate analgesia
- B) Sterile water irrigation
- C) Intubation
- D) Fluid resuscitation
- E) Immediate transfer to a specialist burns centre

Q6: A 48-year-old man is admitted with a burn over his arm and anterior chest. The involved tissue includes the entire circumference of his upper arm. Following initial resuscitation, he is admitted for observation. You are called to assess him as he is beginning to complain of increasing pain and tightness in his forearm. On examination you note weak peripheral pulses, paraesthesia and pain on active movement of the fingers, hand and wrist. The next stage in management is

- A) Angiography
- B) Fasciotomy
- C) Fluid resuscitation
- D) Electrolyte assay and replenishment
- E) Escharotomy

Answers

Q1	B, D	Q4	B, C
Q2	A, B, C, D	Q5	C
Q3	B, D	Q6	E

**Extra
Questions**

439 Quiz

Explanations

Q1 Explanation: The inflammatory phase begins immediately after the wounding and lasts 2–3 days. Platelets

stick to the damaged endothelial lining of the vessels and release ADP and cytokines such as platelet-derived growth factor (PDGF), platelet factor 4 and transforming growth factor (TGF)-beta. These attract inflammatory cells such as polymorphonuclear lymphocytes and macrophages.

The proliferative phase lasts from the third day to the third week, consisting mainly of fibroblast activity with the production of collagen and ground substance, the growth of new blood vessels as capillary loops and re-epithelialisation of the wound surface. The remodelling phase is characterised by maturation of collagen, with type 1 replacing type 3 until a ratio of

4:1 is achieved. There is realignment of collagen fibres along the line of tension, decreased wound vascularity and wound contraction due to fibroblast and myofibroblast activity..

Q2 Explanation: A, B, C, D

A keloid is defined as excessive scar tissue that extends beyond the boundaries of the original incision or wound. Its aetiology is unknown but it is associated with elevated levels of growth factor, deeply pigmented skin, an inherited tendency and certain areas of the body (a triangle whose points are the xiphisternum and each shoulder tip). Histology shows excess collagen with hypervascularity and increased B type of collagen..

Q3 Explanation: The maturation phase of healing results in scarring. The mature scar becomes mature over a period of a year or more. At first, it is pink, hard, raised and itchy. As the scar matures, it becomes almost acellular as the fibroblasts and blood vessels reduce. The scar then becomes paler, flat and soft. Most of the changes take place over the first 3 months but a scar will continue to mature for 1–2 years. The strength gradually increases but will never reach that of normal skin. Suture marks can be reduced by using monofilament sutures. A hypertrophic scar is defined as excessive scar tissue that does not extend beyond the boundary of the original incision or wound. It results from a prolonged inflammatory phase of wound healing and from unfavourable siting of the scar..

Q4 Explanation: The majority of burns in children are scalds with kettles, pans, hot drinks and bath water. Legislation, health promotion and appliance design, together with education of patients regarding smoke alarms and hot water thermostats kept at 60oC, have reduced the incidence of burns. IV fluids in children is required when the TBSA is 10 per cent or more..

439 Quiz

Explanations

Q5 Explanation: Intubation

The subglottic airway is protected from thermal injury by the larynx. However, the supraglottic airway is susceptible to such injury and upper airway occlusion is a common consequence of inhalational injury or extensive burns to the neck. Signs of inhalation injury include singed nasal hair, facial burns, carbon deposits around the nose and oropharynx, hoarseness of voice, carbonaceous sputum and history of confinement in a burning environment.

This patient is at high risk of complicating his airway, with evidence of inhalational injury combined with external injury to the neck. Securing his airway is of highest priority as delay may lead to laryngeal oedema and need for surgical airway placement. This patient will also require fluid resuscitation and transfer to a specialist burns centre. Water irrigation and removal of all clothing is required to ensure removal of all burning material from the site of injury; only warmed fluid should be used to avoid hypothermia. Excessive analgesia should be avoided in the acute stages of burn resuscitation, as such medications mask signs of hypoxia and hypotension, which are used to guide fluid therapy..

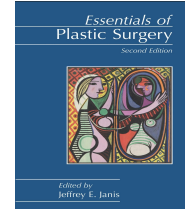
Q6 Explanation: Escharotomy

Skin is inherently elastic and allows expansion and relaxation of underlying tissues. When skin is lost due to burns or other causes, fibrotic scarring occurs. When such injuries are circumferential, as in this case, healing can constrict underlying tissues, blood vessels and nerves. Limbs are vulnerable, as is the neck and even the chest, where extensive injury can restrict chest expansion and impair breathing.

The patient in this case is clearly exhibiting the signs of muscle compartment compromise secondary to restricted blood supply. There is concomitant paraesthesia, which may be as a result of ischaemia or a direct result of nerve compression. Fluid resuscitation is not required and although an electrolyte imbalance should be ruled out it is unlikely to be causative. Angiography is not indicated. This patient requires urgent escharotomy (incision of scar tissue to release constricting pressure). Fasciotomy is rarely required in such cases, but may be indicated if vascular supply remains compromised for a prolonged period and true compartment syndrome develops..

438 Quiz

The doctor recommended
this book (click on it)



Q1: Q1: A 22-year-old healthy African-American woman presents with a recurrent growth on her right thigh. She has a childhood history of a third-degree scald burn to the same area that did not require skin grafting. The growth was completely removed 2 years ago. On physical examination there is a 5 cm × 2 cm, raised, irregularly shaped purple lesion with a smooth top. Which of the following is the most likely diagnosis?

- A) Angiosarcoma
- B) Malignant melanoma
- C) Squamous cell carcinoma
- D) Kaposi sarcoma
- E) Keloid

Q2: A 65-year-old man sustains a 50% TBSA burn while burning trash in the backyard. The patient is resuscitated with lactated Ringer (LR) solution using the Parkland formula and a weight of 80 kg. What is the rate of LR given in the first 8 hours?

- A) 100 mL/h
- B) 500 mL/h
- C) 1000 mL/h
- D) 5000 mL/h
- E) 10,000 mL/h

Q3: What reverses the deleterious effects of steroids on wound healing?

Vitamin A

Q4: 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

Q5: What lab value assesses smoke inhalation?

Carboxyhemoglobin level (carboxyhemoglobin level >60% is associated with a 50% mortality); treat with 100% O₂ and time

Q6: How 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

Answers

Q1	E	Q4	
Q2	C	Q5	
Q3		Q6	

Extra
Questions

Good Luck!



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lectures (438 & 439)

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