جامعة الملك سعود
King Saud University

Surgical Infections & Antibiotics

Surgery Team
MED 433

MED 433

Objectives :

1. Pathogenic Potential Of Microbes

a. Exaltation

b. Pathogenic synergy

2. Asepsis (Was mentioned in OR set up lecture)

a. Surgical ritual

b. Sterilization

c. Disinfection

3. Surgical Infection

a. Infection, bacteremia and septicemia

b. Microbiological diagnosis of infection

c. Wound infection

d. Sepsis, shock and the systemic Inflammatory response syndrome

e. Helicobacter pylori*

4. Anaerobic Infection

a. Tetanus

b. Gas gangrene and other clostridia

c. infections

d. Progressive bacterial gangrene and

e. necrotizing fasciitis

f. Other anaerobic infections

5. Hospital-acquired (Nosocomial) Infections

a. Sites of colonization

b. Hospital microbial challenges

c. Control of hospital-acquired

d. (nosocomial) infection

6. Antimicrobial Management Of Wound Infections

7. Principles Governing The Choice And Use Of Antibiotics

a. Antibiotic policy

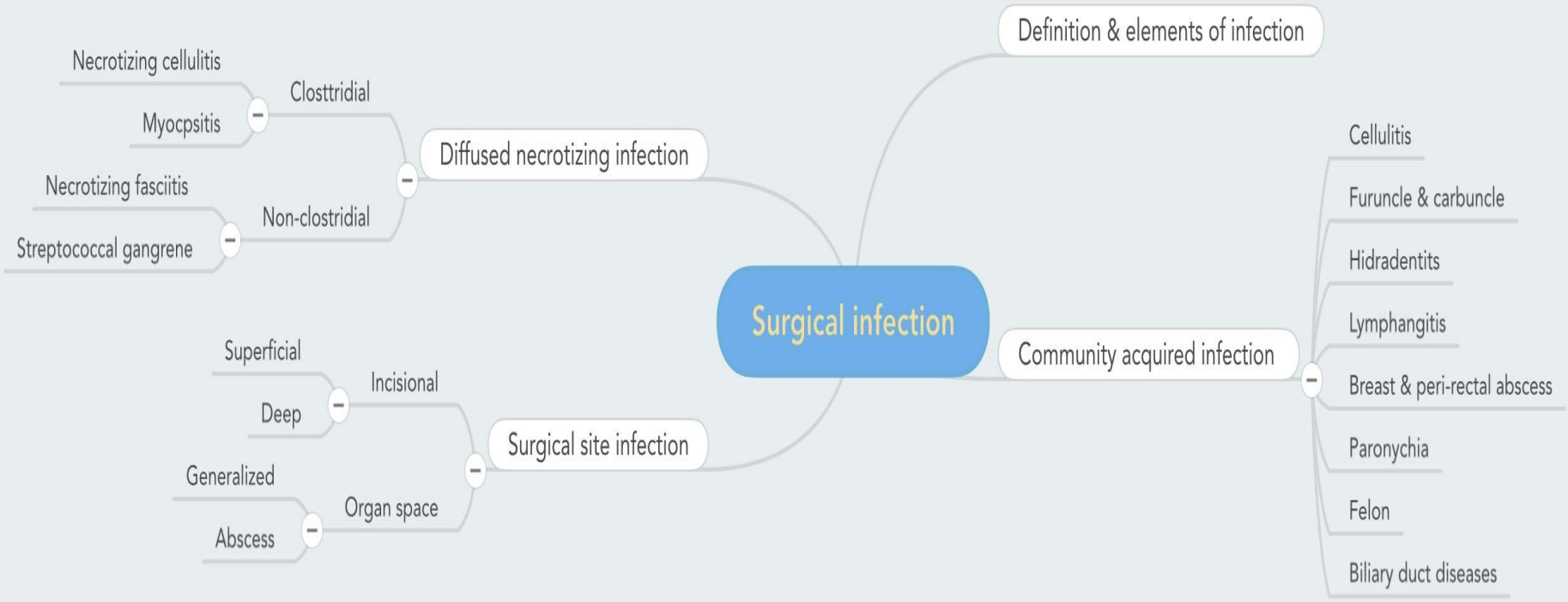
b. Prophylactic use of antibiotics

8. Management Of Immunosuppressed Patients, Including Those Who Have Had Splenectomy

Sources : Slides, Raslan's Notebook, Principles & Practice of Surgery by: O. James Garden

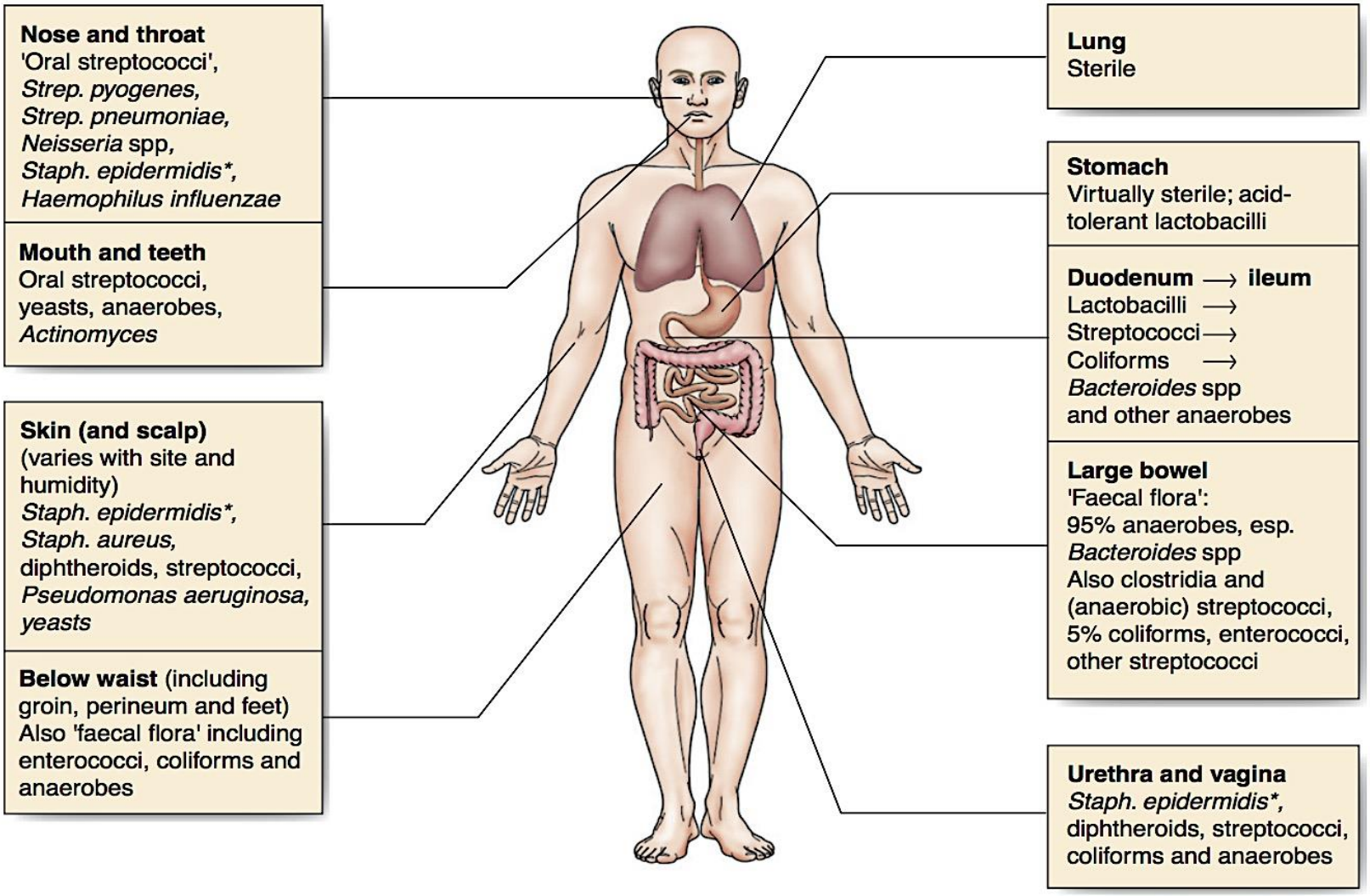
Color Index : Slides & Raslan's | Textbook | Doctor's Notes | Extra Explanation

Mind Map


Surgical infection
Definition & elements of infection
Community acquired infection
Cellulitis
Furuncle & carbuncle
Hidradentits
Lymphangitis
Breast & peri-rectal abscess
Paronychia
Felon
Biliary duct diseases
Diffused necrotizing infection
Clostridial
Necrotizing cellulitis
Myocpsitis
Non-clostridial
Necrotizing fasciitis
Streptococcal gangrene
Surgical site infection
Incisional
Superficial
Deep
Organ space
Generalized
Abscess

Distribution Of Normal Adult Flora

(Extra from the Textbook)



- Mucosal or skin breaches may allow normal flora to infect usually sterile sites.
- The most common yeast is Candida albicans.
- Staphylococcus epidermidis is the most common 'coagulase-negative staphylococcus' frequently found on skin.

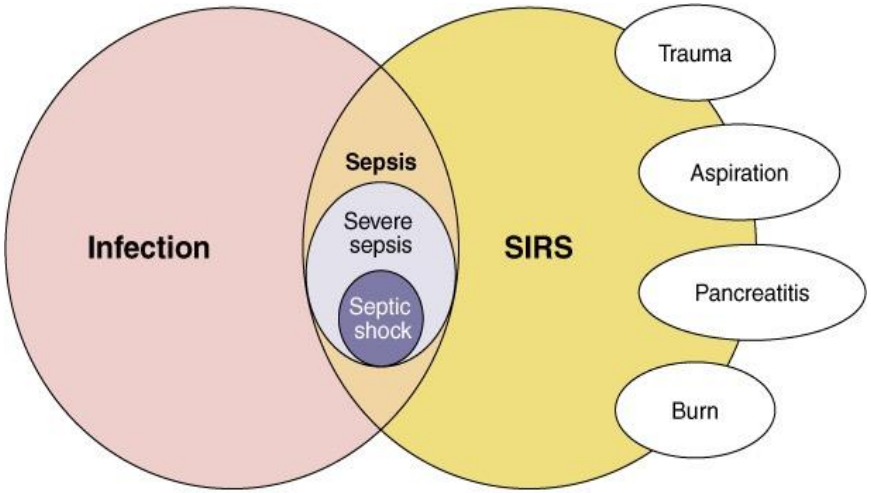
1st :Introduction to Infections

INFECTION is defined by:

1. **Microorganisms** in host tissue or the bloodstream.
2. **Inflammatory** response to their presence. It could be either:
   - **Localized:**
     - ✓ **Rubor** (redness=erythema), **Calor** (heat), **Dolor** (pain), **Tumor** (mass=swelling/edema), and **functio laesa** (loss of function).
   - **Systemic:**
     - ✓ **Systemic Inflammatory Response Syndrome (SIRS):** Any Two of the Following Criteria:
       - Temperature: < 36.0 (hypothermic) or >38.0 (Hyperthermic)
       - Heart Rate : >90
       - Respiratory Rate: >20
       - WBC: <4,000, >12,000

IMPORTANT !

Surgery, trauma, non-trauma local invasion can lead to bacterial insult. Once present, bacteria initiate the host defense processes. Inflammatory mediators (kinins, histamine, etc.) are released, compliment and plasma proteins are released, PMN's arrive, etc



- **Sepsis:** SIRS plus evidence of local or systemic infection.
- **Septic shock:** Sepsis plus end organ hypoprofusion. Mortality of up to 40%

✸ Surgical Infection Risk Factors:

- **Type of procedure:** e.g. site of the procedure (colon is loaded with normal flora compared with superficial organ)
- Degree of contamination. (necrotic tissue is more contaminated)
- Duration of operation.
- Urgency of operation. (Some operation the surgeon doesn't apply enough time for sterilization)

✸ Spread Of Surgical Infection Through:

- Necrotizing infection
- Abscesses
- Phlegmons (diffuse inflammation of the soft or connective tissue due to infection.) and superficial infections
- Spread of infections via the lymphatic system
- Spread of infection via bloodstream

✸ Clinical Findings And Diagnosis:

- **Physical Examination:** Warmth, erythema, induration, tenderness
- **LaBoratory Findings:**
  - ✓ General findings: leucocytosis, acidosis, and signs of disseminated intravascular coagulation
  - ✓ Cultures
- Imaging studies.
- Source of infection.

✸ Complication Of Surgical Infection:

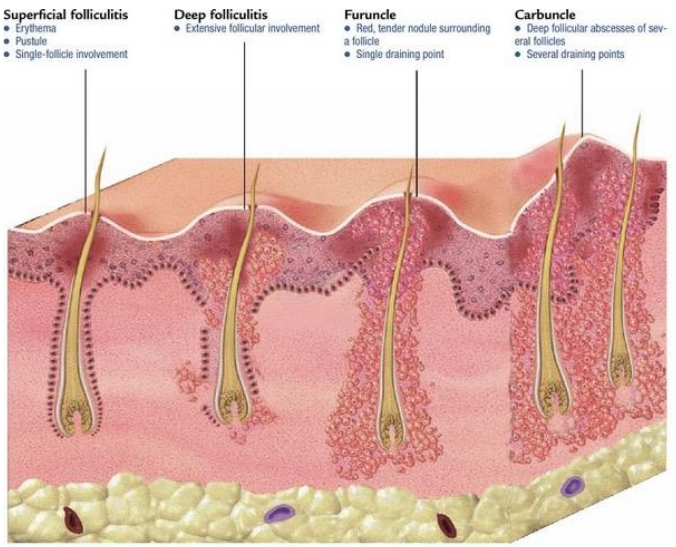
- Fistulas and sinus tract
- Suppressed wound healing
- Immunosuppression and superinfection
- Bacteremia
- Organ dysfunction Sepsis, and systemic inflammatory response syndrome

✸ Treatment:

- Source control
- Antibiotics
- Nutritional support

✸ Types:

- Community-acquired infection
- Hospital-acquired infection



2nd :Community Acquired Infections

Community Acquired Infections		Treatment
1- Cellulitis (Strep. / Staph.) IMPORTANT !	• **Diffused** infection with severe inflammation of dermal and subcutaneous layers (Superficial layer) of the skin. • **Diagnosis:** Pain, Warmth, Hyperesthesia • **Common Pathogens:** Skin Flora • Common in **immunocompromised** patient.	Antibiotics (mark the border of the redness then keep monitoring it to see if the antibiotics work or not *redness will be reduced*) Rest and limb elevation
2- Furuncle (Staph. Aureus)	• **Pilosebaceous Apparatus** becomes **obstructed** at the skin level. • Funruncles are the **most common surgical infections** (common in diabetic and immunocompromised)	Drainage without antibiotics. (if invasive, excision and antibiotics)
3- Carbuncle (Staph. Aureus)	• A deep–seated mass of fistulous tracts between infected hair follicles. • Carbuncles are **rare**. • Their site is usually at the nape of the neck.	Excision and antibiotics.
4- Hidradenitis (Staph. Aureus) IMPORTANT !	Serious skin infection of the skin folds (mostly, axillae or groin..) Consisting of multiple abscesses of the apocrine sweat glands. The condition often becomes chronic leading to **scaring.** The cause is unknown but may involve a defect of terminal follicular epithelium.	Nasty infection, needs excision ,drainage of abscess and followed by careful hygiene (scars will remain)
5- Lymphangitis (Staph. Aureus)	Lymphangitis arising from cellulitis produces red, warm, tender streaks 3-4 mm wide leading from the infection along lymphatic vessels to the regional lymph nodes.	
6-Breast Abscess	• Caused by: Staphylococcal infection (MRSA is uncommon) • Usually post-partum	Drainage & antibiotics

Cont. Community acquired infections		Treatment
Abscess	Infectious accumulation of purulent material (Neutrophils) in a closed cavity. In examination: Fluctuant, Moveable and compressible	**Drainage**
Peri-rectal Abscess	Results from infection of the anal crypts Can be extensive Can result in bacteremia	
Hand Infection		

IMPORTANT !
Paronychia
(nailfold infection)
	- **Site:** folds of the skin surrounding the fingernail. It is characterized by acute or chronic purulent, tender, and painful swellings of the tissues around the nail, caused by an abscess of the nail fold.
	- **Causative organism:**
	  - **Yeast** causing paronychia is most frequently Candida albicans.
	  - **Bacteria** are usually Staphylococcus, Pseudomonas aeruginosa, or Streptococcus.	

Felon	Felons are closed-space infections of the fingertip pulp. Both **Paronychia and Felon** can lead to Tenosynovitis (inflammation of a tendon and its sheath)	

Cont. Community acquired infections	
Biliary Duct Infection	Usaully resulted from obstruction. Most common causative agents: E. coli, Klebsiella, Enterococci
Acute Cholecystitis	Causes gall bladder empyma
Ascending Cholangitis | Peritonitis	Will be covered in “Acute Abdomin” & “Biliary obstruction and Biliary stones” lectures
Viral Infection	HIV/Hepatitis
Tetanus	Infection caused by Clostridium tetani (Anaerobic organism found in soil and animal feces). Wound after contamination should be cleaned and debrided, otherwise the organism will release tetanospasmin which is a neurotoxin spreading along nerves causing skeletal muscles rigidity and spasm (Specially, the jaw ***Lockjaw*** and neck). Treat with Penicillin + vaccinate children *Tetanus Vaccine*.

3rd : Diffused Necrotizing Infection

- Particular dangerous
- Difficult to diagnose, extremely toxic, spread rapidly, often leading to limb amputation
- **Pathogenic factors** (why necrotizing infection is happening): 1.Anaerobic organisms (nasty) 2.Wound Bacterial exotoxins 3.Bacterial synergy 4.Thrombosis of nutrient bridging vessels 5.weak immune response

	Classification	
	Clostridial (Necrotizing cellulitis & Myositis)	**Non-Clostridial** (necrotizing fasciitis & streptococcal gangrene)
Organism IMPORTANT !	They are fastidious anaerobes On gram-stain they appear as relatively large, gram-positive, rod-shaped bacteria. A broad spectrum of disease is caused by **clostridia**	Caused by multiple non-clostridial microorgasms: Microaerophilic streptococci, staphyloccci, aerobic gram-negative bacteria, and anaerobes, especially peptostreptococci and bacteroides.
Clinical Features	▸ Crepitant abscess (filled with air bubble) or cellulitis ▸ Invasion is usually superficial to the deep fascia and may spread very quickly, producing discoloration. ▸ Severe pain suggests extension into muscle compartments (myositis). ▸ The disease progresses rapidly, with loss of blood supply to the infected tissue. ▸ Profound shock can appear early, rapidly leading to organ dysfunction. ▸ Air bubbles (bullae) often visible on plain radiograph Crepitus may be present, but not reliable to differentiation .	▸ Usually begins in a localized area such as a puncture wound, leg ulcer, or surgical wound. ▸ Externally, hemorrhgic bullae are usually the first sign of skin death ▸ The skin is anesthetic and crepitus is occasionally present. ▸ The fascial necrosis is usually wider than the skin appearance indicates. ▸ At operation, the finding of edematous, dull-gray, and necrotic fascia and subcutaneous tissue confirm the diagnosis.

Cont. Diffused Necrotizing Infection

Classification

Clostridial (Necrotizing cellulitis & Myositis)	**Non-Clostridial** (necrotizing fasciitis & streptococcal gangrene)

Treatment

- **Complete debridement and decompress tight fascial compartment.**
- **Amputation: if severe.**
- Broad-spectrum antibiotic therapy
- Resuscitative therapy
- Treat diabetes mellitus aggressively
- Hyperbaric oxygenation inhibit bacterial invasion but does not eliminate the focus of infection.

* Treatment for cellulitis: antibiotics
* Treatment for necrotizing cellulitis: debridement

Streptococcal Gangrene

- Streptococcus is a bacterium frequently found in in the skin and throat, but streptococcal gangrene is uncommon.
- The sudden onset of severe pain is the most common presenting symptom, usually in an extremity associated with a wound.
- Fever and other signs of systemic infection are frequently present at the time of presentation.
- Shock and renal dysfunction are usually present within 24 hours.

Post-Operative Fever

- Fever after surgery
- The "Five W's" (causes)
  - **Wind:** Atelectisis
  - **Water:** UTI
  - **Walking**: DVT (Deep Vein thrombosis)
  - **Wonder Drug:** Medication Induced
  - **Wound:** Surgical Site Infection

Fever may be due to an infection or any type of tissue injury. After surgery sometimes the patients develop fever but there's no infection (due to cytokines release.

Necrotizing Soft Tissue Infection

Gas gangrene

4th : Surgical Site Infection (SSI)

Surgical Site infection (SSI)

- Systemic and local signs of inflammation
- Bacterial counts ≥ 10^5 cfu/mL
- Purulent versus nonpurulent

- LOS effect (Length of stay)
- Economic effect (The length of stay for the patient and economic effects of the hospital stay are important factors to consider in SSIs).

Incisional SSI

Superficial: The first type of surgical site infection is the superficial incisional surgical infection which occurs within 30 days post-op and involves only the skin or subcutaneous tissue.

Deep: Infection occurs within 30 days after the operation if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operation and the infection involves the deep soft tissue (e.g., fascia and muscle layers)

Organ space SSI

Generalized: Infection occurs within 30 days after the operation if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operation and the infection involves any part of the anatomy, other than the incision, which was opened or manipulated during the operation (e.g. Peritonitis after appendectomy)

Abscess: : Infectious accumulation of purulent material (Neutrophils) in a closed cavity

- **Diagnosis:** Fluctuant: Moveable and compressible
- **Treatment:** Drainage

SSI Risk Factors

Operation Factors

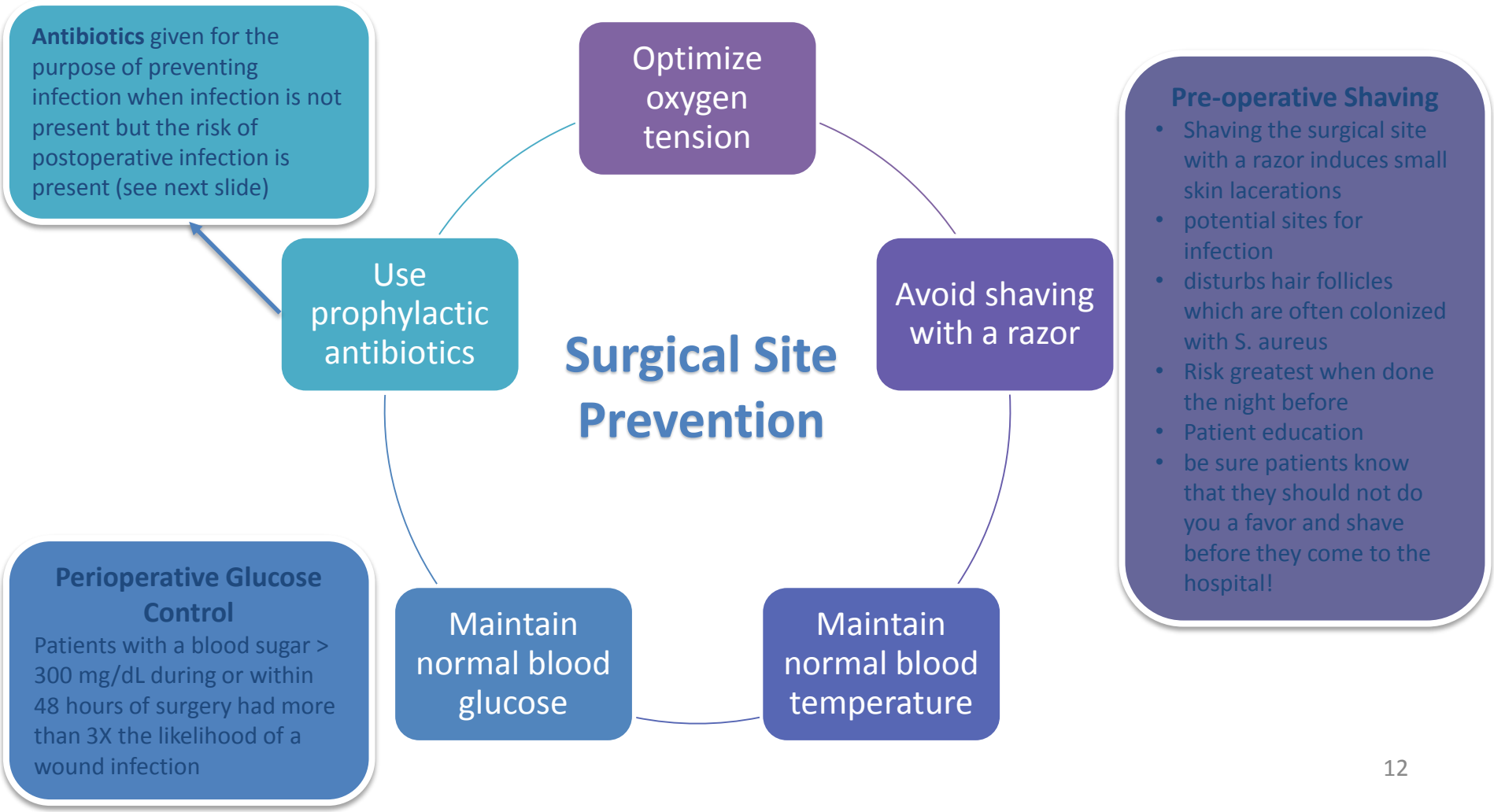
- Duration of surgical scrub (give enough time for sterilization)
- Maintain body temp
- Skin antisepsis
- Preoperative shaving
- Duration of operation
- Antimicrobial prophylaxis
- Operating room ventilation
- Inadequate sterilization of instruments
- Foreign material at surgical site
- Surgical drains
- Surgical technique
  - Poor hemostasis
  - Failure to obliterate dead space
  - Tissue trauma

Patient Factors

- Age (neonates & older people more prone to infection)
- Diabetes: Glucose > 200 mg/dL postoperative 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 and comorbid conditions
- Preoperative nares colonization with Staphylococcus aureus: significant association
- Perioperative transfusion: controversial issue
- Coexistent infections at a remote body site
- Altered immune response

Cont. Surgical Site infection

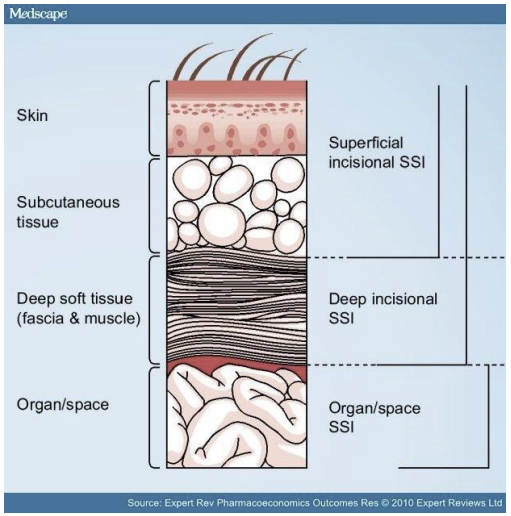
	Incisional SSI	Organ space SSI
Treatment	open surgical wound, antibiotics for cellulitis or sepsis	Source control, antibiotics for sepsis



Hospital-Acquired infections:

- Infections occurring within 48 hs of hospital admission, 3 days of discharge or 30 days following operation.
- Highest prevalence in **ICU**.
- **Organisms:** Enterococcus, Pseudomonas, E.coli, Staph. Aureus.
- **Sites: urinary**, surgical wound, respiratory, skin, blood and GIT.

Immunosuppressed patients (Specially those **undergone splenectomy**) are at high risk of infection with encapsulated bacteria and protozoa and should be :
1- Commenced on lifelong prophylactic antibiotics (Penicillin or amoxicillin)
2- Immunized against pneumococcus, H.Influenzae type B, and meningococcus type C.



Types of surgical site infections

Cellulitis, Figure 2 shows a sign of healing (reduce the redness after antibiotics)

Furuncle

Carbuncle

Hiradenitis

Lymphangitis

Paronychia

Felon

Breast abscess

Abscess

5th : Antibiotics

✸ Classes Of Antibiotics :

Class	Examples	*Coverage*
Penicillins	Penicillin G, Piperacillin	*Gram +ve*
Penicillins with β-lactamase inhibitors	Tazocin (piperacillin + tazobactam) Methicillin, cloxacillin	*Anti-pseudomonal* *Anti-staphylococcal*
Cephalosporins	Cephalexin 1st, Cefuroxime 2nd, Ceftriaxone 3rd	*1st & 2nd gen.: Gram +ve cocci 3rd gen.: Gram –ve rods*
Carbapenems	Imipenem, Meropenem	*Gram +ve, gram –ve & anaerobes*
Monobactam	Aztreonam	*Gram –ve, aerobic*
Aminoglycosides	Gentamycin, Amikacin	*Gram –ve rods e.g. E. coli*
Fluoroquinolones	Ciprofloxacin	*Gram +ve, Gram –ve, pseudomonas*
Glycopeptides	Vancomycin	*MRSA*
Macrolides	Erythromycin, Clarithromycin	*Erythro ≈ penicillin, Clarithro = extended*

The doctor said it's not important

✸ Therapeutic Uses Of Antibiotics :

Pseudomembranous colitis	Oral vancomycin/ metronidazole
Biliary-tract infection	Cephalosporin or gentamycin
Peritonitis ⓘ	Cephalosporin/ gentamycin + **metronidazole/ clindamycin**
Septicemia	Aminoglycoside + ceftazidime, tazocin or imipenem
Septicemia due to vascular catheter	Flucloxacillin/ vancomycin
Cellulitis	Penicillin, erythromycin

Types Of Surgeries

IMPORTANT!

Class	Type	Examples	Chance of infection
I	Clean	e.g. Hernia repair & breast biopsy (No inflammation. respiratory, alimentary and genitourinary tracts are not entered *a lot of normal flora*)	1.5%
II	Clean-Contaminated	e.g. Cholecystectomy, planned bowel resection (respiratory, alimentary and genitourinary tracts are entered, but without spillage)	2-5%
III	Contaminated	e.g. Non-preped bowel resection *colon resection* (Acute inflammation *without pus*, or visible contamination of wound)	5-30%
IV	Dirty	e.g. perforation *peritonitis*, abscess *necrotizing tisuue* (operation in the presence of pus)	5-30%

- Prophylaxis in class I,II
- Class III,IV need antibiotics last for 5-7 days

Operative Antibiotic Prophylaxis

- The choice of Antibiotic should cover the likely pathogen.
- The Antibiotic concentration should be high in the surgical site, to decreases bacterial counts.
- Single parenteral dose given within 30 minutes prior to starting surgery
- Vancomycin 1-2 hours prior to surgery
- Second dose if surgery prolonged, or in excessive blood loss.
- Do not continue beyond 24 hours

IMPORTANT!

Occupational Blood Bourne Virus Infections

	HBV	HCV	HIV
Risk From Needle Stick	30%	2%	0.3%
Chemoprophylaxis	✓	✗	✓
Vaccination	✓	✗	✗

SUMMARY

✓ Surgical Infections:

a. Infection, bacteremia and septicemia:

Infection is microorganisms in host tissue or the bloodstream, and inflammatory response to their presence. Bacteremia is bacteria in the blood. Sepsis is documented infection and SIRS.

b. **Microbiological diagnosis of infection:**

Staph. aureus is common in surgical site infections. Staph. epidermidis in endocarditis. Enterococci in urinary infections and intra-abdominal infections. Pseudomonas in hospital-acquired infections..

c. **Wound infection (surgical site infection):**

Infection in an operative wound, characterized by pain at incision site, erythema, warm skin, fever

d. Sepsis, shock and the systemic Inflammatory response syndrome:

Systemic Inflammatory Response Syndrome (SIRS): any two of the following criteria: Temperature: < 36.0 (hypothermic) or >38.0 (Hyperthermic), Heart Rate : >90, Respiratory Rate: >20, WBC: <4,000, >12,000
Sepsis: SIRS plus evidence of local or systemic infection.
Septic shock: Sepsis plus end organ hypoprofusion. Mortality of up to 40%

✓ Anaerobic Infection

a. Tetanus: caused by Cl. tetani

b. Gas gangrene and other clostridia: caused by Cl. Perfringens, Cl. Septicum, Cl. Novyi

c. necrotizing fasciitis: treated surgically by repeated debridement

✓ Hospital-acquired (Nosocomial) Infections

a. Sites of colonization: urinary, surgical wounds, respiratory tract

b. (nosocomial) infection: the most common nosocomial infection causing death is respiratory tract infection

✓ Antimicrobial Management Infections

Antibiotics have two roles; either therapeutic or prophylactic.

Pseudomembranous colitis → vancomycin\metronidazole. Biliary-tract infections → cephalosporin or gentamycin

Cellulitis → penicillin, erythromycin. Septicemia → aminoglycoside + ceftazidime, tazocir imipenem

MCQs

1. All of the following are principles of antibiotic prophylaxis to prevent surgical site infection EXCEPT:

(A) Administer intravenous (IV) antibiotics within 1 hour of incision time
(B) Select an antibiotic with a spectrum of activity against pathogens likely to be encountered during surgery
(C) Discontinue antibiotics 48 hours postoperatively
(D) Intra-operatively re-dose cephalosporin prophylactic antibiotics every 2 half-lives for long procedures

2. All of the following are factors known to be associated with an increased risk for surgical site infection EXCEPT

(A) Hypothermia during surgery
(B) Poorly controlled blood glucose in the perioperative period
(C) Skin shaving
(D) Positive pressure airflow in the operating room
(E) Colonization with Staphylococcus aureus

3. The use of Vancomycin for surgical prophylaxis should be reserved for the following patients EXCEPT

(A) Patients with significant penicillin allergy
(B) Patients with known methicillin- resistant S.aureus (MRSA) colonization
(C) Patient on dialysis
(D) Patients who have had surgical procedures involving implantation of prosthetic materials or devices
(E) Patients in long-term care facilities

4. All of the following can improve the rate of surgical site infection in the colorectal surgical patient EXCEPT

(A) IV antibiotic administration preoperatively
(B) Oral antibiotic bowel preparation
(C) Prophylactic antibiotics in the postoperative period
(D) Targeting Escherichia coli and Bacteroides fragilis with prophylactic antibiotics
(E) Thorough and complete mechanical bowel preparation

5. Patients with nasel carriage of S. aureus have an increased risk of surgical site infection by that organism. All of the following statements regarding preoperative treatment of these patients with mupirocin ointment ar true EXCEPT

(A) Mupirocin reduces the risk for S.aureus surgical site infection
(B) Mupirocin reduces the risk for S.aureus nosocomial infection overall
(C) Mupirocin cannot prevent infections that originate from colonizing strains transmitted from health care workers
(D) Staphylococcus strains become resistant against mupirocin

1:C 2:D 3:D 4:C 5:A

Thank You..

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