



Surgical infections and antibiotics

Objectives:

1. Pathogenic potential of microbes.
2. Asepsis.
3. Surgical infection.
4. Anaerobic infection.
5. Hospital-acquired (nosocomial) infections.
6. Antimicrobial management of wound infections.
7. Principles governing the choice and use of antibiotics.
8. Management of immunosuppressed patients, including those who have had splenectomy.

Resources:

- Davidson's.
- Slides
- Surgical recall.
- Raslan's notes.
- surg wiki.
- wikipedia

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Once you stop learning
you start dying.

Introduction:

- 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.

What is an infection?

- **Infection** is invasion of the body by pathogenic microorganisms and reaction of the host to organisms and their toxins. (microorganism + inflammatory response)
- **Surgical infections:** Infections that require surgical intervention as a treatment or develop as a result of surgical procedure.
 - o A major challenge
 - o Account for 1/3 of surgical patients
 - o Morbidity and mortality (e.g. septicemia due to post-op infection), Increase cost of health care (longer hospital stays)

Principles Of Treatment:

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

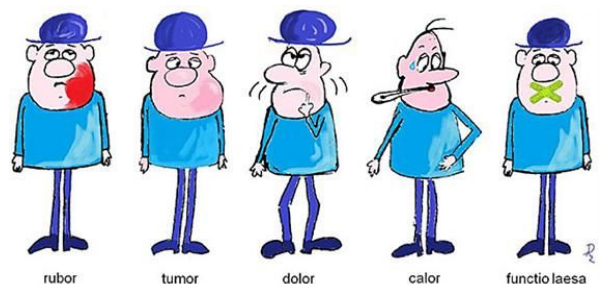
Surgical Infections²

Infection is defined by:

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

Types of Inflammatory Response:

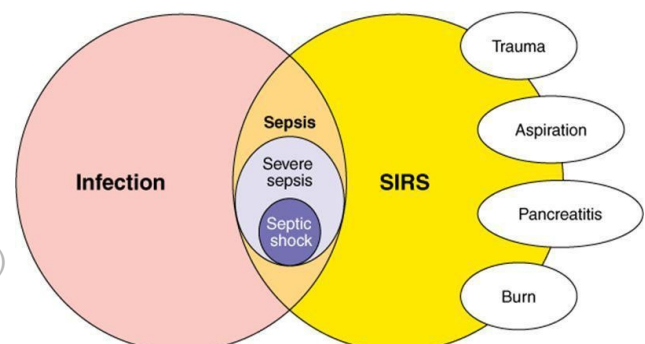
- **Localized:** The four classical signs of inflammation:
 - o Dolor (pain)
 - o Calor (heat)
 - o Rubor (redness)
 - o Tumor (swelling)
 - o Functio laesa (loss of function)



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

Defined as **Two or more** of the Following Criteria:

- Temperature: < 36.0 (hypothermic) or >38.0 (hyperthermic)
- Heart Rate : >90
- Respiratory Rate: >20
- WBC: <4,000(leukopenic), >12,000(leukocytosis) or >10% band cells



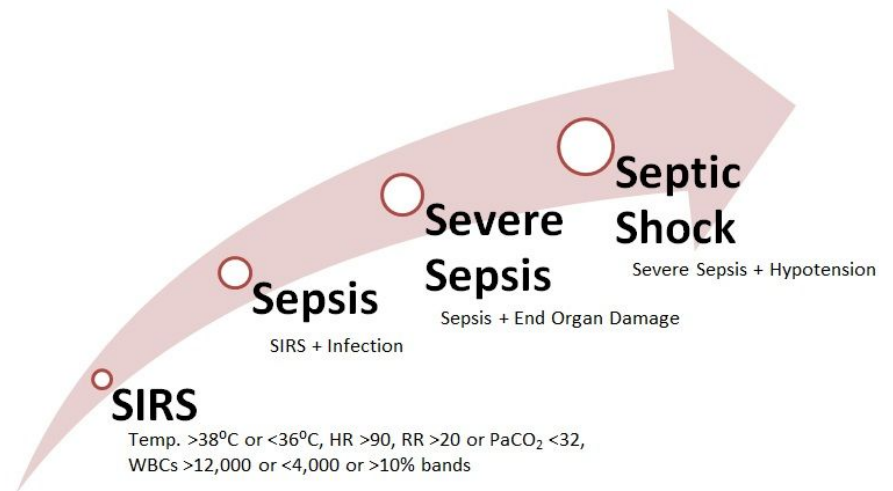
¹ IND = incision and drainage

² it has two types: pt who undergone surgical procedure or pt with sepsis who require a surgery (management)

Sepsis	SIRS + evidence of local or systemic infection
Septic Shock = end organ damage/failure	Sepsis + end organ hypoperfusion . Mortality of up to 40%

Spread Of Surgical Infections:

- direct /local
 - necrotizing infection
 - abscesses
 - phlegmons³ and superficial infections
- via the lymphatic system
- via blood stream



Recall:

what are the classic signs of infection/inflammation?

mass, heat, pain, redness.

What is "Bacteremia"?

Bacteria in the blood

what is "SIRS"?

Systemic Inflammatory Response Syndrome (fever, tachycardia, tachypnea, leukocytosis)⁴

Define "Sepsis"?

Documented infection and SIRS

Define "Sepsis Shock"?

Sepsis and hypotension

Define "Cellulitis"?

Blanching erythema from superficial dermal/epidermal infection (usually strep more than staph)

Define "Abscess"?

Collection of pus within a cavity

Define "Superinfection"?

New infection arising while a patient is receiving antibiotics for the original infection at a different site (e.g., Clostridium difficile colitis)

Define "Nosocomial infection"?

Infection originating in the hospital

what is the most common nosocomial infection?

UTI

What is the most common nosocomial infection causing death?

Respiratory tract infection (pneumonia)

Define "Empiric"?

Use of antibiotic based on previous sensitivity information or previous experience awaiting culture results in an established infection

Define "Prophylactic"?

Antibiotics used to prevent an infection

³ **Phlegmon** is a spreading diffuse inflammatory process with formation of purulent exudate (the suppuration of pus).

⁴ the criteria mentioned above in the previous slide

Soft tissue infections

- **Cellulitis:** more common among young children & elderly
- Diffuse infection with severe inflammation of dermal and subcutaneous layers of the skin commonly in the limbs. Non-suppurative⁵
- Sx: Pain, Warmth, Hyperesthesia
- Treatment: Antibiotics. Drainage won't be a good idea bc it's diffuse
 - Rest, limb elevation
 - Penicillin, Erythromycin
 - Flucloxacillin (if staph. suspected)
- Common Pathogens: Skin Flora (Streptococcus/Staphylococcus) most commonly Strep. pyogenes



- Picture 1: Diffuse redness, shiny and swelling, painful and warm bilateral in the anterior surface of lower limbs. (Clear signs of inflammation).
- Picture 3: Mark the edges of the swelling to monitor the response of antibiotics.
- sometimes it can have a small localized abscess which should be drained.

- **Furuncles And Carbuncles⁶:** both can be in hairy area but furuncles, can also be in non-hairy area, back, back of the neck Carbuncle: extension of furuncle into subcutaneous tissue
- Furuncles and carbuncles are cutaneous abscesses that begin in skin glands and **hair follicles**.
- If the pilosebaceous apparatus⁷ becomes obstructed at the skin level, the development of a furuncle can be anticipated
- A carbuncle is a deep – seated mass of fistulous tracts between infected hair follicles. (**multiple**)
- Furuncles are the **most common** surgical infections, but carbuncles are **rare**
- Treatment:
 - The classic therapy of furuncle is incision & **drainage**.
 - Invasive carbuncles must be treated by excision and antibiotics.



Furuncle: localized redness & whitehead & pus collection
carbuncle: more indurated & diffuse & red, with whitish/yellowish discharge

- **Hidradenitis:** التهاب الغدد العرقية
- recurrent Serious skin infection of the axillae or groin Consisting of multiple abscesses of the **apocrine sweat glands**.
- The condition often becomes chronic.
- The cause is **unknown** but may involve a defect of terminal follicular epithelium. common in smoker
- infection > inflammatory response⁸ > scarring
- It happens in any folded hairy area, Scarring, irregular brownish vacuoles and patchy discoloration, forming scars which can affect movement of joint⁹



⁵ doesn't produce pus

⁶A furuncle (boil) is an acute Staph. aureus infection of the hair follicle, usually with necrosis.

If a deep Staph. aureus infection of a group of contiguous hair follicles occurs, this is termed a carbuncle

⁷ The structure consisting of hair, hair follicle, arrector pili muscles, and sebaceous gland is an epidermal invagination known as a pilosebaceous unit.

⁸ immunosuppressant is an option in treatment

⁹ A graft can be placed to restore normal range of movement to the joint

- Treatment is difficult and recurrence is common, usually an antibiotic & drainage of the individual abscess (if there's any) and followed by careful hygiene. (doesn't mean that low hygiene cause it), excision

Recall:

what is "Suppurative Hidradenitis" ?

Infection/abscess formation in apocrine sweat glands.

In what three locations does it occur?

Perineum/buttocks, inguinal area, axillae (site of apocrine glands) (folded area)

What is the most common causative organism?

Staphylococcus aureus

What is the treatment?

-Antibiotics

-Incision and drainage (excision of skin with glands for chronic infections)

● Abscess:

- Definition: Infectious accumulation of purulent material (Neutrophils) in a **closed cavity**
- Sx: Fluctuant: Moveable and compressible
- May develop an abscess in a background of cellulitis
- Treatment: Drainage / IND¹⁰, antibiotic
- Localized collection of pus.
- Superficial on the trunk, head and neck > S. aureus, (less commonly streptococci)
- In the axillae > gram-negative
- On the perineum > mixed aerobic & anaerobic gram-ve
- Abscess may be mistaken for cellulitis when located deep



● Tetanus:

- Organism : Clostridium tetani (produces neurotoxin)
- Risk factors: penetrating wound (rusty nail, thorn)
- Diagnosis/clinical picture :
 - Trismus¹¹: first symptom; stiffness in neck & back
 - Respiration and swallowing become progressively difficult
 - Reflex convulsions along with tonic spasm
 - Death by exhaustion, aspiration or asphyxiation¹²
- Treatment :
 - Prevention: wound debridement, IV antibiotics (penicillin)
 - **T toxoid**: if previously immunized and booster taken >10 years ago

Recall:

What are the signs of tetanus?

Lockjaw, muscle spasm, laryngospasm, convulsions, respiratory failure

¹⁰ IND = incision and drainage

¹¹ Tetanospasmin (a neurotoxin) spreads along nerves from the site of infection and causes generalized rigidity and spasm of skeletal muscles.

● Diffuse Necrotizing Infection:

- Particularly dangerous, Necrosis of superficial fascia, overlying skin,
- Risk factors: elderly, diabetic, immunosuppressed
- Difficult to diagnose, extremely toxic, spread rapidly (**hours**), often leads to limb amputation
- Pathogenic factors
 - Anaerobic
 - wound Bacterial exotoxins
 - Bacterial synergy
 - Thrombosis of nutrient bridging vessels
- The causative bacteria may be aerobic, anaerobic, or mixed flora.
- A) NON-clostridial;
 - Type I, polymicrobial (synergistic bacterial gangrene)
 - Type II, single organism (group A streptococcal)
- B) Clostridial
 - gas gangrene (aka clostridial myonecrosis)
- Starts as cellulitis > edema > systemic toxicity > shock
- Appears less extensive than actual necrosis
- Investigation: aspiration, Gram's stain, CT, MRI
- **Sites:**
 - Limbs
 - Perineum (Fournier's gangrene)
 - Abdominal wall (Meleny's)
 - Trunk (in elderly, diabetics, immunosuppressed)

Classification of Diffuse Necrotizing infections

Clostridial Infections

- Necrotizing cellulitis
- Myositis

- They are fastidious anaerobes,
- gram+ve, large, rod-shaped bacteria,
- A broad spectrum of diseases is caused by clostridia

Non-clostridial Infections

- Necrotizing fasciitis
- streptococcal gangrene

- Caused by multiple nonclostridial bacteria.
- Microaerophilic streptococci, staphylococci, aerobic gram-negative bacteria, and anaerobes, especially peptostreptococci and bacteroides.

Clinical Findings

- **Crepitant**¹³ 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.

- Usually begins in a localized area such as a puncture wound, leg ulcer, or surgical wound.
- Externally, hemorrhagic 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 Dx.

Examples

❖ Gas Gangrene (myositis)

- Severe pain suggests extension into muscle compartments (myositis)
- The disease progresses rapidly (**within 20 min**), with loss of blood supply to the infected tissue.
- Profound shock can appear early, rapidly leading to organ dysfunction.
- Air bubbles often visible on plain radiograph
- Crepitus may be present, but not reliable to differentiation.

❖ Streptococcal gangrene (Uncommon)

- **Group A** streptococcus is a bacterium frequently found in the skin and throat.
- 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.

General Treatment for Necrotizing Fasciitis

- **Complete debridement** and “depress tight fascial compartment¹⁴”.
- Amputation **in peripheral area (limb)**.
- Broad-spectrum antibiotic therapy Penicillin, clindamycin, metronidazole (in case of clostridial infection)
- Resuscitative therapy, IV fluids
- Treat diabetes mellitus aggressively
- Hyperbaric oxygenation, inhibit bacterial invasion but does not eliminate the focus of infection.
- IV antibiotics (broad spectrum: ampicillin, cephalosporins, clindamycin, metronidazole, aminoglycosides)
- Surgical: repeated debridement, dressings, skin grafting

Necrotizing Soft Tissue Infection¹⁵



Necrotizing¹⁶



Diffuse discoloration in background of redness and patchy blue and black area, undemarcated edges with swelling and desquamation to skin

Gas Gangrene



Recall:

what is “Clostridial Myositis” ?

Clostridial muscle infection

What is another name for this condition?

Gas gangrene

What is the most common causative organism?

Clostridium perfringens

What are the signs/ symptoms?

Pain, fever, shock, crepitus, foul-smelling brown fluid, subcutaneous air on x-ray

What is the treatment?

IV antibiotics, aggressive surgical débridement of involved muscle, tetanus prophylaxis

what is “Necrotizing Fasciitis” ?

Bacterial infection of underlying fascia (spreads rapidly along fascial planes)

What are the causative agents?

Classically, group A Streptococcus pyogenes, but most often polymicrobial with anaerobes/gram-negative organism

What are the signs/ symptoms?

Fever, pain, crepitus, cellulitis, skin discoloration, blood blisters (hemorrhagic bullae), weeping skin, increased WBCs, subcutaneous air on x-ray, septic shock

What is the treatment?

¹⁴ "Nonadherent compressive dressings"

¹⁵ brown= dead/ischemic

¹⁶ gangrene affecting the genital area affect the diabetic pt

IVF, IV antibiotics and aggressive early extensive surgical débridement, cultures, tetanus prophylaxis

What antibiotics?

Triple therapy: e.g. Zosyn, Vancomycin, Clindamycin

Why Clindamycin?

Binds STAPH/STREPT exotoxin

Is necrotizing fasciitis an emergency?

YES, patients must be taken to the O.R. immediately!

Hospital-acquired Infections

- Also known as Healthcare Associated Infections (HCAI)
- Occurring within **48 hours** of hospital admission, **3 days** of discharge or **30 days** following an operation.
- 10% of patients admitted to hospitals, **Highest** prevalence in ICU.
- **Organism:** Enterococcus, Pseudomonas, E.coli, S. aureus
- **Sites:** Urinary , surgical wounds, respiratory tract, skin, blood, GIT

Postoperative Infections

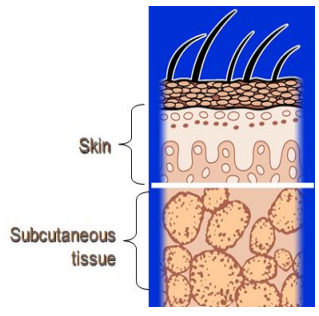
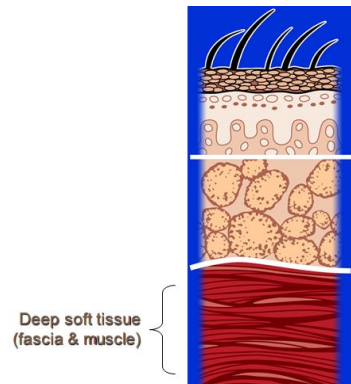
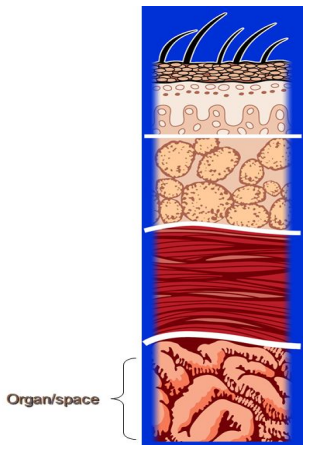
- Fever After Surgery
- look for The **“Five W’s”**
 1. **W**ind: Atelectasis (partial or complete collapse of the lung) (SIRs)
 2. **W**ater: UTI (infection)
 3. **W**alking: DVT (SIRs)
 4. **W**onder Drug: Medication Induced (SIRs)
 5. **W**ound: Surgical Site Infection (infection)

Surgical Site Infections¹⁷ (SSI)

- All surgical wounds are contaminated by microbes, but in most cases infection does not develop because of innate host defences. A complex interplay between host, microbial, and surgical factors ultimately determines whether infection takes hold and how it progresses
- **3rd most common hospital infection**
- **Characteristic:**
 - 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

¹⁷ used to be called Surgical wound infection

- Classified into:

incisional		organ/space SSI (30%)
Superficial SSI (50%)	Deep SSI (20%)	
involves only <u>the skin or subcutaneous tissue</u> .	involves the deep soft tissue, which include <u>the fascia and muscle layers</u> .	involves <u>any part of the anatomy, other than the incision</u> . <ul style="list-style-type: none"> generalized (peritonitis). abscess.
 <p>Labels: Skin, Subcutaneous tissue</p>	 <p>Labels: Deep soft tissue (fascia & muscle)</p>	 <p>Labels: Organ/space</p>
Treatment		
open surgical wound and drainage, antibiotics for cellulitis or sepsis		Source control ¹⁸ , antibiotics for sepsis
diagnosis		
erythema, edema, discharge and pain (take a swab of any discharge)	no local signs, fever, pain, hypotension. Needs investigation (e.g. CBC, blood & urine cultures, CXR, CT scan)	—

- Risk factors:

- Surgery-related:** poor surgical technique, prolonged surgery, **preoperative shaving** and type of surgery (clean/contaminated)
 - Patient-related:** age, malnutrition, DM, smoking, obesity, immunocompromised,

- Influence of Shaving on SSI:

statistics have shown that the incidence of SSI will increase with pre-op self shaving compared to shaving in hospital .

- Causative organisms:

- S. aureus** is the most common organism
 - E coli, Enterococcus & other Enterobacteriaceae** deep infections
 - B. fragilis** intra-abdominal abscess

- Surgical site prevention:

- Use antibiotics appropriately
 - Maintain normal Body temperature.
 - Maintain normal Blood glucose
 - Optimize oxygen tension
 - Avoid shaving Site.

¹⁸ e.g. Abscess

The doctor said it is a super important table :

Classes		Site	Infection
I	Clean ¹⁹	hernia repair, breast biopsy and Thyroid surgery	1.5 %
II	Clean-contaminated ²⁰	Cholecystectomy, planned bowel resection	2-5 %
III	Contaminated ²¹	Unprepared bowel resection	5-30 %
IV	Dirty/Infected ²²	perforation, abscess	5-30 %

for example : A 35-year-old woman undergoes an elective laparoscopic **cholecystectomy** for symptomatic cholelithiasis. Which of the following wound classes best describes her procedure?

Answer : 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.

Occupational Blood Borne Virus Infection			
Virus	HBV	HCV	HIV
Risk from needlestick	30%	2%	0.3%
Chemoprophylaxis	Yes	No	Yes
Vaccine	Yes	No	No

when HIV transmission is susceptible, we start chemoprophylaxis immediately

the infection of HCV is more critical than HBV because it **doesn't** have chemoprophylaxis nor vaccine

Recall :

what is the surgical site infection?

infection in an operative wound.

what do these infections arise ?

classically PODs (post-operative day) 5 to 7

what are the signs and symptoms?

pain at incision site, erythema, drainage, induration, warm skin, fever.

what is the treatment?

remove skin sutures\staples, rule out fascial dehiscence, pack wound open, send wound culture, administer antibiotic.

what are the most common bacteria found in postoperative wound infections?

staph.aureus (20%), escherichia coli (10%), enterococcus (10%), others: s.epidermidis, pseudomonas, anaerobes, other gram negative organisms, streptococcus.

which bacteria cause fever and wound infection in the first 24 hrs after surgery?

streptococcus, clostridium (bronze-brown weeping tender wound).

what are examples of an immunosuppressed state?

immunosuppressant treatment, chemotherapy, systemic malignancy, trauma or burn, DM, obesity, malnutrition, AIDS, uremia.

¹⁹ are not inflamed or contaminated and do not involve operating on an internal organ.

²⁰ have no evidence of infection at the time of surgery, but do involve operating on an internal organ.

²¹ involve operating on an internal organ with a spilling of contents from the organ into the wound.

²² are wounds in which a known infection is present at the time of the surgery.

Antibiotic

Depends on the expected pathogen of that surgical site (so the antibiotic must cover it), most hospitals have policies that take into account local resistance patterns.

in recent years co-amoxiclav has largely replaced cefuroxime because cefuroxime has a tendency to **cause c.difficile infection**.

This table for your knowledge

class	example	coverage
Penicillins	Piperacillin, penicillin G.	Gram +ve.
Penicillins with beta-lactamase inhibitors	Tazocin (Piperacillin+Tazobactam) Methicillin, Cloxacillin.	Anti-Pseudomonal. Anti-staphylococcal.
Cephalosporins	Cephalexin(1st), Cefuroxime(2nd), Ceftriaxone(3rd).	1st & 2nd : Gram +ve cocci 3rd : Gram -ve rods.
Carbapenems	Imipenem, Meropenem.	Gram +ve, Gram -ve & Anaerobes.
Monobactam	Aztreonam.	Gram -ve , Aerobic.
Aminoglycosides	Gentamycin, Amikacin.	Gram -ve rods eg. E.coli
Fluoroquinolones	Ciprofloxacin.	Gram +ve, Gram -ve, Pseudomonas.
Glycopeptides	Vancomycin.	MRSA.
Macrolides	Erythromycin, Clarithromycin.	Erythromycin = Penicillin, Clarithromycin = extended.

● Prophylactic Uses :

- Administration of antimicrobials 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

● Prophylaxis for immunosuppressed patients :

The choice of agent will depend on individual circumstances and expert microbiological help should be sought.

Splenectomized patients are at increased risk of infection with encapsulated bacteria and protozoa and should be:

- commenced on lifelong antibiotic prophylaxis with penicillin or amoxicillin.
- immunized against pneumococcus, Haemophilus influenzae type b (Hib), Group C meningococcus.

For elective splenectomy, the vaccines should be given 2–4 weeks prior to the procedure and for emergency procedures, 2–4 weeks after.

● **Antibiotic policy** : just read it :)

- Antibiotics should be **avoided** in self-limiting infections and due consideration should be given to expense, toxicity and the need to avoid the emergence of resistant strains.
- Choice of therapy is determined positively by **knowledge of the nature and sensitivities of the infecting organisms**. Therapy may be initiated on clinical evidence, but must be reviewed in the light of culture/sensitivity reports.
- Restrict the use of antibiotics to which resistance is developing (or has developed).
- **Single** agents are preferred to combination therapy, and **narrow-spectrum** agents are preferred to broad-spectrum agents whenever possible.
- **Adequate doses** must be given by the **recommended route** at correct time intervals.
- Antibiotics that are used **systemically must not be used topically**.
- Antibiotics used for **prophylaxis are not used for treatment**.
- The side effects of antibiotics should be known by the prescriber and monitored.
- Expensive antibiotics are not used if equally effective and cheaper alternatives are suitable.
- With few exceptions (e.g. lung abscess), antibiotics should not be used to treat abscesses unless adequate surgical or radiological drainage has been achieved
- Policies may include automatic 'stop' orders.