

SURGICAL INFECTIONS & ANTIBIOTICS

Surgery team

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Team notes in blue

OBJECTIVES

Students will learn:

- Definition of surgical infections.
- Pathogenesis of infections.
- Common clinical features.
- Surgical microbiology.
- Common surgical infections.
- Antibiotics use in surgery.

REFERENCES

- **Sabiston Textbook of Surgery**

18th Edition Pages 299- 327

- **Schwartz Principles of Surgery**

8th Edition Pages 109- 127

INFECTION

Invasion of the body by pathogenic microorganisms and **reaction of the host to organisms** and their toxins. **IMP**

The presence of an organism doesn't mean infection, we have plenty of organisms on our skin and inside our body (bowel and the oral cavity) but we don't call it infection unless the body responds to it by inflammatory response!

SURGICAL INFECTIONS

What do we mean by surgical infections?

- Infections that require surgical intervention as a treatment (like a liver abscess) or as a result of surgical procedure (ex: if the patient develop an infection after an appendectomy)
- Surgical infections is a big part of the surgical practice and an important subject for the following reasons:
 - A major challenge
 - Accounts for 1/3 of surgical patients
 - Morbidity: Usually after an appendectomy, the patient can leave the hospital in 1-2 days, but if the patient develops a wound infection we have to keep him in the hospital because it may lead to septicemia which can lead to mortality!
 - Mortality
 - Increased cost to healthcare (if the infection was a result of a medical procedure)

PATHOGENESIS OF INFECTIONS

Interaction between microbes and host related factors

Not every organism will cause infection, some opportunistic organism only cause infection when the host is compromised and some organism may not cause at all.

The host will develop infection if the following factors favor the organism against the host:

- **Microorganism related factors:**
 - Adequate dose
 - Virulence of microorganisms (pathogenicity): organism is pathogenic for the human, able of causing a disease.

- **Host related factors:**

- Suitable environment: **ex.** If the operation room or the instruments weren't sterilized enough, or no good drainage of the wound during the surgery (leaving a lot of the blood in the wound) it would be a good environment for the organism.
- Susceptible host: **ex.** diabetics

PATHOGENICITY OF BACTERIA

Pathogenicity (can harm the humans) of a bacteria exists if has one or more of the following:

Exotoxins: bacteria secretes **toxins**, [toxins secreted by living bacteria]

Specific, soluble proteins toxins, with remote (far away) **cytotoxic effect** (the effect is not at the site of infection **ex** Clostridia Tetani where the bacteria will present in the wound site but it effects the nervous system)

Ex: Strep. pyogenes

Endotoxins: **toxin are released from the bacteria when it breaks down** [toxin is a structural molecule]

Part of gram-negative bacterial wall, lipopolysaccharides

e.g., E coli

Resist phagocytosis: (the bacteria have special cell wall or structure) - resist the immune system

Protective capsule -

Ex: Klebsiella and Strep. Pneumoniae

• U should know how each of the organisms can harm the humans, **ex:** endotoxins Or exotoxins or a protective capsule!

HOST RELATED FACTORS:

Susceptibility factors:

- **Skin / mucous membrane breach**, **ex:** surgery or **trauma**.
- **Suitable environment**

Hematoma, seroma, closed space

For ex. If the patient comes after 6 hrs of injury, don't close the wound because u will create a suitable environment for infections

Compromised immunity: cellular (phagocytes), antibodies

Ex: patients on corticosteroid, chemo & radiotherapy

CLINICAL FEATURES OF INFECTIONS:

What are the clinical features of infection?

- **Local-pain, heat, redness, swelling, loss of function.** (apparent in superficial infections)
(patients usually manifest some local feature which is a sign of a superficial infection the infected area will become painful, look red and warm on touch like in tonsillitis)
- **Systemic (general)-fever, tachycardia** (in response to inflammatory cytotoxins), **chills**
Ex: A patient underwent appendectomy → develop a local infection, (swelling, pain, heat, which can lead to a systemic infection (fever, tachycardia, chills).

PRINCIPLES OF SURGICAL TREATMENT:

So what to do? Pretty much always the same thing:

- **Debridement-** removing necrotic, injured tissue [clean the wound] because it form suitable environment for organism and leave the wound open.
- **Drainage-** abscess, infected fluid drain it and give antibiotics.
- **Excision-** of the infection source, ex: appendectomy
The source of the infection was the appendix so we take it out

• In addition we do:

- **Supportive measures:**
 - antibiotics
 - immobilization (if It's a limb)
 - limb elevation (to avoid fluid collection)

SURGICAL MICROBIOLOGY: The most common surgical infection are caused by:

1. STAPHYLOCOCCI IMP

- Inhabitants of skin, Gram positive
- Responsible for most of Wound infection
- Infection characterized by suppuration. The wound is characterized by pus formation+suppuration
- Sensitive to penicillinase-resistant
- MRSA – resistant to penicillinase-resistant β -lactam antibiotics

Treated by **Vancomycin IMP**

*Methicillin-resistant Staphylococcus aureus (MRSA), resistant type of staph.

- Staph.aureus- SSI, nosocomial, superficial infections SSI=Surgical site infection
- Staph. epidermidis- opportunistic (wound, endocarditis)

*patients with artificial valves we give them antibiotic to prevent endocarditis

- This type of bacteria produces a lot of thick pus IMP

2. STREPTOCOCCI

- Gram positive, aerobe/anaerobe
- Flora of the mouth and pharynx, bowel **IMP**
- Streptococcus pyogenes –(β hemolytic) 90% of infections
E.g., lymphangitis, cellulitis, rheumatic fever
*The majority of the infection from this group
- Strep. viridens-endocarditis, urinary infection
- Enterococci- urinary infection, intra-abdominal infections (Anaerobic pathogens)
- This group produces a little pus **IMP**

3. GRAM NEGATIVE RODS

- Most fall into the family **Enterobacteriaceae**.
 - **Escherichia, Proteus, and Klebsiella** (Common in wound infections)
 - All are facultative anaerobic bacteria
* A patient with appendectomy, develops an infection the most likely organism is E.coli (normal flora from the bowel).
 - Common in mixed surgical infections
 - Susceptible to a broad variety of antibiotics, e.g second-generation **cephalosporins**
*They are usually easy to treat
 - Other **Enterobacteriaceae** in surgical infections- **Enterobacter, Morganella, Providencia, and Serratia**. *Difficult to treat and we need to exhibit higher spectrum antibiotic.
 - Exhibit greater antimicrobial resistance.*Characterized by higher incidence of resistant to common antibiotic.
 - Antibiotic- **third-generation cephalosporin, expanded-spectrum penicillins, monobactam, carbapenem, quinolone, or aminoglycoside.**
- Pseudomonas** (commonly seen in ICU as hospital acquired infection specially with tubes and catheters) and **Acinetobacter** species **IMP: HOSPITAL ACQUIRED**
 - Obligate aerobic gram-negative
 - Common: hospital-associated pneumonia, peritoneal cavity or severe soft tissue infections. Needs much higher level of antibiotic to cover them:
 - **ceftazidime**, cefepime, aztreonam, **imipenem/cilastatin**, meropenem, **ciprofloxacin**, an acylureidopenicillin, or an aminoglycoside
 - Remember antibiotics in bold are effective against pseudomonas.

4. ANAEROBES

- Inhabitants of GIT & the mouth. **IMP**
- Most common- **Bacteroides fragilis** **IMP**
 - * Most of abdominal surgery related wound infections will have this organism as you go to the colon the population of this organism increases the stomach, duodenum and jejunum doesn't have this pathogen.
 - We use metronidazole, clindamycin or combination of both.
- Antibiotics-**metronidazole, clindamycin**, imipenem, meropenem, ertapenem, the combinations ticarcillin/clavulanate, ampicillin/sulbactam, & piperacillin/tazobactam

5. CLOSTRIDIA

- Gram positive, anaerobe
- Rod shaped microorganisms
- Live in bowel & soil **IMP**
- Produce **exotoxin** for pathogenicity
 - *usually causes super infections (infection occurring after or on top of an earlier infection, esp. following treatment with broad-spectrum antibiotics)
- Important members (examples of super infections):
 - Cl. Perfringens
 - CL.Septicum - **gas gangrene**
 - Cl. Tetani - **tetanus**
 - Cl. Difficile- **pseudomembranous colitis**

SPECIFIC SURGICAL INFECTIONS

- Surgical Site Infections = wound infections
- Soft Tissue Infections
- Body Cavity Infections
- Prosthetic Device related Infections
 - e.g. the device: artificial valve, infection: endocarditis
- Miscellaneous

SURGICAL SITE INFECTIONS (SSI)

Very common problem (MCQ)

- 38% of all surgical infections
- Infection within 30 days of operation.
- Infection within 1 year if prosthetic if a prosthetic device was used.
 e.g.: vascular graft or mesh for hernia repair. Infections that happen 30 days after a surgical procedure are not considered SSI. Unless a prosthetic device has been used.

Classification: IMP

(depending on depth of infection, and the level at which the infection has developed)

- **Superficial SSI:** skin & subcutaneous plane (47%) Pus appears when the skin is open
 - **Deep SSI:** sub-facial and muscle plane (23%) pus appears if superficial level of muscular layer is exposed.
 - **Organ/ space SSI:** intra-abdominal within the chest cavity, other spaces (30%)
- **Staph. aureus**- most common organism (IMP)
- **E coli**, Enterococcus, other Enterobacteriaceae- **deep infections IMP**
- **B. fragilis** – intrabdominal abscess. IMP

NOTES:

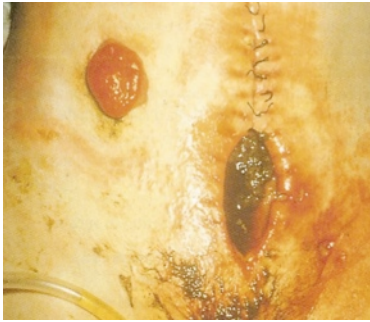
1. In abdominal-related surgeries the most likely organisms are E.coli and B.fragilis (can be either single infection or mixed infection)
2. Knowing the causative organisms is important to help us provide the proper treatment (Antibiotics that cover the causative organism)
3. If a patient comes after appendectomy with wound infection or superficial SSI → E.coli is suspected

Risk Factors:

- Extremes of age (very young/old)
- Malnutrition
- Obesity
- Immunocompromised
- Poor surgical techniques. e.g. leaving behind a lot of blood in the wound
- Prolonged surgery. Prolonged duration of operation = higher risk of infection
- Preoperative shaving. Surgical site should not be shaved a day before the surgery, it's recommended either to shave it on the table in the OR, or use other means of removing hair
- Type of surgery (operations on appendix, bowel or colon = high infection rate | lipoma or breast biopsy = very low infection rate)

Diagnosis:

- **Sup.SSI**- erythema, oedema, discharge and pain
- **Deep infections**- no local signs, fever, pain, hypotension. Investigation is needed

Treatment:

- Surgical / radiological intervention. (depending upon what type of surgery we are talking about)

A patient who has had colon surgery and ileostomy, then developed wound infection (Most likely organism = E.coli)

- Take a swab and send it to the lab for cultures
- Start empirical treatment.

Prevention:

- **Pre-op:** Treat pre-existing infection Improve general nutrition
Shorter hospital stay
Pre-op. shower
Hair removal -shaving vs clipping
- **Intra-operative:** Antiseptic technique
Good surgical technique
Normothermia
- **Post-operative:** Wound dressing in 48-72 hours
Early drain removal
Blood sugar control

SOFT TISSUE INFECTIONS -ERYSIPELAS

- Superficial spreading **cellulitis** (deep SC infection) & **lymphangitis** (Lymphatic system) (**IMP**).
- Area of redness, sharply defined irregular border
- Follows minor skin injuries
- **Organism**-Strep pyogenes
- **Treatment**-Penicillin, Erythromycin

Very superficial infection, bright red tendered limbs

(Note that the rash is spreading towards the groin area “lymph nodes”)

Lymphangitis → streptococci → penicillin



SOFT TISSUE INFECTIONS – CELLULITIS

- Both cellulitis and lymphangitis are caused by streptococci and are treated by the same agents.
- Lymphangitis is superficial and is bright red
- Cellulitis is much more deeper with swelling of the limbs and a different type of redness and tenderness. **IMP**

- Inflammation of skin & subcutaneous tissue
- Non-suppurative
- Strep. Pyogenes
- **Common sites-limbs**
- Affected area is red, hot & indurated
- **Treatment:** Rest
Elevation of affected limb
Penicillin, Erythromycin
Fluocloxacillin (staph. suspected)



SOFT TISSUE INFECTIONS – ABSCESS

- **localized** pus collection
- Superficial abscesses on the trunk, head and neck - S. aureus, (Streptococci) **(IMP)**
- Abscesses in the axillae- gram-negative bacteria
- Abscesses on the perineum- mixed aerobic and anaerobic gram-negative flora
- Abscess may be mistaken for cellulitis when located deep
- **Treatment-** drainage, antibiotics (depending on what type of infection is suspected)

SOFT TISSUE INFECTIONS – FURUNCLE

- **Furuncle-** infection of hair follicle / sweat glands

SOFT TISSUE INFECTIONS – CARBUNCLE

- **Carbuncle-** extension of furuncle into subcutaneous tissue common in diabetics
- Common sites-back, back of neck
- **Treatment:** drainage, antibiotics, control diabetes
- Both Furuncles and Carbuncles are caused by staph. aureus

Superficial abscess of parotid gland
Caused by staphylococcus
Spreading type of redness, pus formation
Treatment: drain abscess & antibiotics



NECROTIZING SOFT TISSUE INFECTIONS (NECROTIZING FASCIITIS)

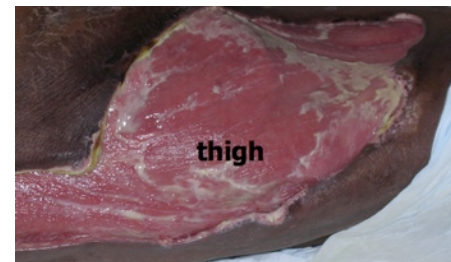
- Necrosis of superficial fascia, overlying skin
- Risk group- elderly, diabetics, immunosuppressed
- **Polymicrobial:** (multiple organisms, mainly streptococci)
 - Streptococci (usually the leader)
 - Staphylococci,
 - Gram-negative Bacilli
 - Anaerobes.
- Sites- Limbs (Doctor says: you don't have to memorize the other name "in grey")
Perineum (Fournier's), Abd.wall (Meleny's), Trunk- elderly, diabetics, immunosuppressed

Clinical Picture: Patients usually are immunocompromised

- Starts as cellulitis, edema, systemic toxicity, shock **IMP**
*Small cellulitis + very ill (-/+ hypotensive) patient, suspect necrotizing fasciitis
- Appears less extensive than actual necrosis **IMP**

Investigation: Aspiration, Gram's stain, CT, MRI

- Treatment:** - IV fluid, IV antibiotics (broad spectrum)
ampicillin, cephalosporins, clindamycin + metronidazole,
aminoglycosides
- **Repeated debridement (IMP)** dressings, skin grafting.



CLOSTRIDIAL MYONECROSIS (GAS GANGRENE)

It happens with traumatized bone

- Cl. Perfringens, Cl. Septicum, Cl. Novyi (**exotoxins**)
- Large wounds of muscle (contaminated by soil, foreign body), drug users
- Myonecrosis, crepitus, seropurulent discharge, foul smell, swollen, toxemia, tachycardia, ill looking
- X-ray: gas in muscle and under skin
- **Treatment:** Penicillin, clindamycin, metronidazole
Debridement, drainage, amputation, hyperbaric oxygen

(Swollen, painful, air felt under skin, its characteristic is traumatized wounds – wasn't treated properly or treated late)

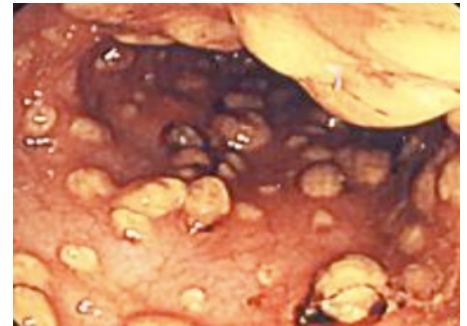
TETANUS

Leave the wound open until it heals

- Cl. Tetani, (neurotoxin) Here the treatment is prevention
- Penetrating wound (rusty nail, thorn)
- Trismus- first symptom, stiffness in neck & back
- Respiration & swallowing progressively difficult
- Reflex convulsions along with tonic spasm
- Death by exhaustion, aspiration or asphyxiation
- **Prophylaxis**- wound debridement, penicillin , T toxoid
- Previously immunized- booster >10 years

PSEUDOMEMBRANOUS COLITIS

- Cl. Difficile
- Overtakes normal flora in patients on antibiotics
- Watery diarrhea, abdominal pain, fever
- Sigmoidoscopy: membrane of exudates (pseudomembranes)
- Stool- culture and toxin assay
- **Treatment:** Stop offending antibiotic
Oral vancomycin/ metronidazole (IMP)
 Rehydration, isolate patient



BODY CAVITY INFECTIONS

There are 2 types, primary and secondary

- **Primary peritonitis:** There will be abscess → liver abscess

Spontaneous

Children, Ascitic

Haematogenous/ lymphatic route

Antibiotic

- **Secondary peritonitis:**

Inflam./ rupture of viscera

Polymicrobial

Investigations: blood, radiological

Treatment of original cause



Drainage of liver abscess



Drainage of appendicular abscess

PROSTHETIC DEVICE RELATED INFECTIONS

- Artificial valves and joints
- Peritoneal and haemodialysis catheters
- Vascular grafts
- **Staphylococcus aureus**
- Antibiotics, washing of prosthesis or removal

HOSPITAL ACQUIRED INFECTIONS

Enterococcus, Pseudomonas comes on the top causes here

- Occurring within 48 h of hospital admission, three days of discharge or 30 days following an operation
- 10% of patients admitted to hospitals
- Spent 2.5-times longer in hospital - UK
- Highest prevalence **in ICU-**
- Enterococcus, Pseudomonas, E coli, Staph. aureus.
- **Sites:** Urinary, surg. Wounds, resp., skin, blood, GIT

ANTIBIOTICS

ROLE OF ANTIBIOTICS:

Chemotherapeutic agents that act on organisms

- **Therapeutic:** To treat existing infection
- **Prophylactic:** To reduce the risk of wound infection

ANTIBIOTICS:

- **Penicillins-** Penicillin G, Piperacillin
- **Penicillins with β -lactamase inhibitors** - Tazocin
- **Cephalosporins (I, II, III)-** Cephalexin, Cefuroxime, Ceftriaxone
- **Carbapenems-** Imipenem, Meropenem
- **Aminoglycosides-** Gentamycin, Amikacin
- **Fluoroquinolones-** Ciprofloxacin
- **Glycopeptides-** Vancomycin
- **Macrolides-** Erythromycin, Clarithromycin
- **Tetracyclines-** Minocycline, Doxycycline

Doctor mentioned penicillin and cephalosporin only

THERAPEUTIC USE OF ANTIBIOTICS

Doctor skipped this point

- **Pseudomembranous colitis**- oral vancomycin/ metronidazole
- **Biliary-tract infection**- cephalosporin or gentamycin
- **Peritonitis**- cephalosporin/ gentamycin + metronidazole/ clindamycin
- **Septicemia**-aminoglycoside + ceftazidime, Tazocin or imipenem, (may add metronidazole)
- **Septicemia due to vascular catheter**- Flucloxacillin/vancomycin or Cefuroxime
- **Cellulitis**-penicillin, erythromycin
(flucloxacillin if Staphylococcus infection. Suspected)

PROPHYLACTIC USE OF ANTIBIOTICS

- Administration of antimicrobial(s) prior to surgical procedures to reduce the number of microbes that enter the tissue or body cavity.
- Antibiotics are selected according to microbes likely to be present at the surgical site.

SURGICAL WOUND CLASSIFICATION

- **Clean wound.** No need for antibiotics.

(Class I)-thyroid surgery, breast biopsy (5%)

Class ID when graft, mesh used → antibiotics is a must.

When performing a thyroid or breast biopsy; Antibiotics are not used, because the infection rate is very low, but in case of bone or blood vessels surgeries, antibiotics are needed due to the high risk of infection.

- **Clean-contaminated**

(Class II)- minimal contamination

e.g., biliary, urinary, GI tract surgery (11%) Antibiotics are used, without leaks

- **Contaminated**

(Class III)-gross contamination

e.g., during bowel surgery- (17%) **IMP** leaks can be seen by surgeons

- **Dirty**

(Class IV)-surgery through established infection

e.g., peritonitis (>27%) antibiotics are a must

ANTIBIOTIC PROPHYLAXIS

- Prophylaxis in class ID, II, III, IV
- Antibiotic is given just before patient sent for surgery
- Duration of antibiotic is controversial (one dose-24 hour regimen)