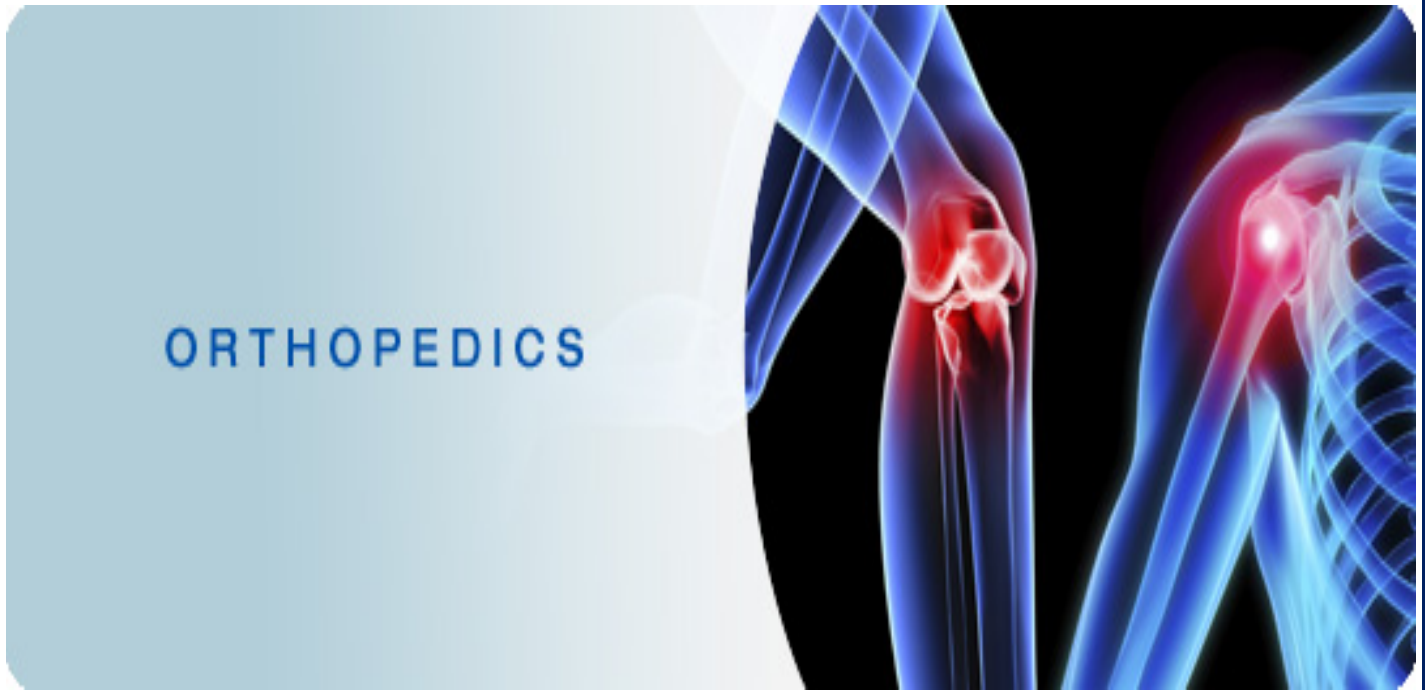


Isn't it funny how someone can say "I believe in Allah " but still follow the Satan who by the way also, " believes " in Allah...

430 ORTHOPEDICS TEAM



Lecture: Bone and Joint Infections

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-The slides were provided by the doctor.

-Important notes in **Red**. -429 (A) in **orange**.

-Copied slides in **Black**. -Doctor's notes in **green**.

Introduction:

- Bone infections are considered one of the red flags because if you ignore them, they may affect patient's life (he may die). Also, they are easily preventable just by giving the right treatment at the right time & they are very obvious (clear to identify).

- Initial treatment → based on presumed infection type → clinical findings and symptoms.
- Definitive treatment → based on final culture.
- ✓ **Glycocalyx:** [It's a polysaccharide formed by the bacteria around metal implants (e.g. prosthetic knee) to protect themselves against the immunity, usually the treatment is not completed unless the metal is removed.
 - exopolysaccharide coating.
 - envelops bacteria.
 - enhances bacterial adherence to biologic implants.

Bone Infections:

1. **Osteomyelitis.** [oste= bone , myel= bone marrow , itis= inflammation]

2. **Septic arthritis.**

3. **Infected Total Joint Arthroplasty.**

-Mostly OM is treated medically by Abx unless there is pus.
-While waiting for the culture results (take 3-5 days) always start with broad spectrum empirical Abx depending on the most common organism in this area.

1] Osteomyelitis [OM]:

- Infection of bone and bone marrow.
- Route of infection.
 - Direct inoculation → Open fractures, e.g. inserting the bacteria while you are giving an injection to a patient with tendonitis. [from the environment]
 - Blood-borne organisms → Haematogenous. [most common]
- Determination of the offending organism
 - A. NOT a clinical diagnosis. [It's → Microbiological diagnosis , that is why deep culture is essential. So, before you start giving the empirical Abx, you have to take a sample for culture because after 2-3 days if the patient isn't responding, you can adjust your Abx according to the culture that you send 5 days ago]
 - B. DEEP CULTURE is essential.
- Classification: [It's important to know the severity & to choose the right treatment]
 - A. Acute hematogenous OM.
 - B. Acute OM.
 - C. Subacute OM.
 - D. Chronic OM

A. Acute Hematogenous OM: [No Hx of trauma , open wound or injections (nothing from outside) before 2 weeks]

Case: child, Hx of sore throat 2 weeks ago. He was ok but 5 days ago he started to limp then unable to walk. He is febrile & look sick [acute presentation]



❖ **Clinical Features:**

- Caused by blood-borne organisms.

- **More common in children.**

b/c they are rich blood supplied areas.

- **Boys > girls.**

- Most common in long bone metaphysis or epiphysis.
- Lower extremity >> upper extremity.

- **Pain.**[localized]
- **Loss of function of the involved extremity.** (e.g. if it's in the upper extremity he will not be able to shake hands, eat, wave & move...)
- Soft tissue abscess.[**Redness/swelling**][localized to the site of infection especially at the beginning].
- **Fever.**



❖ **Radiographic Changes:**[x-ray is **not** a diagnostic tool]

- **Soft tissue swelling (early sign).**[the only sign you're going to see in acute presentation]
- Bone demineralization (10-14 days).
- **Sequestra** → dead bone with surrounding granulation tissue. which looks in the X-ray as a white area within a black area. The black area is the infection while the white area is the necrotic bone → **late sign.**[It has to be removed in the OR b/c mostly it won't resolve by itself otherwise they will become a source of infection]
- **Involucrum** → periosteal new bone. which looks in the X-ray as if the cortex of the bone is doubled with a black space, separates the 2 layers → **late sign.**

Taking a sample from the throat to know the organism doesn't help b/c it is usually different organism. Also, the culture will take 5 days either you take it from the bone or throat. So, there is no benefit.

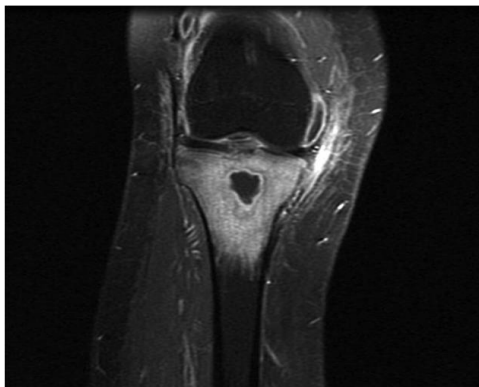
❖ Diagnosis:

- Elevated WBC count.
- Elevated ESR.[takes almost 3 weeks to peak up]
- Blood cultures → may be positive.
- **C-reactive protein (CRP)**:[very important for diagnosis & follow up of treatment, it takes 5 days to peak up]
 - **Most sensitive monitor of infection course in children.**
 - Short half-life.
 - Dissipates in about 1 week after effective treatment

Case about CRP: If you have a young patient with a history of frequent travelling abroad (these people have tendency to have multiple organisms) & you gave him a broad spectrum first generation cephalosporin, in 5 days the patient still spiking fever & he doesn't look well (this mean that you don't treat the right organism with the right Abx) & the clinical examination suggesting that he isn't responding , what you are going to do??

-Request CRP & it will peak up within 5 days & if the patient isn't responding to Abx , you have to change it otherwise he will go into septic shock & die.

- Nuclear medicine studies (bone scan)→ may help when not sure. [there will be high uptake(reactive area)but it is **not specific** (it just give a clue) b/c it could be soft tissue, bone infection or pathology other than infection like tumor]
- MRI:[**the best diagnostic/sensitive tool** but it takes time to arrange, children need to be anesthetized][**MRI is the most sensitive for infection**]
 - Shows changes in bone and bone marrow before plain films
 - Decreased T₁-weighted bone marrow signal intensity.
 - Increased postgadolinium fat-suppressed T₁-weighted signal intensity
 - Increased T₂-weighted signal relative to normal fat.



There is increase signal intensity of the proximal tibia which indicates OM of proximal tibia.

❖ **Treatment Outline:** [Mostly with broad spectrum Abx at first then change to specific Abx after the culture except in some indications. So, it's treated medically most of the time not surgery].

- Take samples for culture.
- **Start empirical broad-spectrum Abx.**
- Observe improvement with clinical parameters (Temp, pain) and blood tests (ESR,CRP).
- Review culture results **within 3-5 days**, if you find discrepancy between what you thought is the organism & the culture result then you have to think either you need to adjust your Abx or not and proceed accordingly.

Case:

Pt is suspected to have OM and you admit him & started to give him empirical Abx because you thought that it is S.aureus as it's the most common organism. However the culture showed that the organism is not covered by your Abx>> what should you do?

If the pt is improving clinically(symptoms) + Lab test (CRP going down) to your Abx don't change it even if the sensitivity test shows that the organism isn't sensitive to the ABx. If there is not improvement change it.

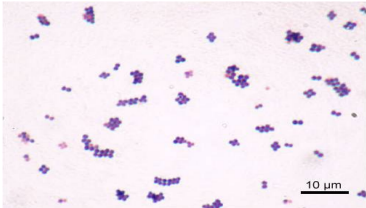
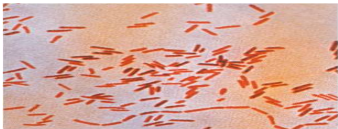
- Decide on duration of Abx (IV vs oral).

[Duration mostly complete 6 weeks, sometimes start with IV for few weeks and then orally and sometime all the 6 weeks IV→ depends on the severity ,immunocompromised pt,...ect]

e.g.: young ,no medical problems barely acute presentation→ 3 weeks is enough. While if he is old with HTN,DM and renal failure → max (6weeks).

- **Empirical Treatment:**[is the one you give w/o definitive diagnosis or organism]
- Before definitive cultures become available.
- Based on patient's age and other circumstances.
 - The most common organism in all age groups is S.aureus. So, what you need to think about is the second organism in each age.



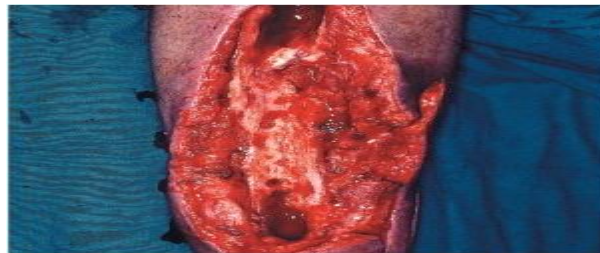
	Organism	Empirical Tx	Notes
Newborn [0-4 months]	<ul style="list-style-type: none"> ▪ <i>Staphylococcus aureus</i>(most common) ▪ Gram-negative bacilli. ▪ Group B streptococcus. 	Broad Spectrum Abx	<ul style="list-style-type: none"> ▪ Immunity is not fully Developed→ so they may be Afebrile(don't have fever), Cry.[difficult to dx] ▪ 70% positive blood Culture before Abx, not aspiration from bone or deep tissue. .[other age groups are less] -You may find some swelling. -can't localize the pain, wherever you touch the baby, he will cry.
Children [>4 months]	<ul style="list-style-type: none"> ▪ <i>S. aureus</i> (most common). ▪ Coliforms → (uncommon → Vaccnine) 	Broad Spectrum Abx	<ul style="list-style-type: none"> ▪ Haemophilus influenza Boneinfections→ almost Completely eliminated → due to Vaccination.
Adults [≥21 years old]	<ul style="list-style-type: none"> ▪ <i>S. aureus</i>(most common). ▪ Wide variety of other organisms have been isolated [especially in people who have abnormal life style.] 	Broad Spectrum Abx	
Sickle Cell Anemia	<ul style="list-style-type: none"> ▪ <i>Salmonella</i> is a characteristic (most specific) organism – but not the most common ▪ <i>S.aureus</i> is still the most common. 	Broad Spectrum Abx	
Hemodialysis and IV drug abuser	<ul style="list-style-type: none"> ▪ <i>S. aureus</i> ▪ <i>S. epidermidis</i>[b/c usually the problem come from the skin] ▪ <i>Pseudomonas aeruginosa</i> 	Broad Spectrum Abx	They are treated aggressively (combining 2-3 Abx or one but Very tough Abx)b/c they are considered as immunocimpramised patients.

- **Operative Treatment:**

- Indications for operative intervention:
- ✓ Drainage of an **abscess**.
- ✓ Débridement of infected and necrotic tissues → **sequestrum** → prevent further destruction.
- ✓ Refractory cases that show **no improvement** or the patient is getting worse **after nonoperative treatment**.

B. Acute OM:

- **After open fracture or open reduction with internal fixation.**[injections]
- ❖ **Clinical findings**→**similar to acute hematogenous OM.**[same presentation the only difference is the treatment]
- ❖ **Treatment:**
- ✓ **Radical I&D** [Irrigation & Debridement], remove anything looks like dirty or died tissue→**SURGERY.** [b/c infection after open fractures tends to be chronic also you want to prevent the infection before its happening that why you start aggressively by surgery].
- ✓ Removal of orthopaedic hardware if necessary.
- ✓ Soft tissue coverage for open wounds → if needed. [The bone must be covered to prevent infection and if it's infected it will get worse].



- ❖ **Most common offending organisms are:**
- **S. aureus.**
- P. aeruginosa.
- Coliforms.
- ❖ **Empirical therapy** → Broad-spectrum Abx.

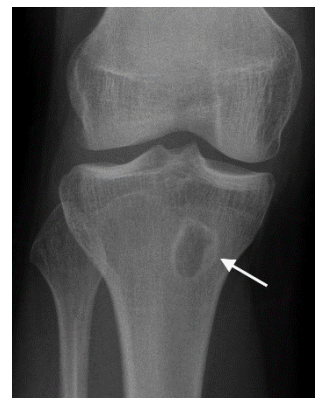
C. Subacute OM:

❖ Diagnosis [Usually]:

- Painful limp.[mild]
- **No systemic and often no local signs or symptoms.**
- Signs and symptoms on plain radiograph.
 - May occur in:
 - Partially treated acute osteomyelitis.
 - Occasionally in fracture hematoma.
 - **Frequently normal tests:** [usually results appear normal]
- **WBC count.**
- **Blood cultures.**

❖ Usually useful tests:

- ✓ ESR.
- ✓ Bone cultures.
- ✓ Radiographs → **Brodie's abscess** (the arrow) → localized radiolucency seen in long bone [femoral,tibia]metaphyses → difficult to differentiate from Ewing's sarcoma.

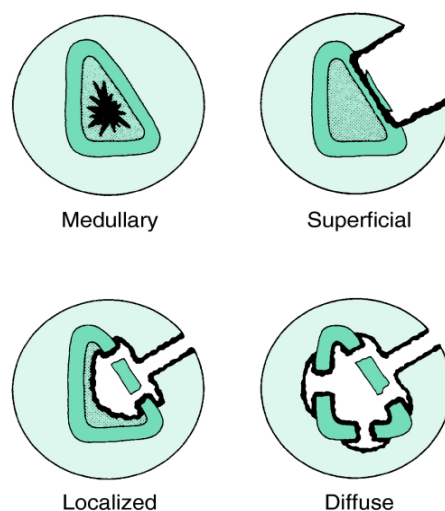


❖ Treatment:

- **Most commonly involves femur and tibia.**
- **It can cross the physis even in older children.**
- **Metaphyseal Brodie's abscess → surgical curettage.**

D. Chronic OM:

- Can arise from:
 - Inappropriately treated acute osteomyelitis
 - Trauma
 - Soft tissue
- Anatomical classification → check fig.[not imp]
- **Population at risk:**
 - ✓ **Elderly.**
 - ✓ **Immunosuppressed patients.** (e.g. rheumatoid arthritis)
 - ✓ **Diabetic patients.**
 - ✓ **IV drug abusers.**
 - ✓ **Hemodialysis patient.**



❖ **Most common organisms:**

- **S. aureus.**
- Enterobacteriaceae.
- P. aeruginosa.

❖ **Clinical Features:** [not acute presentation & mostly no fever/some pain/some loss of function]

- **Skin and soft tissues involvement.**[pus discharge]
- **Sinus tract** → may occasionally develop squamous cell carcinoma.[b/c of the chronic irritation]
- Periods of quiescence → followed by acute exacerbations.[means they don't present the same for the whole period, they recover and then relapse ...so on]



Sonogram: It is a special X-ray procedure that is done with contrast dye to visualize any abnormal opening (sinus) in the body. If the dye reaches the bone that means it is chronic OM.

❖ **Diagnosis:**

- Nuclear medicine → activity of the disease
- Best test to identify the organisms → Operative sampling of deep specimens from multiple foci.

❖ **Treatment:** [Should Be Based on the Culture]

- **Empirical Therapy** → is not indicated. **MCQ** [wait for the culture unless it is acute in-top if chronic]
- IV antibiotics → must be based on deep cultures.



- **Surgical Debridement:** [imp to remove the implant]
- Complete removal of compromised bone and soft tissue
- Hardware:
 - Most important factor.
 - Almost impossible to eliminate infection without removing implant. [If you can't remove the implant e.g. patient with fractured ankle . You wait until the fractured heal & then take it out & then do your aggressive treatment & Abx. If you can't & the patient started to develop septicemia or septic shock, you need to transform your implant by removing it & put external fixture but don't leave the fracture loose & mobile].
 - Organisms grow in a glycocalyx (biofilm) → shields them from antibodies and antibiotics.
- Bone grafting and soft tissue coverage is often required.
- Amputations are still required in certain cases.
 - Treatment is to open & clean the abscess & if you can take culture.

2] Septic Arthritis: [mostly treated surgically b/c the cartilage is very sensitive to infection, So if it was leaved for a few hours to a day the cartilage will be gone forever→ take the patient to the OR and wash it out]

- Route of infection:
 - Hematogenous spread.
 - Extension of metaphyseal osteomyelitis in children.
 - Complication of a diagnostic or therapeutic joint procedure.
- Most commonly in infants (hip) and children.
- **Metaphyseal osteomyelitis can lead to septic arthritis in:** [areas where it's near the cartilage (within the joint capsule).
 - ✓ Proximal femur [e.g. greater trochanter]→ most common in this category.
 - ✓ Proximal humerus.[suspect the shoulder is also affected].
 - ✓ Radial neck.
 - ✓ Distal fibula. (ankle).

- Adults at risk for septic arthritis are those with:
 - ✓ RA → Due to joint effusion, Synovium is always inflamed & the immunity is compromised.
 - Tuberculosis → most characteristic
 - *S. aureus* most common
 - ✓ IV drug abuse → *Pseudomonas* most characteristic, but not the most common.
- Case: Pt has septic arthritis in the elbow
→ Suspect RA
- ❖ **Treatment Outline:** 1st → OR (surgery : open or orthoscopic & take sample for culture) 2nd → Empirical Abx & after 3-4 days you will get the result & adjust according to it.
 - **Empirical therapy:** [**After the surgery**][if the patient has OM and SA is suspected take him to the OR, SA has the priority]
 - Prior to the availability of definitive cultures.
 - Based on the patient's age and/or special circumstances.
 - **Newborn (up to 3 months of age):**
 - ✓ Most common organisms:
 - *S. aureus*.
 - Group B streptococcus.
 - ✓ Less common organisms:
 - Enterobacteriaceae.
 - *Neisseria gonorrhoeae*.
 - 70% with adjacent bony involvement.
 - Blood cultures are commonly positive.
 - Initial abx **after** surgical wash out → broad-spectrum Abx.
 - **Children (3 months to 14 years of age)**
 - ✓ Most common organisms:
 - *S. aureus*.
 - *Streptococcus pyogenes*.
 - *S. pneumonia*.
 - *H. influenzae* → markedly decreased with vaccination.
 - Gram-negative bacilli.
 - Initial treatment → broad-spectrum Abx.

- **Acute monarticular septic arthritis in adults:** [severity depends on how many joint is involved, if monarticular = less serious while if polyarticular = more serious].

✓ Most common organisms:

- *S. aureus*
- *Streptococci*
- *gram-negative bacilli*

– Antibiotic treatment → broad-spectrum Abx

- **Chronic monarticular septic arthritis**

✓ Most common organisms:

- *Brucella*
- *Nocardia*
- *Mycobacteria*
- *fungi*

- **Polyarticular septic arthritis:**

✓ Most common organisms:

- *Gonococci*
- *B. burgdorferi*
- *acute rheumatic fever*
- *viruses*

○ **Surgical Treatment:**

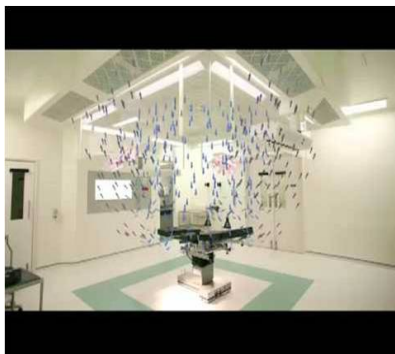
- Mainstay of treatment.
- **Surgical drainage → open or arthroscopic.** [Arthoscopic is used more b/c it is less invasive, can reach difficult places, same results as open] when you are asked what is better? **Say the results are comparable and you can do either.**
- Daily aspiration [not recommended].
- Tuberculosis infections → pannus → similar to that of inflammatory arthritis. [not imp]
- Late sequelae of septic arthritis → soft tissue contractures **It's a problem even after cleaning the joint** → may require soft tissue procedures (such as a quadricepsplasty **to be able to bend the knee**). [not imp].

-Just remember that the treatment of choice for SA is surgery (either open or arthroscopic) & give empirical Abx after the surgery.

3] Infected Total Joint Arthroplasty [TJA]: [always when there is a metal you are afraid of infection, most common knee then hip & shoulder].

❖ **Prevention:** [measures to avoid infection] [the best Treatment is prevention].

- Perioperative intravenous antibiotics → most effective method for decreasing its incidence.
- Good operative technique
- Laminar flow → avoiding obstruction between the air source and the operative wound.
- Special “space suits”.
- Most patients with TJA do not need prophylactic antibiotics for dental procedures.
- Before TKA revision → knee aspiration is important to rule out infection. [so if there is any sign of infection e.g scratch don't start TKA procedure]



Laminar flow



Special “space suits”

❖ **Most common pathogen:**

- *S. epidermidis* → most common with any foreign body. [b/c the problem comes from the skin].
- *S. aureus*.
- Group B streptococcus.

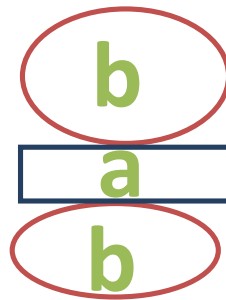
❖ **Diagnosis:**

- ESR → most sensitive but not specific.
- Culture of the hip aspirate → sensitive and specific.
- CRP may be helpful.
- Most accurate test → tissue culture.
- Preoperative skin ulcerations → ↑ risk.

❖ Treatment Outline:

- **Acute infections** [within 2-3 weeks of arthroplasty]: [Just wash it out & take the insert out & replace it].
 - Prosthesis salvage → stable prosthesis.
 - Exchange polyethylene [a plastic material] components.
 - Synovectomy → beneficial.
- **chronic TJA infections** [>3 weeks of arthroplasty]:
 - Implant and cement removal. [to replace the metal, take it out & put a new one].
 - Staged exchange arthroplasty.
 - Glycocalyx:
 - ✓ Formed by polymicrobial organisms.
 - ✓ Difficult infection control without removing prosthesis and vigorous debridement.
 - Helpful steps:
 - ✓ Use of antibiotic-impregnated cement.
 - ✓ Antibiotic spacers/beads.

- 1-Take out all the implant.
- 2-Put a. Polyethylene (to prevent soft tissue contraction) and b. Cement is mixed with Abx and placed in the joint.
- 3-After infection is over.
- 4-Place a new implant.



The doctor mentioned these scenarios at the end of the lecture:

1- You have a patient who is 30 years old, drug abuser came to the ER because of limping, inability to walk, fever & pain. What are you going to do?

- Hx. - Physical EX. BP=80/40. The doctor mentions that he is in septic shock. So, he will start very aggressive Abx & IV fluid & take the patient to the OR ASAP.

Let us assume that the patient was taken to the OR, it was septic arthritis with distal femur OM, you washed it out & you debrided the joint. Everything was good & the patient stabilized a little bit & you took him back to his room. What are you going to do now??

-continue on Abx & monitor his response by clinical exam, vital signs, WBC, ESR, CRP.

- The second day you find the patient looks better than before but the vital sign is still spiking fever & CRP is still high. So, you give broad spectrum ABx or add another Abx to the one you already gave.

