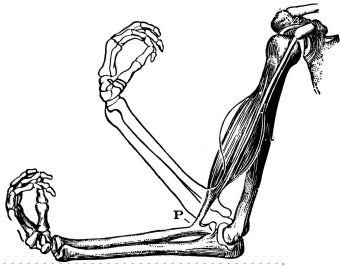
Microbiology of joints and bone infections

- Important
- Doctor Notes
- Extra

Editing File

Objectives:



- Recognize the differences between osteomyelitis and arthritis.
- Know how infection reaches the bone /joint.
- Recognize the epidemiology ,risk factors and pathogenesis of both osteomyelitis and arthritis
- Recall the route of infection of bone and joint.
- Know the commonest causative organisms of acute and chronic osteomyelitis and arthritis.
- Recall the differential diagnosis of both conditions.
- Know the laboratory diagnosis and investigation of osteomyelitis and arthritis.
- Recognize the management and treatment of both osteomyelitis and arthritis.
- Recall the complications of both conditions.
- Know the causative organisms ,diagnosis , management and treatment of infection of the joint prosthesis.

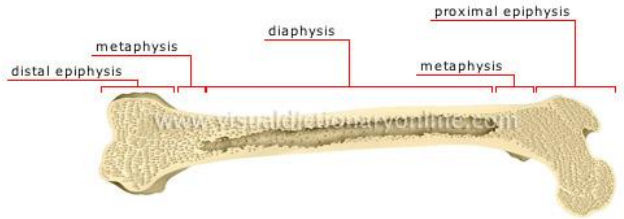
Introduction:

- Bone & joint infections may exist separately or together.
- Both are more common in infants and children.
- Often associated with foreign body at the primary wound site.
- If not treated lead to devastating effect.

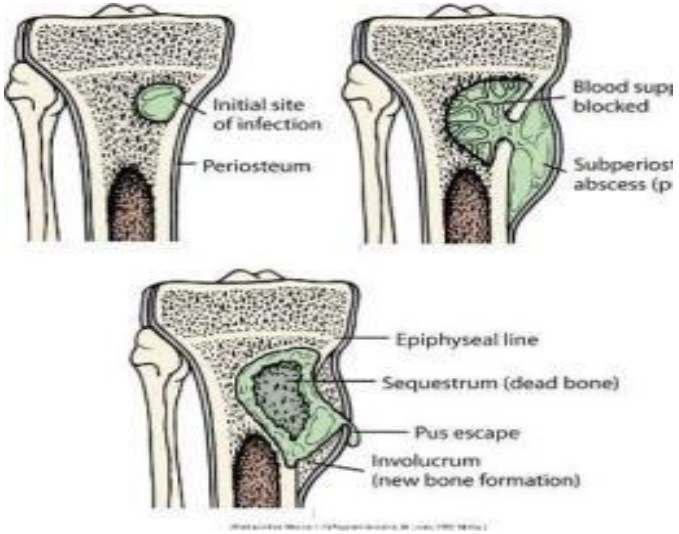
Caused by

Usually; Blood borne spread	Local trauma	Spread from contiguous soft tissue infection

(metaphysis: most serious (has most of blood supply) most infection starts there and usually spread)



Acute Osteomyelitis



- Definition: An acute infectious process of the bone and bone marrow.
- How the pathogen reaches the bone:
  - 1. **Hematogenous route** (blood)
  - 2. **Contiguous soft tissue focus** (postoperative infection, contaminated open fracture, soft tissue infection , puncture wounds)
  - 3. **In association with peripheral vascular disease** "chronic diseases" (diabetes mellitus ,severe atherosclerosis, vasculitis)
- Duration:
  - **short duration** (few days for hematogenously acquired infection).
  - **last several weeks to months** (if secondary to contiguous focus of infection).

Etiology, Epidemiology and Risk Factor

How they reach	Risk Group	Etiology
Primary Hematogenous route **site:(Metaphysis of long bones)**	•Children and infants common •Adult less common (may occur due to reactivation of a quiescent (خامد) focus of infection from infancy or childhood) ⟶ معناه شخص أصيب بانفكشن وهو صغير ورجعت له لمن كبر •most cases are due to S.AUREUS •S. Aureus is common as the infection begins in the diaphysis. •Septic infection can be in the beginning of infection (in diaphysis) and then it can spread to metaphysis.	**Infant :** S.aureus, group B streptococci , gram –ve rods like (**E.coli.** , Klebsiella).
		Children: S.aureus, group A streptococci, Haemophilus **(H.)influenzae.**
		Adults: S.aureus, Salmonella species
Other cases – special clinical situations:	Infection after puncture wound of foot.	Pseudomonas aeruginosa ⟶ common in watar, S.aureus .
	Fist injuries, and diabetic foot and decubitus ulcers,	Streptococci ,, anaerobes
	in sickle cell patients (phagocytosis will be affected because they have Autosplenectomy ⟶ infection of spleen)	Salmonella or S. pneumoniae (Salmonella and other capsulated organism) , and s. aureus
	Immunocompromised patients ⟶ AIDS patients .	M.tuberculosis or M. avium (Mycobacterium tuberculosis (MTB) or Mycobacterium avium)
	Infection after trauma ,injury or surgery	S.aureus, group A Streptococcus, Gram negative rods, anaerobes.

Clinical presentation & investigation findings

Acute osteomyelitis usually of abrupt “sudden” onset

Clinically Usually Quick	**Blood findings**	**X-ray findings**	**Ultrasound findings**	**CT scan findings**	**MRI findings** (the most sensitive)
- fever - localized pain - heat - swelling - tenderness of affected site (one or more bones or joints affected in hematogenous spread) - May be local tissue infection (abscess or wound)	-leukocytosis -High ESR -High C-reactive protein. 	**Early stages:** normal **Later stages:** Swelling of soft tissues followed by elevation of periosteum ,demineralization and calcification of bone. (lytic bone lesion)	Fluid collection (abscess) and surface abnormalities of bone. (Good for pediatrics)	Reveal small area of osteolysis in cortical bone. 	In early detection , help in unclear situation (Define bone involvement in patients with negative bone scan). (Baseline) - you use it in complicated cases, if you highly suspected in infections, but all the investigations are normal.

Diagnosis of acute osteomyelitis :

Blood culture:
Bacteremia "presence of bacteria in blood" common

If blood culture is negative:
biopsy of periosteum or bone,
or needle aspiration of overlying abscess

Blood test:
complete blood and differential counts

Erythrocyte sedimentation rate (ESR): elevated but could be normal

C-reactive protein

Imaging studies:
X-RAY, MRI, CT-SCAN

Differential diagnosis and complications

Differential diagnosis includes:

- Rheumatoid arthritis
- Septic arthritis
- Fractures (esp pathological fracture)
- Sickle cell crises (hypoxia ---> sickling of RBCs ---> Thickened blood ----> hypoxia -----> severe pain)

Complications of acute osteomyelitis include:

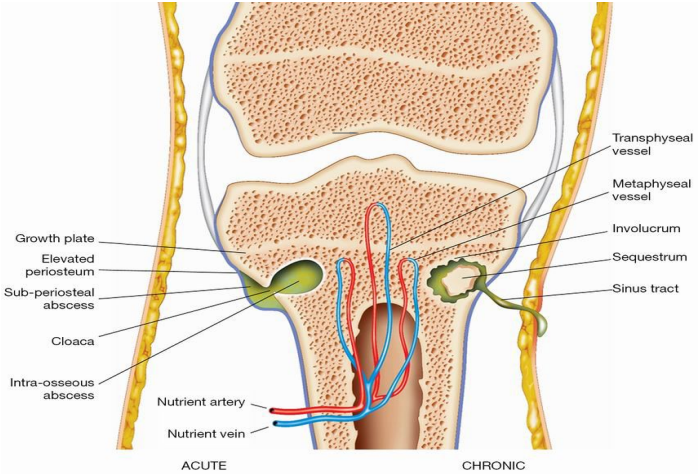
-Septic arthritis
-Chronic osteomyelitis
-Metastatic infection to other bones or organs(especially staph.aureus)
-Pathological fractures

Management and treatment

Organisms	Antibiotics	Duration/Surgery/complication and follow up
Methicillin sensitive (MSSA) Ex: *Staph.aureus*	Cloxacillin, cefazolin or Clindamycin .	• Early treatment is critical • **Treat for 2-4 weeks parenteral (I.V) followed by oral therapy for a total of at least 6 weeks.** • **Surgery for neurological complications, para-vertebral abscess & hip joint involvement.** • Complications: septicemia, metastatic abscesses, septic arthritis, chronic osteomyelitis, loss of limb ,or paravertebral abscess. • Monthly ESR for 3 months and at 6 months useful to document treatment. • Cases due to contiguous source more difficult to eradicate, Relapse common (50%) , surgery indicated. - Duration: 4 - 6 weeks to ensure cure and prevent progression to chronic osteomyelitis. - Surgical drainage: (as needed) if there is local purulent process.
Methicillin resistant(MRSA) Ex: *Staph.aureus*	**Vancomycin followed by Clindamycin**, Linezolid, or TMP-SMX (cannot use Beta-Lactam antibiotics)	
Polymicrobial* infection:	Ampicillin-Sulbactam, Piperacillin-Tazobactam or Quinolone with Metronidazole.	
S.epidermidis:	Vancomycin and Rifampicin	
Enterobacteriacae:	Ceftriaxone	
Other Gram negative bacilli:	Quinolones	
P. aeruginosa:	Cefepime, Meropenem, or Piperacillin +/- Aminoglycoside.	
Anaerobes:	Metronidazole or Clindamycin	

Organized by 436

Chronic Osteomyelitis



- A chronic infection of the bone and bone marrow usually <u>secondary</u> to inadequately treated or relapse of acute osteomyelitis or foreign body.
- Difficult management and Poor prognosis
- Infection may not completely cured.
- May recur many years or decades after initial episode.
- Most infections are secondary to a contiguous focus or peripheral vascular disease.
- Chronic infection due to hematological spread is rare.

The blood vessels coming in and out of the bone will be obstructed from the pus ➡ No or small amount of antibiotics can enter the bone ➡ Difficult management + poor prognosis

Pathogens:

Diabetic patients lose sensation of pain due to nerve damage , so they will not feel the pain when they get a cut and may not clean the wound early, which can increase the chances of more microbes to infect the patient

- **S.aureus** : is the most common pathogen
- **Other microorganisms :**S.epidermidis,Enterococci , streptococci, Enterobacteriaceae, Pseudomonas and anaerobes
- **Tuberculosis and fungal:** clinically have indolent “chronic” course
- **immunosuppressed patients:** Mycobacteria and fungi
- **Polymicrobial infection:** common with decubitus ulcers and diabetic foot infections.

Tuberculous and Fungi Osteomyelitis

Tuberculous osteomyelitis:

- primarily results from:

1-hematogenous spread from lung foci

2-caseating lymph bone (50% in spine).

- It resembles Brucella osteomyelitis .

TB and Brucella are common in KSA

Fungi Osteomyelitis:

- Hematogenous osteomyelitis due to fungi

Examples:

- Candida species, Aspergillus species and other fungi may occur.

Diagnosis of chronic osteomyelitis:

1- Blood:

. Blood culture: is not very helpful because bacteremia is rare.

. WBC: usually normal.

. ESR: elevated but not specific.

2- radiology:

. MRI: helpful for diagnosis and evaluation of the extent of disease.(MRI excellent for chorionic osteomyelitis*)

. Radiological changes are complicated by the presence of bony abnormalities.

RIF= Rifampicin.
INH= Isoniazid.

Management & Treatment of chronic osteomyelitis:

★ Extensive surgical debridement (and then start) with antibiotic therapy.(because of long time infection & abscess formation)

★ **Antibiotics:**

. Parenteral antibiotics for 3-6 weeks followed by long term oral suppressive therapy.

. MSSA: Cloxacillin

. MRSA & S.epidermidis: Vancomycin then oral Clindamycin or TMP-SMX.

.Other bacteria: treat as acute osteomyelitis.

.Brucella :Tetracycline and Rifampicin for 2 to 3 months (6 Weeks)

. MTB: combination of 4 drugs : INH+RIF +Pyrazinamide & Ethambutol for 2 months followed by RIF + INH for additional 4 months. (Please Know them this is a possible question different between Brucella and TB)

. Some patients may require lifelong antibiotic ,others for acute exacerbations

Septic (infectious) arthritis

- an **acute inflammation** of the **joint space** secondary to infection.
- Generally affects a **single joint** and results in **suppurative inflammation.**
- May caused by bacteria or viruses commonly by **haematogenous seeding**

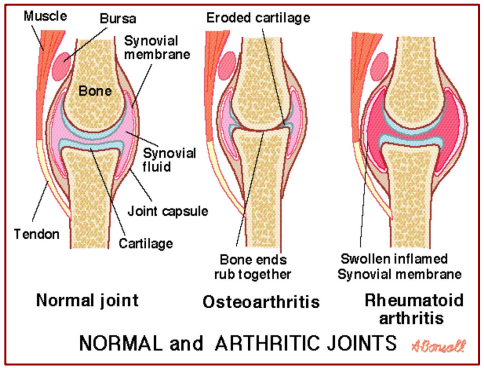
Haematogenous seeding = Blood borne spread = transmitted by blood circulation

Septic arthritis

How it happen ? When the joint space is blocked and there is contact of bones . Then Inflammation will take place and the synovial membrane will swallow

Arthrocentesis is procedure to maintain synovial fluid of the joint

- Symptoms :
  - **pain, swelling, limitation of movement.** (esp; in children)
- Diagnosis by :
  - **Arthrocentesis** to obtain synovial fluid analysis, Gram stain , culture & sensitivity.
- Management :
  - Drainage & antimicrobial therapy



Septic arthritis caused by ;

Bacteria

Age / special condition	Common organisms
Neonates	S.aureus , group B streptococcus , -Gram rods (eg.E.coli,klebsiella, proteus , pseudomonas)
Infants / children	S.aureus, group A streptococcus ,S.pneumoniae, H.influenzae type b
Adults	S.aureus,(Neisseria gonorrhoeae)
Sickle cell disease	Salmonella species, S.aureus
Trauma / surgery	S.aureus
Chronic arthritis	MTB , Fungi
Prosthetic arthritis	Skin flora ; S.epidermidis

Sexually transmitted disease

Chronic is always associated with TB or Fungi

Other causes of Septic arthritis ;

Viruses

Include: Rubella(rash) , Hepatitis B , mumps, Parvovirus B19(common), Varicella , EBV , Adenovirus ,..etc.

These are self limiting

It doesn't need treatment

Reactive arthritis due to(antigen-antibody complex) ;

- Campylobacter jejuni
- Yersinia enterocolitica
- Some Salmonella species

Non infectious causes of arthritis ;

- Rheumatoid arthritis
- Gout
- Traumatic arthritis
- Degenerative arthritis

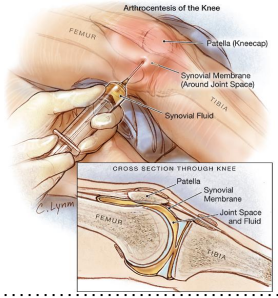
Risk Factors

Gonococcal (Maybe reactive)	Nongonococcal	Trauma procedures (arthroscopy) contiguous soft tissue	Lyme disease	Sickle cell disease	Chronic arthritis
-Most common in **young , sexually active adults** -caused by **Neisseria gonorrhoeae** -Leads to disseminated infection secondary to **urethritis/cervicitis** -Initially present with **polyarthralgia**, **tenosynovitis**, **fever**, **skin lesions** -If untreated leads to **suppurative monoarthritis**	Most common in **older adults** -caused by introduction of organisms into joint space as a results of bacteremia or fungaemia from infection at other body sites.	Most common cause **S.auros** Other organisms : **streptococci and aerobic Gram negative bacilli**	Due to tick bite in endemic areas(skin rash) uncommon in KSA	caused by **Salmonella species**	Due to **MTB** or **fungi**

Diagnosis of septic Arthritis

History/examination to exclude systemic illness. Note history of tick exposure in endemic areas

Arthrocentesis should be done as soon as possible;
1-Synovial fluid is cloudy and purulent ⟵ Normally is transparent
2- Leukocyte count generally > 25,000/mm3,with predominant neutrophils ⟵ Because it's acute inflammation
3- Gram stain and culture are positive in >90% of cases.(except in gonococal the percentage is smaller)
4-Exclude crystal deposition arthritis or noninfectious inflammatory arthritis.



Arthrocentesis is procedure to maintain synovial fluid of the joint

Blood cultures indicated

If Gonococcal infection suspected ;; **take specimen** from cervix, urethra, rectum & pharynx for culture

Investigation for other sexually transmitted diseases ;; **DNA testing** for N.gonorrhoeae

Culture of joint fluid and skin lesions

Management & Treatment

1- Surgical drainage / debridement

In some cases.

2- antimicrobial therapy

Depends on :-
1- suspected organism
2- sensitivity results

Gonococcal arthritis

IV Ceftriaxone (or Ciprofloxacin or Ofloxacin) then switch to oral Quinolone or Cefixime for 7-10 days.

Nongonococcal arthritis

1. MSSA: Cloxacillin or Cefazolin
2. MRSA: Vancomycin
3. Streptococci: Penicillin or Ceftriaxone or Cefazolin
4. Enterobacetriacae: Ceftriaxone or Fluroquinolone
5. Pseudomonas: Piperacillin and Aminoglycoside
6. Animal bite : Ampicillin-Sulbactam

Lyme disease arthritis

Doxycycline for one month

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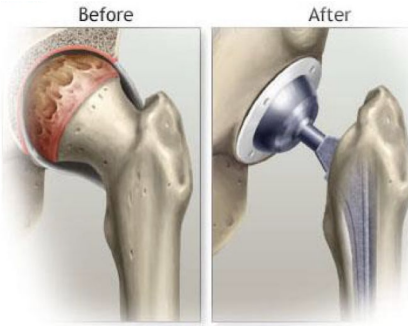
Prognosis & complication

Gonococcal arthritis → Excellent outcome

Nongonococcal arthritis → hip or shoulder involvement

Risk factors for long term adverse sequelae include: → Age - prior rheumatoid arthritis - polyarticular joint involvement - hip or shoulder involvement - virulent pathogens - delayed initiation or response to therapy



Infections of Joint Prosthesis

- Occur in 1 -5 % of total joint replacement.
- Most infections occur within 5 years of joint replacement.
- Often caused by skin flora.
- Diagnostic aspiration of joint fluid necessary .
- Result in significant morbidity and health care costs.
- Successful outcomes results from multidisciplinary approach.

Diagnosis of Prosthetic Arthritis

1-Aspiration & surgical exploration to obtain specimen for culture , sensitivity testing & histopathology.

. Skin flora regarded as pathogens if isolated from multiple deep tissue cultures.

2- Radiology:

. Plain X-ray: may not be helpful.

. Arthrography: may help define sinus tracts. (A series of joint infection after injection of contrast media)

. Bone scan: not specific for infection.

3-Blood:

ESR and C-reactive protein(CRP) may be high.

Management & Treatment of Prosthetic Arthritis

impregnated cement

1-Surgery: removal of prosthesis.

2-Antibiotics :

. impregnated cement during re-implantation

. Antimicrobial for 6 weeks:

. Begin empiric IV antibiotic to cover MRSA and Gram negative rods (Vancomycin, Cefepime, Ciprofloxacin, or Aminoglycoside)

. Chronic therapy with oral drug if removal of prosthesis not possible.

Spacers are made with bone cement that is loaded with antibiotics. The antibiotics flow into the joint and surrounding tissues and, over time, help to eliminate the infection.

Empiric therapy: is therapy based on experience and, more specifically, therapy begun on the basis of a clinical educated guess in the absence of complete or perfect information.

Summary

	Acute osteomyelitis	Chronic osteomyelitis	Septic arthritis	Joint Prosthesis
Type of infection ;	Acute	Chronic	Acute	-
Infection of ;	Bone and bone marrow	Bone and bone marrow	Joint space	Joint due to joint replacement
Caused by ;	S.aureus : is the most common pathogen In infants : group B streptococci , gram –ve rods Children: group A streptococci, Haemophilus (H.)influenzae.	-S.aureus : is the most common pathogen -Tuberculosis and fungal: clinically have indolent “chronic” course. -immunosuppressed patients: Mycobacteria and fungi -Polymicrobial infection: common with decubitus ulcers and diabetic foot infections	Bacteria / viruses	skin flora: S.epidermidis
Significant Symptom ;	-	-bony abnormalities. -sinus tracts	limitation of movement	sinus tracts
Diagnosis ;	Blood culture , Ultrasound findings for pediatrics, MRI in complicated cases.	MRI	Arthrocentesis	Arthrography
Management ;	Antibiotics , surgical drainage if needed	Extensive surgical debridement with antibiotic therapy	Drainage & antimicrobial therapy	Surgical debridement and prolonged antimicrobial therapy

Doctor's notes:

- In general Staph. Aureus is the most common cause of these infections,
  - Except in joints, paediatrics, and (adult patients sexually active ⟶ Neisseria gonorrhoeae).
- Infants have diff type of organisms ⟶ (Gram -ve, group B strepto) beside S.aureus .
  - When they grow little bit older (children), they will have (**Haemophilus influenzae**, S.aureus, group A).
- Acute Osteomyelitis:
  - Generally the infection common in children.
  - The routes of infection are blood borne, foreign body, animals bites, and deep injury, so by this the organism can inter the bone.
  - Metaphysis is the most serious part in infections, WHY?
    - Because lots of blood supplies there, so the infection can start there then spread to joints.
    - And it will affect the growth plate (growth of bone).
  - Acute infection will affect the bone and bone marrow, how the pathogen will reach there!?
    - 1- throw blood (hematogenous route)
    - 2- Contiguous ⟶ means from skin and soft tissue or by near organ, then the organism can reach the bone.
    - 3- it's associated more with people who has vascular diseases ⟶ it will decrease blood supply and this create good environment for the bacteria to pass, SPECIALLY anaerobes.
  - The infection might be gradual onset or acute onset.
  - Duration range between days to weeks.
  - Primary hematogenous infection mainly in children and infants:
    - In case of infants think about group B & E.coli as the causes.
    - In case of children H. influenzae is there because the child will lose the immunity (IgG) that coming from his/her mother.
  - Long bones mainly are the site of infection (in diaphysis) , other bones can be affected but it's less common.
  - This infection is less common in adults, however the most causes here is S. aureus .
  - Bacteremia: means the infection of blood.
  - Duration of treatment is long (4-6 weeks) ⟶ majority of infections (2 weeks mostly) ⟶ except few reach to (4-6 weeks) e.g joint infections, bone infections, and then TB is the long one (6-9 months) ⟶ so acute osteomyelitis is one of the serious infections.

Doctor's notes:

- Chronic osteomyelitis:
  - An acute osteomyelitis that didn't treated or wound infection that didn't treat well → it will develop to a chronic osteomyelitis → where there will be pus formation, and it's difficult to treat it.
  - S. aureus is the champion, and it's the most causes here.
  - Rifampicin used to treat MTB & brucella.
    - If u treat a patient that you suspect he have brucella by Rifampicin, but he have MTB → it will develop to resistance.
    - In KSA both of MBT & brucella are common, and Rifampicin was sold in pharmacies and described by doctors a lot → so TB became resistance.
- Septic arthritis:
  - Affect a single joints, not like inflammatory diseases (e.g Rheumatoid arthritis) → which usually affect multiple joints, but Septic arthritis means that cause by microbes (bacteria and viruses)
  - Joint infections is very serious, bacteria can cause liquidation of the joint → joint become like liquid → then the joint will lose its function → so you need to act quickly.
  - Will be swilling in synovial space due to accumulation of the suppurative fluid (suppurative inflammation), there will be lots of pus cells.
  - Prosthetic arthritis التهاب المفاصل الصناعية → caused by the normal flora of the skin (s.epidermidis, propionibacterium acnes, corynebacteria, s.aureus , bacillus. → these are the organism that can cause joint infection in case of prosthetic joints
  - The common virus that cause septic arthritis is Parvovirus B19 (and other hilarious viruses you can memorise it S.17)
    - The patient will have a systemic disease (rash, fever, etc.) in viruses cases.

MCQs

1) joint and bone infections are more common in ?

A)infants and children B) young. C) older people. D) in female

2) arthrocentesis is diagnostic procedure for ?

A)acute osteomyelitis. B) septic arthritis. C) chronic osteomyelitis. D) atherosclerosis

3) animal bite leads to nongonococcal arthritis is treated by ?

A) ampicillin. B) vancomycin. C) cloxacillin D) IV ceftriaxone

4) In case of Prosthetic Arthritis the doctor should use an empiric antibiotics that must cover which type of bacteria?

A) MRSA and aerobics B) Gram negative and aerobics C) Gram positive and anaerobics D) Gram negative and MRSA

5) the most common pathogen that can cause chronic osteomyelitis in immunosuppressed patients?

A)fungi B) streptococci C) Enterobacteriaceae D) Pseudomonas

1-A 2-B 3-A 4-D 5-A

SAQ Cases:

1) Patients come with severe pain and fever a blood test showed -ve. Physician had followed this by a biopsy to the periosteum abscess and culture the organism of the cause was identified as MSSA what is your treatment plan? (please note it is acute OM)

A) Give Cloxacillin.

2) Patients come with severe pain and fever a biopsy a blood test showed -ve. Physician had followed this by a biopsy to the periosteum abscess and culture the organism of the cause was identified as MRSA what is your treatment plan? (please note it is acute OM)

A) Give Vancomycin.

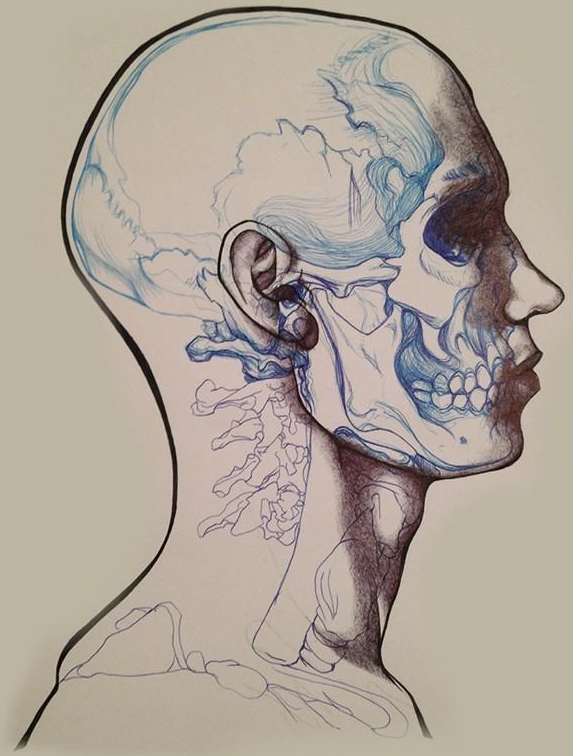
3) 25 Yr old patient present with joint swelling and pain , other complains includes urethral discharge. The patient is not married, has travelled lately, lymes disease test showed -ve. What is the disease and what is the organism of the cause and what treatment should be given?

Disease: Gonococcal infectious arthritis.

Organism: Neisseria Gonorrhoeae, treatment: Ceftriaxone

"We cannot fathom the marvelous complexity of an organic being; but on the hypothesis here advanced this complexity is much increased. Each living creature must be looked at as a microcosm--a little universe, formed of a host of self-propagating organisms, inconceivably minute and as numerous as the stars in heaven."

— Charles Darwin



Thank You

Badr Al-Qarni

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