



SURGERY TEAM 437

Surgical Infections & Antibiotics



Team leaders: Alanoud Almansour, Ghaida Al Masmaa , Moath Alhamoud & Mohammed Alqwaifli



Done by: Alfahdah Alsaleem, Sultan Alfehaid, & Abdulaziz Al Abdulkareem



Revised by: Aseel Badukhon

Color Index:

● Important

● Doctor's Notes

● Extra

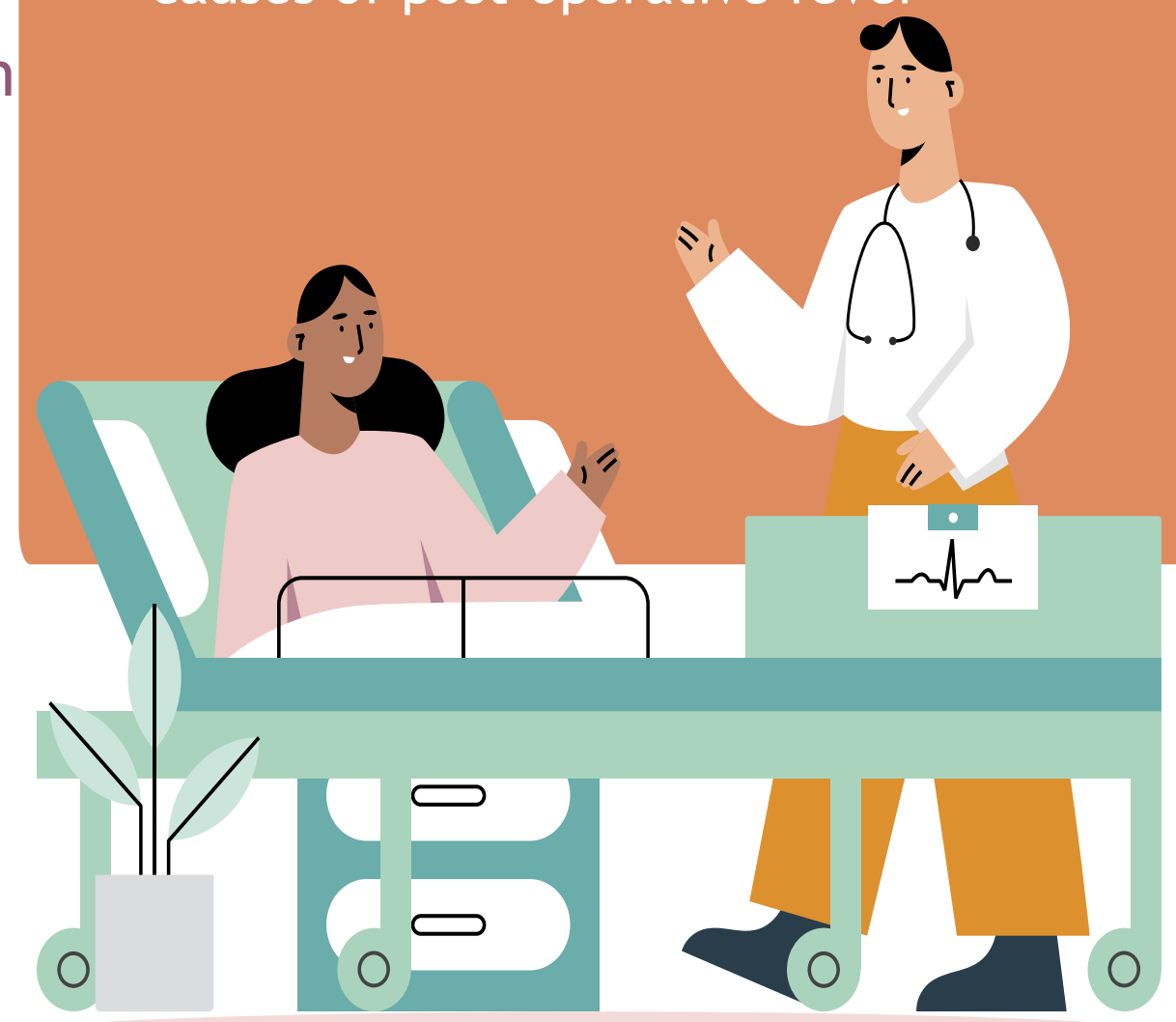
● Davidson

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Objectives:

1. List factors predisposing to surgical infection
2. Discuss the difference between modifiable factors e.g. time of surgery vs. non modifiable factor e.g. age of patient
3. Discuss the management options to decrease rate of infection
4. Mode of transmission of MRSA
5. The effect of presence of MRSA carries on rate of infection, rate of patient and on other patient
6. Identify the most common organism in needle stick injury and rate of infection and preventive methods
7. Identify and differentiate between specific types of infection (cellulitis, tetanus, gas gangrened, necrotizing infection)
8. Define (term) colonization vs infection.
9. List causative organism of cellulitis
10. List and recognize the clinical manifestation of cellulitis
11. Develop a plan to treat cellulitis and monitor effects of treatment
12. Identify the different causes of postoperative fever
13. Discuss the expected time for common postoperative fever
14. List factors predisposing to surgical infection
15. Identify the most common organism in needle stick injury and rate of infection and preventive methods
16. List the various causes of post-operative fever
17. Describe the difference between various respiratory complication e.g. atelectasis, pneumonia and pulmonary edema
18. Outline the management of various causes of post-operative fever



Introduction

The difference between infection and colonization:

- Many body surfaces are colonized by a wide range of microorganisms, called commensals, with no ill effects.
- Once the normal defences are breached in the course of surgery, such as skin (e.g. Staphylococcus aureus) and bowel (e.g. Bacteroides spp. and Escherichia coli) commensals can then cause infection. Infection is defined as the proliferation of microorganisms in body tissue with adverse physiological consequences.

What is an infection?

- Infection is defined as the proliferation of microorganisms in body tissue with adverse physiological consequences.
- Surgical infections: Infections that require surgical intervention as a treatment or develop as a result of surgical procedure.
- Surgical infections occur because of a breakdown of the equilibrium that exists between organisms and the host. This may be due to a breach in a protective surface, changes in host resistance, or particular characteristics of the organism.
- The possible outcomes are resolution, abscess formation, extensive local spread with or without tissue death, and distant spread.

Principles Of Treatment:

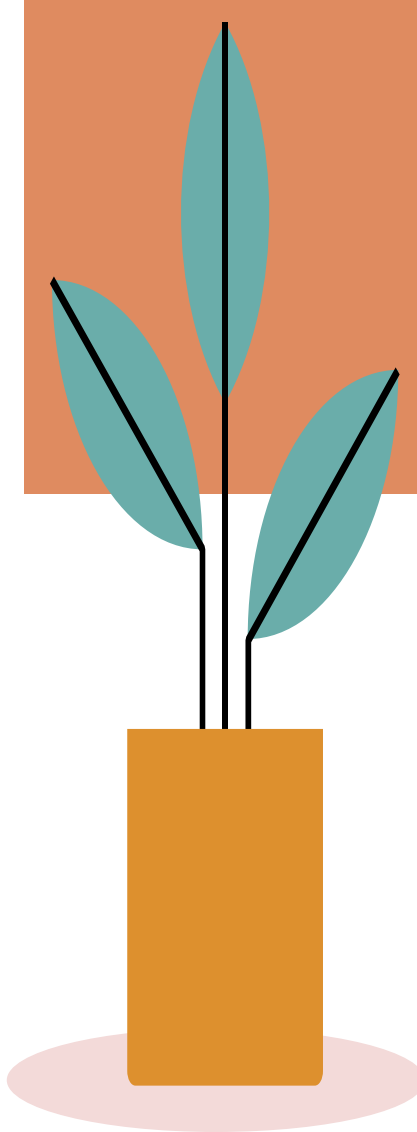
1. Drainage: for abscess, or infected fluid
2. Excision: infection source (e.g. appendectomy)
3. Debridement: remove necrotic, injured tissue
4. Supportive measures:
 - a. Antibiotics
 - b. Immobilization (if in a limb)
 - c. Limb elevation (to avoid fluid collection)

Discussion of MRSA:

- Carriers receive decolonisation treatment (nasal **mupirocin** cream and an antiseptic skin wash) and appropriate antibiotic prophylaxis, usually a glycopeptide antibiotic (**teicoplanin**) prior to surgery.
- Preoperative MRSA screening has been shown to reduce MRSA transmission in surgical wards. Although this regime is only 50-60% effective, in the remainder, reduced bacterial shedding reduces the risk of transmission and infection.
- The main mode of transmission of MRSA infections is through direct contact with wounds, discharge and soiled areas.

Pulmonary Complications:

- **Atelectasis**: When there is a complete obstruction of a bronchus or bronchi air in the lung distal to the obstruction is absorbed, the alveolar space close and the affected portion of the lung become solid. (collapsing of the lung)
- **Pulmonary edema**: S condition caused by excess fluid in the lungs. This fluid collects in the numerous air sacs in the lungs, making it difficult to breathe.
- **Pneumonia**: An infection that inflames the air sacs in one or both lungs. The air sacs may fill with fluid or pus (purulent material), causing cough with phlegm or pus, fever, chills, and difficulty breathing



Surgical Infections

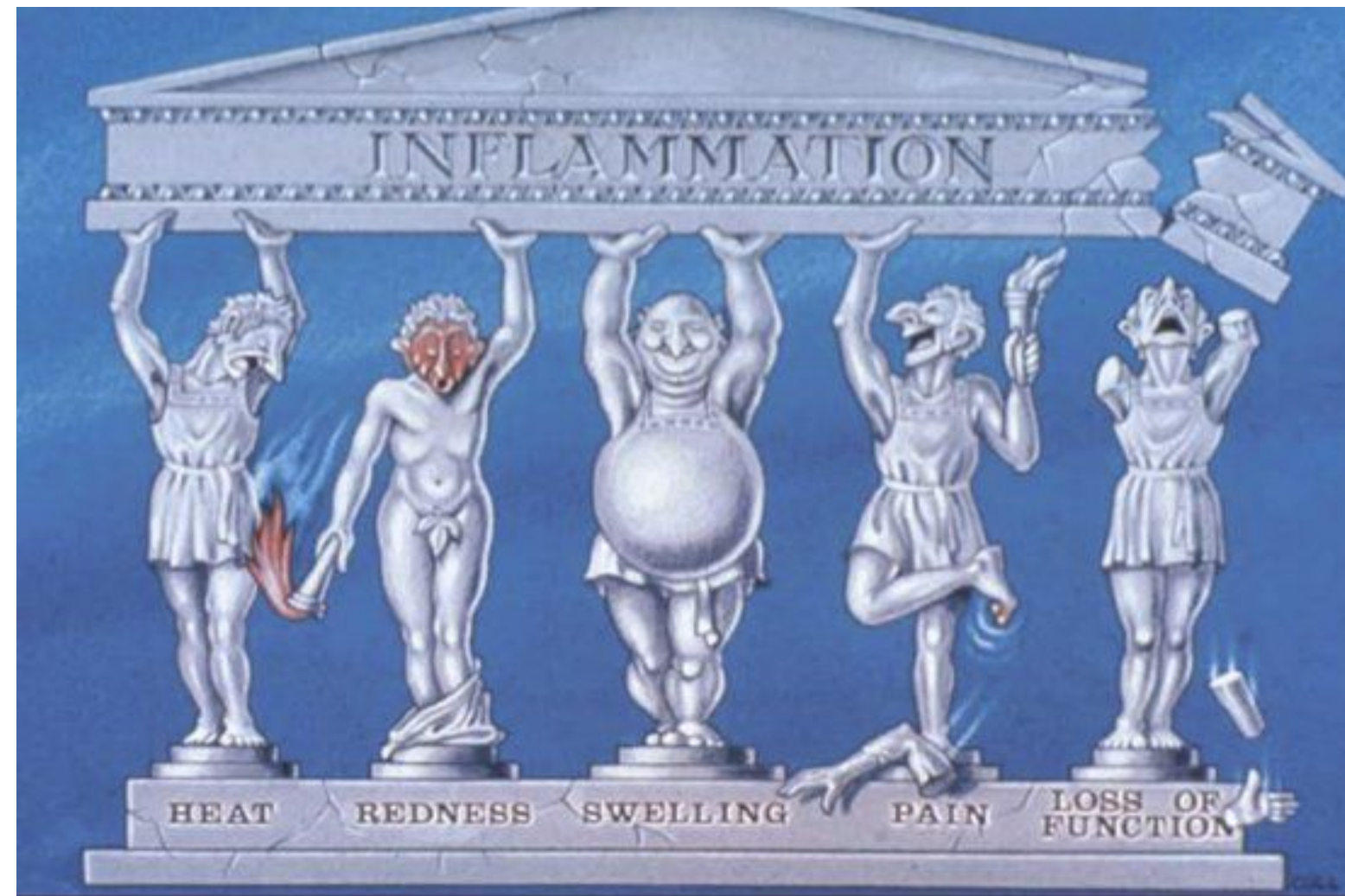
Infection is defined by:

- Microorganisms in host tissue or the bloodstream
- Inflammatory response to their presence

- Dolor (pain)
- Calor (heat)
- Rubor (redness)
- Tumor (swelling)
- Functio laesa (loss of function)

- **Localized**
(The 5 classical signs of inflammation)

Types of Inflammatory Response



- **Systemic**
Systemic Inflammatory Response Syndrome (SIRS)

Factors predisposing to surgical infection:

- **Host defence systems:**
 - Physical barriers (e.g. skin)
 - Antagonism by commensals
 - Antibacterial substances (e.g. peptides)
 - Immune state (e.g. cancer, diabetes)
 - Acquired immunity
 - Innate immunity
- **Insults:**
 - Foreign body
 - Necrosis
 - Ischemia
 - Haematoma
- **Bacterial factors:**
 - Virulence
 - Inoculum
 - Growth rate

Cellulitis

Causative Organism	<p>Skin Flora:</p> <ul style="list-style-type: none"> - Streptococcus - Staphylococcus <p>Infection happens in the skin, diffusely infect the superficial part (dermis) and its happen by the normal flora invading the immune system in any part of the body The pathogen is normal flora so the treatment is Empirical antibiotic Which is mean that there is infection but not sure it's viral or bacteria (not sure about the cause)</p>
Clinical Features	<ul style="list-style-type: none"> - Diffuse infection with severe inflammation of dermal and subcutaneous layers of the skin commonly in the limbs. - Diagnosis: pain, warmth & hyperesthesia



Important for OSCE

- bilateral limbs, diffuse shiny redness (NOT localized)
- In OSCE, you can't say the patient has pain or tenderness by inspection, you have to palpate



the redness was diffuse then its become localized (better inflammatory response)

Treatment	<ul style="list-style-type: none"> - Antibiotics (oral or IV depending on your judgement of how sick the patient is) <ul style="list-style-type: none"> - Penicillin - Erythromycin - Flucloxacillin (if staph. suspected) - Rest, limb elevation <div data-bbox="1129 1285 1958 1466" style="border: 1px solid gray; padding: 5px; margin-top: 10px;"> <p>Unlike Necrotizing fasciitis <i>cellulitis</i> develops within days (2 days or more according to team 436) while Necrotizing fasciitis develops within minutes to hours.</p> </div>
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<h2>Furuncles</h2>		<h2>Carbuncles</h2>
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Causative Organism	<p>Cellulitis, Furuncles & Carbuncles share the same causative normal flora, but in cellulitis the infection went deeper.</p>	
Clinical Features	<ul style="list-style-type: none"> - Localized cutaneous abscesses that begin in skin glands & hair follicles respectively. - If the pilosebaceous apparatus becomes obstructed at the skin level, the development of a furuncle can be anticipated - Most common surgical infections 	<ul style="list-style-type: none"> - Localized cutaneous abscesses that begin in skin glands & hair follicles respectively. - A deep-seated mass of fistulous tracts between infected hair follicles. (multiple) - Rare
Treatment	<p>The classic therapy of furuncle is incision & drainage, not antibiotics</p>	<p>Invasive carbuncles must be treated by excision & antibiotics.</p>




- **Localized** redness with abscess (yellowish white Exudate)
- Treatment: Drainage, why not Antibiotics? Bc it's localized so the immune system is strong enough to make barrier
- Why in some cases there is localized redness and abscess but we still give antibiotics? To **prevent** bacterial complication for high risk patients (prophylaxis antibiotics) so we give it when there is no infection AT ALL




Special type of abscess around hair follicles and much more common in **diabetes**
Treatment: Drainage and if there is surrounding cellulitis give antibiotics

Hidradenitis

Causative Organism	Unknown but may involve a defect of terminal follicular epithelium.	
Clinical Features	<ul style="list-style-type: none"> - Recurrent Serious skin infection of the axillae or groin - Consisting of multiple abscesses of the apocrine sweat glands, & often it becomes chronic. 	
Treatment	Usually treated by drainage of the individual abscess and followed by careful hygiene	

Abscess

Causative Organism	<ul style="list-style-type: none"> - Staphylococcus aureus (most common) - Abscess in the abdomen or pelvis often contain a mixture of gut bacteria e.g. E. coli, enterococci and anaerobic bacteria. - Superficial on the trunk, head and neck → S. aureus - Axillae → gram-negative / Perineum → mixed aerobic & anaerobic gram-ve 	
Clinical Features	<ul style="list-style-type: none"> - Infectious accumulation of purulent material (neutrophils) in a closed cavity. - Diagnosis: fluctuant, moveable and compressible - Abscesses close to the skin are painful, the overlying skin will be raised, red and hot to the touch. 	
Treatment	Drainage + antibiotics afterward in cases of: deep abscess & subcutaneous abscess if the patient has: DM, surrounding cellulitis, prosthetic heart valve or immunocompromised patients	

Tetanus

Causative Organism	Clostridium Tetani; a spore-forming anaerobic organism (in soil)	
Clinical Features	Tetanospasmin (neurotoxin) spreads along nerves from the site of infection and causes generalized rigidity and spasm of skeletal muscles. The muscle stiffness usually involves the jaw (lockjaw) and neck and then becomes generalized.	
Treatment	Penicillins and for penicillin allergic patients, clarithromycin but is only an adjunct to correct surgical care of wounds. Tetanus can be prevented by immunization .	

Diffuse Necrotizing Fasciitis

Causative Organism

Two types depending on the causative organism:

- Type I: Polymicrobial aetiology which is also known as synergistic bacterial gangrene; Fournier's gangrene is a special type affecting the perineal area
- Type II: Single organism infection, usually by β -haemolytic Group A streptococci (*Streptococcus pyogenes*).
- Anaerobic
- Wound bacterial exotoxins
- Bacterial synergy
- Thrombosis of nutrient bridging vessels

Clinical Features

- Severe, life-threatening infection of skin and subcutaneous tissues characterized by necrosis of deep fascia.
- Particularly dangerous.
- Difficult to diagnose, extremely toxic, spread rapidly (within minutes or hours), often leads to limb amputation
- Crepitant abscess or **cellulitis**.
- Invasion is usually superficial to the deep fascia and may spread very quickly producing discoloration.
- Delayed debridement of injured tissue after devascularization injury is the common setting.
- Risk factors: elderly, diabetic, immunosuppressed



- Evidence of black discoloration (worse inflammatory response)
- The most important thing to know that infection is not only in the skin but went deeper and went down to cut the blood supply (necrotic)

Treatment: debridement



- Fournier gangrene: a special form of necrotizing fasciitis in the genital (perineal) area, we see it in diabetic patients. High mortality (60-70%)
- If Necrotizing fasciitis in the abdomen we call it Meleney gangrene.

Treatment

- Broad-spectrum antibiotic therapy
- Resuscitative therapy
- Treat diabetes mellitus aggressively
- Hyperbaric oxygenation (inhibit bacterial invasion but does not eliminate the focus of infection)
- Complete debridement and depress tight fascial compartment
- Amputation

Gas Gangrene

- **Causative organism:** *Clostridium perfringens*; a spore-forming anaerobic organism (in soil)
- **Clinical features:**
Symptoms and signs are toxin mediated and include rapid deterioration, sepsis, spreading muscle necrosis; skin discoloration and oedema; crepitus of tissues
- **Treatment:** Urgent extensive surgical excision of necrotic tissue AND high-dose antibiotics (penicillin and metronidazole).

Presence of air (subcutaneous emphysema)



Post-Operative Infections

Fever after surgery: (the five W's)₁



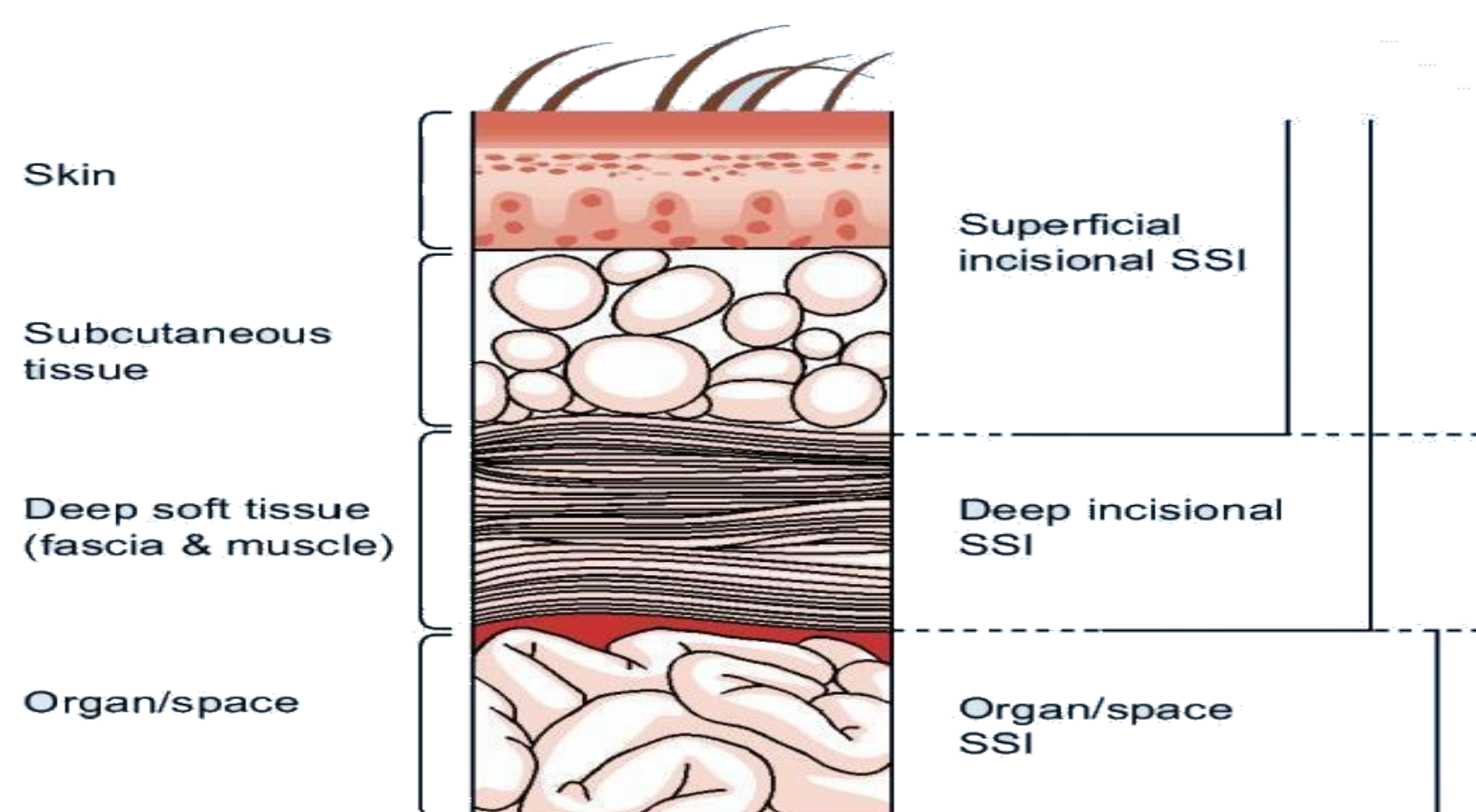
The release of cytokines in response to the trauma of surgery may elicit a febrile response in the absence of infection. Early postoperative fevers (within 48h) are usually due to the inflammatory response to surgery and are not associated with infections.

This table is very important!

Postoperative fever
Days 0–2 <ul style="list-style-type: none"> Physiological as response to tissue injury: low grade Pulmonary collapse, atelectasis Blood transfusion Thrombophlebitis
Days 3–5 <ul style="list-style-type: none"> Sepsis: wound infection Biliary or urinary infection: catheter Intraabdominal collection Pneumonia
Day 5–7 <ul style="list-style-type: none"> Deep-vein thrombosis (DVT) Enteric anastomotic leak
>7 days <ul style="list-style-type: none"> Intraabdominal collection DVT Septicaemia.

Surgical Site Infections

- 3rd most common hospital infection
- Surgical wound infections is a SSI
- Type of surgical infections:
 1. Incisional
 - a. Superficial
 - b. Deep₃
 2. Organ Space₄
 - a. Generalized (peritonitis)
 - b. Abscess



Treatment

- Incisional superficial infection: open surgical wound & antibiotics for cellulitis or sepsis
- Deep/ Organ space infection: **source control** & antibiotics for sepsis

Characteristics

- ★ Systemic and local signs of inflammation
- ★ Infection within 30 days after operation
- ★ Infection within 1 year if prosthetic device used (e.g. vascular graft, artificial heart valve, or mesh for hernia repair)
- ★ Bacterial counts $\geq 10^5$ cfu/mL
- ★ Purulent or nonpurulent
- ★ The length of stay (LOS) effect
- ★ Economic effect

₁ Management for post-op. fever: Antibiotics for infections, anticoagulants for DVT & chest physiotherapy e.g postural drainage for atelectasis.

₂ Partial or complete lung collapse due to endotracheal intubation (ventilator).

₃ Deep incisional also includes infection involving both superficial and deep incision sites.

₄ Involves any part of the anatomy in organs & spaces other than the incision which was opened or during operation.

Risk Factors of SSI

There are things we can control (**modifiable factors**) and things we can't control (**nonmodifiable factors**) such as old age.

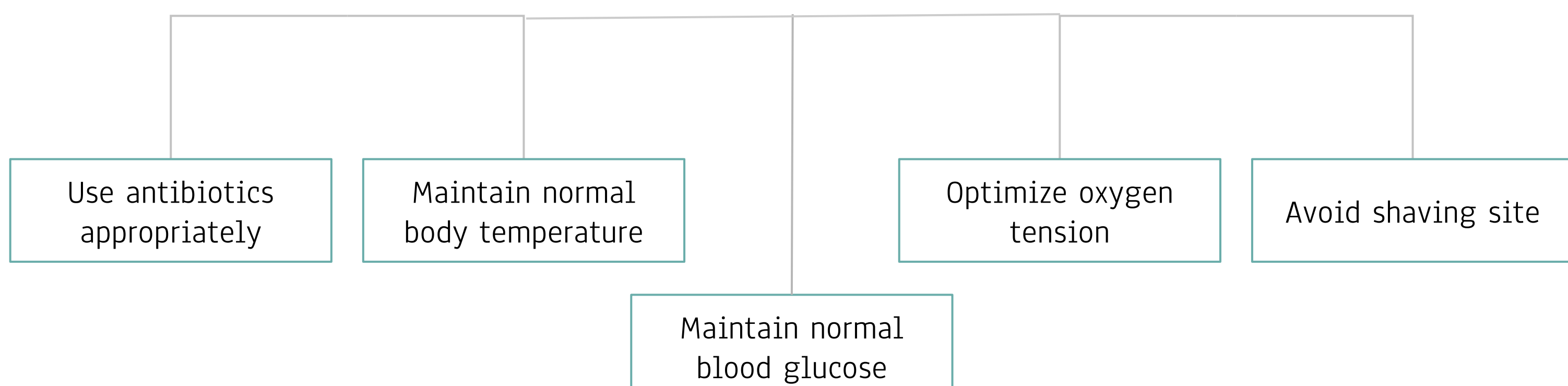
Before surgery if a patient has DM we should try to control it first, also if the patient is obese we encourage them to lose weight before the surgery. But if it's an emergency surgery we don't have the time to correct them and we proceed with the surgery, even if there are risk factors.

Operation Factors	Patient Characteristics
<ul style="list-style-type: none"> - Duration of surgical scrub - Maintaining body temperature - Skin antisepsis - Preoperative shaving - Duration of operation - Antimicrobial prophylaxis - Operating room ventilation - Inadequate sterilization of instruments - Foreign material at surgical site - Surgical drains - Surgical technique <ul style="list-style-type: none"> - Poor hemostasis - Failure to obliterate dead space - Tissue trauma 	<ul style="list-style-type: none"> - Age. - Diabetes: HbA1C and SSI, glucose > 200 mg/dL post-operative period (<48 hours). - Nicotine use: delays primary wound healing. - Steroid use: controversial. - Malnutrition: no epidemiological association. - Obesity: 20% over ideal body weight. - Prolonged preoperative stay: surrogate of the severity of illness & comorbid Conditions. - Preoperative nares colonization with s.aureus: significant association. - Perioperative transfusion: controversial. - Coexistent infections at a remote body site. - Altered immune response.

Preoperative Shaving

- Shaving the surgical site with a razor induces small skin lacerations, **causing a potential sites for infection**, disturbs hair follicles (which are often colonized with S.aureus).
- The risks are greatest when done the night before the operation, that's why patient education is important! be sure patients know that they should not do you a favor and shave before they come to the hospital!

Surgical Site Prevention



Prophylactic Antibiotics

- Antibiotics given for the purpose of preventing infections when infection is not present but the risk of postoperative infection is present.
- We give one dose before surgery when required (depending on the patient and the type of surgery).

But you need to ask yourself these questions before giving them:

- ★ Which cases benefit?
- ★ Which drug should you use?
- ★ When should you start?
- ★ How much should you give?
- ★ How long should antibiotics be continued?

Types of Surgery

	Site	Infection
Clean ₁	Hernia repair, breast biopsy and Thyroid surgery	1.5 %
Clean-Contaminated	Cholecystectomy, planned bowel resection	2-5 %
Contaminated	Unprepared bowel resection (better give a prophylactic antibiotic)	5-30 %
Dirty/infected ₂	perforation (content of bowel/ feces in the peritoneal cavity) abscess, gangrene	5-30 %

Occupational Blood Borne Virus Infection₃

	HBV ₄	HCV	HIV
Risk from needlestick	30%	2%	0.3%
Chemoprophylaxis	Yes	No	Yes
Vaccine	Yes	No	No

¹ Rare to develop fever or infection (Ex: thyroidectomy it's just skin flora and everything else is sterile)

² More invasive and prolonged surgery, is at high risk to develop fever (Ex: Surgery on bowel or bile in the peritoneal cavity)

³ High risk patients include IVDUs, recipients of multiple blood transfusion, those engaged in high risk sexual activity as well as travel from endemic area. All members of the surgical team should be immunized against hepatitis B. Precautions include wearing goggles, waterproof gowns, protective footwear and double gloving.

⁴ After possible exposure to the hepatitis B virus, hepatitis B post-exposure prophylaxis (PEP) can be used to decrease the chance of getting hepatitis B. A single injection of hepatitis B Ig (a solution containing human antibodies that is made from blood products); plus 3 injections of hepatitis B vaccine spread over several months.

Cases Mentioned by Doctor Nuha

- A.** Two 50 year old diabetic men, both have pain at the big toe, they stepped accidentally on broken glass, one of them **(A)** within half an hour he developed redness and severe pain so he asked his son to bring him to KKUH within an hour, by the time he arrived the redness developed to his mid thigh. The Second one **(B)** he had some pain, but he went home and the pain didn't affect his sleeping, the second day the redness increase to his mid-foot with increased pain
- **Which one is worse?** A, because he developed a faster inflammatory response.
- B.** 30 year old female went through **thyroidectomy**, the surgery went well but her temperature after the surgery is **38**. No redness or hotness around the surgical wound, normal HR and slight elevation in white cell count (13000). What do you do? We observe the patient for 24 hrs. If there are no other signs, then this is NOT a post-op infection.
- Is it considered normal or infection? Normal, because it's low grade fever (normal inflammatory response)
 - But if the temperature is **40** it may be a post-op infection (high grade fever)
- C.** A 20 year old boy had a car accident with his 80 yo diabetic and hypertensive grandfather, the boy present with redness in his arm and tenderness, and the grandfather present with high grade fever, low BP and tachycardia.
- So there is localized inflammatory response (redness, pain)
 - And systemic inflammatory response (fever, hypotension)
 - When the systemic effect the organ it become a Shock which is end organ perfusion
- D.** A 35 year old woman undergoes an elective laparoscopic cholecystectomy for symptomatic cholelithiasis. Which of the following wound classes best describes her procedure?
- class II clean-contaminated. If the rate of infection goes above average, the surgeon may be questioned as there may be a problem with the sterilization or the performance.
- E.** A 50 year old diabetic, hypertensive and obese patient with renal failure and is on renal dialysis. The surgery was complicated by injury to the trachea that was repaired. Patient started to develop high fever and has deep localized pain. White cell count is high and blood pressure is borderline. What is happening?
- Deep post-op infection, we need to do imaging. If there is an abscess we drain it and give antibiotics if needed.
 - Female has done a simple surgery few days later she started to bleed!! Everything was fine (the suture and she didn't take any anticoagulant medications or aspirin) then we realized that she **was smoking after her surgery.**

Summary

Soft Tissue Infection

Infection	Causative Organism	Clinical Manifestation	Treatment
Cellulitis	Skin Flora: - Streptococcus - Staphylococcus	Diffuse infection with severe inflammation of dermal and subcutaneous layers of the skin commonly in the limbs. - Sx: pain, warmth & hyperesthesia	Antibiotics
Furuncles		Localized cutaneous abscesses that begin in skin glands & hair follicles respectively.	Incision & drainage, not antibiotics
Carbuncles		A deep-seated mass of fistulous tracts between infected hair follicles. (multiple)	Excision & antibiotics.
Hidradenitis	Unknown	Recurrent Serious skin infection of the axillae or groin consisting of multiple abscesses of the apocrine sweat glands.	Drainage
Abscess	Staphylococcus aureus	Infectious accumulation of purulent material (neutrophils) in a closed cavity.	
Diffuse Necrotizing Infection	Type I: Polymicrobial aetiology synergistic bacterial gangrene (Fournier's gangrene). Type II: Single organism infection, usually by β -haemolytic Group A strep. (Strep. pyogenes).	Severe, life-threatening infection of skin and subcutaneous tissues characterized by necrosis of deep fascia.	Broad-spectrum antibiotic therapy & surgical debridement of necrotic tissue.
Gas Gangrene	Clostridium perfringens	Rapid deterioration, sepsis, spreading muscle necrosis; skin discoloration and oedema; crepitus of tissues	Surgical excision of necrotic tissue AND high-dose antibiotics

Summary

From Davidson:

Prevention of infection

- Preoperative screening of patients for MRSA, and subsequent decolonisation of carriers, is now an integral part of surgical care
- The routine practices of hand washing, surgical scrub, skin preparation of the patient and maintaining a sterile field are collectively known as 'aseptic technique', and is an important component in preventing surgical site infections
- Maintaining normothermia before, during (unless active cooling is part of the procedure) and after surgery lowers the risk of postoperative wound infection
- Sterility of surgical instruments is critical to preventing cross-infection. This may be achieved by decontamination of instruments in Sterile Services Departments or by using sterile, disposable instruments.

Prophylactic antibiotics

- Antibiotic prophylaxis in surgical practice aims to prevent infection by achieving high concentrations of antibiotic at the incision and site of operation during surgery
- The choice of antibiotic must cover the likely pathogens for the operation site
- A single dose of antibiotic is usually adequate for prophylaxis, although during prolonged procedures or where there is excessive blood loss, a second dose may be required
- In some circumstances, e.g., colonisation with multiresistant bacteria or immunocompromised patients, the antibiotic choice may need to be modified and expert advice should be sought.

Postoperative fever

Days 0–2

- Physiological as response to tissue injury: low grade
- Pulmonary collapse, atelectasis
- Blood transfusion
- Thrombophlebitis

Days 3–5

- Sepsis: wound infection
- Biliary or urinary infection: catheter
- Intraabdominal collection
- Pneumonia

Day 5–7

- Deep-vein thrombosis (DVT)
- Enteric anastomotic leak

> 7 days

- Intraabdominal collection
- DVT
- Septicaemia.

Quiz

1. What is the most common bacteria found in SSI?
 - a. E. Coli
 - b. Staphylococcus aureus
 - c. Pseudomonas
 - d. Enterococcus
2. What is the infection rate in clean wound?
 - a. 1%
 - b. 2.5%
 - c. 1.5%
 - d. 3%
3. What is the normal period of time for postoperative fever caused by the release of cytokines? And at what temperature?
 - a. 24-48 hours 40 degrees
 - b. 24-48 hours 38 degrees
 - c. 24-72 hours 38 degrees
 - d. 12-24 hours 40 degrees
4. A 56 year old diabetic male came to the ER complaining of pain and skin discoloration of his foot after walking in his backyard barefooted and injuring his foot, his symptoms started 2 hours after the injury. His temperature was 39 and his WBC were highly elevated. What is your diagnosis?
 - a. Abscess
 - b. Cellulitis
 - c. Gas gangrene
 - d. Necrotizing fasciitis
5. Based on your diagnosis for the question above what is your management plan?

Broad-spectrum antibiotic therapy & surgical debridement of necrotic tissue.

6. What are the five classification of postoperative fever?

Wind: Atelectasis

Water: UTI

Walking: DVT

Wonder Drug: Medication Induced

Wound: Surgical Site Infection

4. D

3. B

2. C

1. B