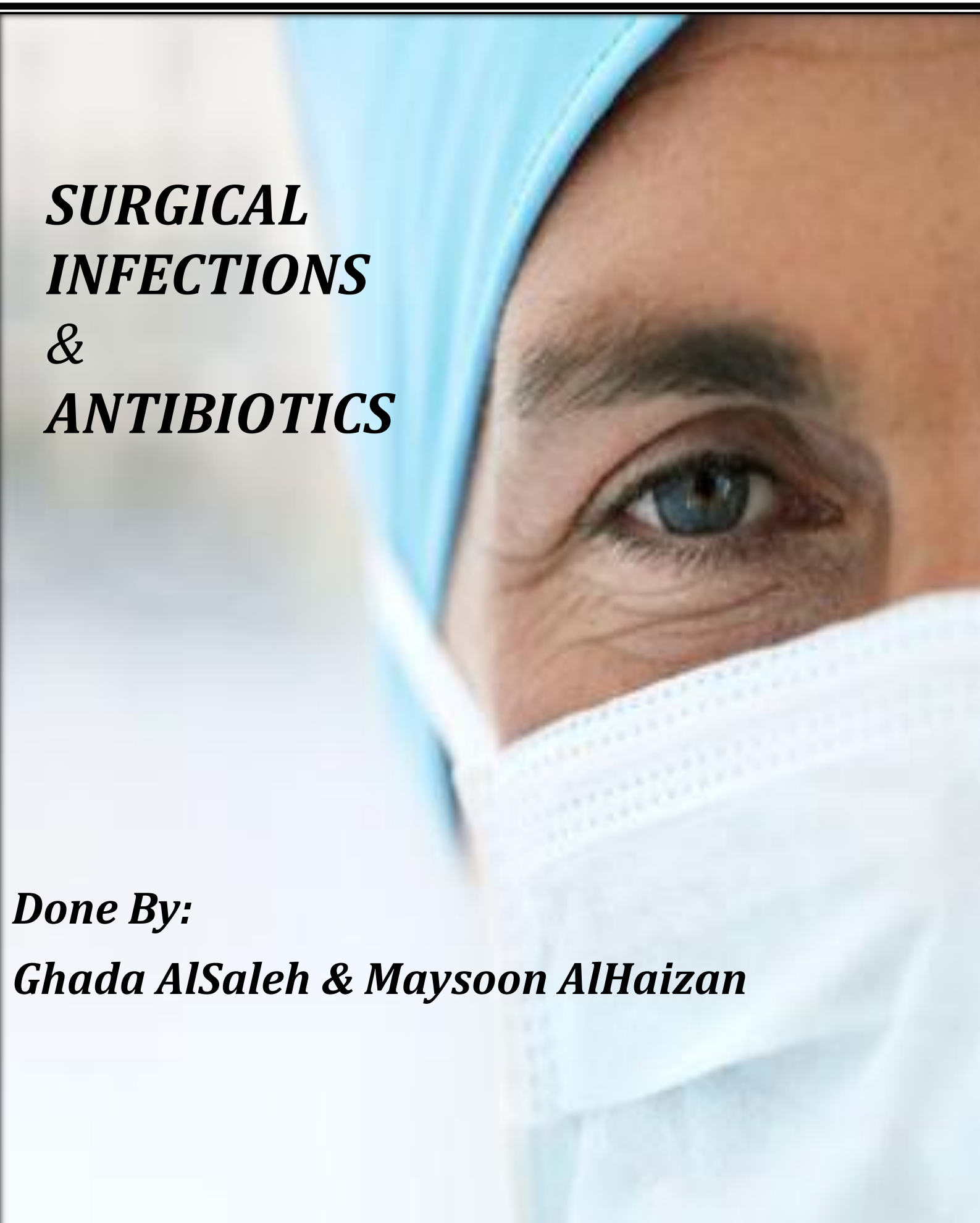

SURGICAL INFECTIONS & ANTIBIOTICS

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Invasion of the body by pathogenic microorganisms and reaction of the host to organisms and their toxins.
The invasion of body with organisms is not called infection unless the body reacts against it or had an inflammatory response to it.

SURGICAL INFECTIONS

- Infections that require surgical intervention as a treatment.
  E.g., chronic sinusitis, abscess
- Infections that happen as a result of surgical procedure.
  E.g., postoperative abscess, an infection after an appendectomy

Surgical infections is a big part of the surgical practice…

IT'S IMPORTANT FOR THE FOLLOWING REASONS:

• A major challenge
• Accounts for 1/3 of surgical patients
In practice every third patient has an infection
• Morbidity
• Mortality
Postoperative infections (developing wound infections few days after the surgery) could cause morbidity or morbidity because it may lead to septicemia
• Increased cost to healthcare

PATHOGENESIS OF INFECTIONS

Interaction between microbes and host related factors
There are some factors that contribute in developing an infection, not all organisms can cause an infection unless there are helpful factors in the host, and at the same time there are microorganism related factors…

• **Microorganism related factors:**
  - Adequate dose
    An adequate number of organisms that can cause the infection.
  - Virulence of microorganisms (pathogenicity)
    Organism should be highly virulent (harmful) and pathogenic to be able to cause an infection.

• **Host related factors:**
  - Suitable environment
    If the drainage wasn't good enough and blood is left inside the wound it may develop a good environment for the organisms.
    Postoperative infections could be developed due to the not well-sterilized operating rooms.
  - Susceptible host
    Immuno-compromised patients, diabetics

PATHOGENICITY OF BACTERIA

Exotoxins:
Bacteria secretes toxins, [toxins secreted by living bacteria]
Specific, soluble proteins, remote cytotoxic effect, it's effect could be in the site of infection and may extend to other places.
E.g., Clostridia Tetani and Strep. Pyogenes.
Clostridia Tetani the bacteria will present in the wound site but it affects the nervous system.
The bacteria produce the toxins and survive!

Endotoxins:
Part of gram-negative bacterial wall, lipopolysaccharides
E.g., E coli
Toxins are released when the cell wall integrates and by that the bacteria also is will break down; the toxin here is a structural molecule. Differs from the exotoxins that produce the toxin and survive.

Resist phagocytosis
Protective capsule
It resists the immune system
E.g., Klebsiela and Strep. Pneumoniae

HOST RELATED FACTORS:

- **Skin / mucous membrane breach**
  E.g. surgery or trauma.

Break in the barriers of the host

- **Suitable environment**
  Hematoma, seroma, closed space

Not closing the wound or not well-drained wounds creates a suitable environment for infections.
Allowing adequate number of organisms to inter the surgery room also cause infections.

- **Compromised immunity**
  Cellular (phagocytes), antibodies

E.g., patients on corticosteroid, chemo & radiotherapy

CLINICAL FEATURES OF INFECTIONS:

• **Local manifestations:**
Local pain, heat, redness, swelling and loss of function.
(Apparent in superficial infections)
Manifesting some local feature is a sign of a superficial infection the infected area will become painful, red and warm on touch like in tonsillitis.

• **Systemic manifestations:**
Fever, tachycardia in response to inflammatory cytotoxins **and chills.**
These are general features occur in deep infections, abdomen infections (post appendectomy infection) in this case patient may develop a local features,(swelling, pain, heat) and systemic features (fever, tachycardia, chills).

The systemic also can occur in a superficial infection if it's large in size E.g., cellulitis

PRINCIPLES OF SURGICAL TREATMENT:

• **Debridement**
Removing necrotic, injured tissue
Clean the wound, remove foreign materials and injured tissue because these form suitable environment for organism.

• **Drainage**
Abscess, infected fluid
Drain it and give antibiotics.

• **Excision**
Of the infection source (appendectomy)
Any source of infection should be removed!
E.g., source of the infection was the appendix so we remove it.

• **Supportive measures**
• Antibiotics
• Immobilization if the infection is in the limbs
• Limb elevation to avoid fluid collection

SURGICAL MICROBIOLOGY:

STAPHYLOCOCCI
• Inhabitants of skin, Gram positive
• Responsible for most of Wound infection (superficial infections)
• Infection characterized by suppuration. (thick pus formation)
• Sensitive to penicillinase-resistant β-lactam antibiotics.
• MRSA (Methicillin-resistant Staphylococcus aureus, resistant type of staph) → resistant to penicillinase-resistant β-lactam antibiotics
Treated by **Vancomycin.**
• Staph.aureus- SSI (Surgical site infection), nosocomial, superficial infections
• Staph. epidermidis- opportunistic in compromised patients (wound, endocarditis) artificial valves patients should be given antibiotic to prevent endocarditis. Thick pus production!

STREPTOCOCCI
• Gram positive, aerobe/anaerobe
• Flora of the mouth and pharynx, bowel
Does not produce too much pus.
• Streptococcus pyogenes –(β hemolytic) 90% of infections
E.g.,lymphangitis, cellulitis, rheumatic fever .
It's a spreading type of infection (rheumatic fever)
The majority of the infections are from this group!
• Strep. viridens- endocarditis, urinary infection
• Enterococci- urinary infection, intra-abdominal infections (Anaerobic pathogens)

Gram Negative Rods

1.Most fall into the family **Enterobacteriaceae.**
• **Escherichia, Proteus, and Klebsiella** Common in wound infections
• All are facultative anaerobic bacteria
After appendectomy, patient 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.**

2. **Pseudomonas** (commonly seen in ICU as hospital acquired infection specially with tubes and catheters) and **Acinetobacter** species.
• Obligate aerobic gram-negative
• Common: hospital-associatedpneumonia, peritoneal cavity or severe soft tissue infections.
Needs much higher level of antibiotic to cover them:
• **ceftazidime**, cefepime, aztreonam, **imipenem/cilastatin**, meropenem, **ciprofloxacin**, an acylurei- dopenicillin,or an aminoglycoside.
ceftazidime, **imipenem/cilastatin**, **ciprofloxacin** antibiotics are affective against pseudomonas.

Anaerobes
• Inhabitants of GIT, & the mouth.
• Most common- **Bacteroides fragilis**
We use metronidazole, clindamycin or combination of both.
• Antibiotics-**metronidazole, clindamycin**, imipenem, meropenem, ertapenem, the combinations ticarcillin/clavulanate, ampicillin/sulbactam, & piperacillin/tazobactam.

CLOSTRIDIA
• Gram positive, anaerobe
• Rod shaped microorganisms
• Live in bowel & soil
• Produce **exotoxin** for pathogenicity
Usually causes super infections (infection occurring after or on top of an earlier infection) + production of fuel smelling pus .
• 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
Artificial valve my cause endocarditis
• Miscellaneous

Surgical Site Infections (SSI)

Very common problem… After operation patients develop infection…
• 38% of all surgical infections
• Infection within 30 days of operation.
• Infection within 1year if a prosthetic device used.
Infections that happen 30 days after a surgical procedure are still considered SSI.
Unless a prosthetic device has been used infection within a year is still called SSI.
E.g., vascular graft or mesh for hernia repair.

Classification:

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, other spaces (30%)
Within the chest or abdomen cavity.
- **Staph. aureus**- most common organism
- **E coli**, Entercoccus,other Entetobacteriaceae- **deep infections**
- **B. fragilis** – intrabdominal abscess.
In abdominal-related surgeries →E.coli and B.fragilis (can be either single infection or mixed infection).
Knowing the causative organisms is important to help us provide the proper Antibiotics.
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. 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 (cream)
•Type of surgery operations on appendix, bowel or colon = high infection rate , lipoma or breast biopsy = very low infection rate

Prevention of surgical site infection:

Surgical site infection could be prevented by:

1)**Pre-operative:** treat pre-existing infection (ex: if the patient came with cough and any symptom of infectious disease delay the surgery until the patient recovers), a common exam question that if the patient came with urinary tract infection should you operate or not the answer is delay the surgery and send the patient to treat for 3-4 weeks. Improving general nutrition, shorten hospital stay (to prevent hospital acquired infection bring the patient just one day before operation to reduce the risk of infection.) (Preventing any hospital acquired infection), pre-operative shower how?? Pre-operative bathing or showering with antiseptic skin wash product is well-accepted procedure to reduce skin bacteria and lower the incidence of skin infection, hair removal **how??** Having a hairless surgical site asses t that the application of dressing and reduces potential infection as hair is source of bacteria. However the process of removing hair cause primary infection because of microscopic cuts to the skin shaving for instance.

2)Intra-operative:

a) Antiseptic technique: it is a technique used to keep patients a way from infection as possible. Hospital-micro-organism

b) Good surgical technique: (handle the tissue gently, control all the bleeder, do not leave behind a lot of hematoma)

c) Normothermia.

3)**Post-operative:**

a) Wound dressing in 48-72 hours

b) Early drain removal

c) Blood sugar control

Soft tissue infections:

1) Erysipelas:

- *Superficial spreading cellulitis & lymphangitis*
- *Patient present with: Area of redness, sharply defined irregular border*
- *Follows minor skin injuries*
- *Caused by:Organism-Strep pyogenes*
- *Treatment;Penicillin, Erythromycin*

2) Cellulitis: **it is more deeper-seated infection**

- *Inflammation of skin & subcutaneous tissue*
- *Non-suppurative*
- *Strep. Pyogenes* the same pathogen of erysipelas but the location gives it different presentation (swelling, edema,you donot see that bright redness as the previous one because erysipelas is sub-dermal while cellulitis is intra-dermal)
- *Common sites- limbs*

- *Affected area is red, hot & indurated*
- *Treatment: Rest, elevation of affected limb* (this patient will have systemic manifestation)

Penicillin, Erythromycin, Fluocloxacillin (staph. suspected)

3) Abscess

Localized pus collection example of

- *Superficial - trunk, head and neck -* **S. Aureus (most common),** *(Streptococci)*
- *Axillae- gram-negative bacteria*
- *Perineum- mixed aerobic and anaerobic gram-negative flora*
- *Abscess may be mistaken for cellulitis when located deep*
- *Treatment:* drainage usually is the tereatment and *antibiotics.*
- **Furuncle-** infection of hair follicle / sweat glands
- **Carbuncle- extension of furuncle** into subcutaneous tissue is called carbuncle.

Common in diabetics

Common sites- back, back of neck

Treatment: drainage, antibiotics,

Control diabetes since the most common causative organism is staph aureus treatment is anti staph aureus.

4) Necrotizing fasciitis

- Necrosis of superficial fascia, overlying skin does not affect muscle
- Risk group- elderly, diabetics, immunosuppressed
- **Polymicrobial:** Streptococci, Staphylococci, Gram-negative Bacilli, and the anaerobes.
- Sites: Limbs, Perineum (Fournier's), Abdominal wall (Meleny's), Trunk- elderly, diabetics, immunosuppressed
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5) Clostridial myonecrosis (GAS GANGRENE) affect muscle, lot of gas , bad smell:

- ***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 do not close the wound*
- *Penicillin, clindamycin, metronidazole*
- *Debridement , drainage, amputation, hyperbaric oxygen*

6) TETANUS:

- ***Cl. Tetani****, (neurotoxin)*
- *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*
- *Prophlaxis- wound debridement, penicillin , T toxoid*
- *Previously immunized- booster >10 years*

6) PSEUDOMEMBRANOUS COLITIS

- ***Cl. Difficile normally present in the gut***
- *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

Rehydration, isolate patient

Body Cavity Infections:

- ***Primary peritonitis:***

Spontaneous

Children, Ascitic

Haematogenous/ lymphatic route the route of administration.

Antibiotic

- ***Secondary peritonitis:***

Inflam./ rupture of viscera(gall bladder,appendix , small bowel) spred surrounding the bowel.

Polymicrobial

Investigations: blood, radiological

Treatment of original cause

Prosthetic Device Related Infections:

- *Artificial valves and joints*
- *Peritoneal and haemodialysis catheters*
- *Vascular grafts*
- *Staphylococcus aureus*
- *Antibiotics, washing of prosthesis or removal if the infection not treated*

Hospital Acquired Infections:

- *Occurring within: 48 h of hospital admission/ 3 days of discharge /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 most common cause surg. Wounds, resp., skin, blood, GIT*

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 not important*

THERAPEUTIC USE OF ANTIBIOTICS:
usage of antibiotic depends on the

- *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 (Class I)- thyroid surgery, breast biopsy (5%) Class ID when graft, mesh used*
- *Clean-contaminated (Class II)- minimal contamination e.g., biliary, urinary, GI tract surgery (11%) collisestectomy*
- *Contaminated (Class III)-gross contamination e.g., during bowel surgery- (17%) one instriment*
- *Dirty (Class IV)- surgery through established infection e.g., peritonitis (>27%)*

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)*