Osteomyelitis:

- Hematogenous Osteomyelitis
  - Metaphyseal long bone (more common in children)
  - Vertebral spine (Spondyloiddiscitis)
  - Usually monomicrobial
- Contiguous Osteomyelitis
  - Trauma / osteofixation
  - Diabetic foot ulceration
  - Often polymicrobial

Osteomyelitis: General Principles

- MRI and CT are the best radiographic studies
  - Bone scan has good negative predictive value but lacks specificity
  - MRI and CT not useful as test of cure
- Diagnosis best confirmed by bone histopathology and culture
  - Identification of organism improves outcomes
  - Swab cultures of drainage are of limited value
- Optimal route and duration of therapy an evolving target
  - 6 weeks of IV antimicrobial therapy commonly employed
  - Longer oral suppression considered in setting of retained hardware

Brodie's Abscess
(Subacute hematogenous osteomyelitis)

- More common in children and young adults
- Bacteria deposit in medullary canal of metaphyseal bone, become surrounded by rim of sclerotic bone → intrasosseous abscess
- "Penumbra sign" on MRI
  - Granulation tissue lining abscess cavity inside bone gives appearance of double line
- Staph aureus most common

Case #1

- 57 year old male presented with a 3 month history of progressive lower back pain
- On ROS denied fevers or chills but wife noticed weight loss
- Originally from Cambodia, emigrated as a child. Employed at a seafood processing plant
- ESR 84 CRP 16
- MRI with discitis and osteomyelitis at L5-S1
- Blood cultures grew Staph epidermidis in 2 of 4 bottles
Case #1: Vote
What is the best next step in management?
A. Repeat 2 sets of blood cultures
B. Initiate vancomycin; place PICC for six week treatment course
C. Obtain interferon gamma release assay
D. Percutaneous biopsy of disc space
E. Empiric treatment with rifampin, isoniazid, ethambutol, and pyrazinamide

Pyogenic Vertebral Osteomyelitis: diagnosis
• Blood cultures (positive in 60%)
  – No further diagnostics if Staph aureus or Staph lugdunensis
• Brucella serologies, PPD/IGRA
  – In appropriate epidemiological setting
• Percutaneous biopsy (paraspinal or bone/disc space)
  – When blood cultures and serology negative
  – Yield 36-65%
  – In absence of sepsis and/or neurologic compromise, withhold antibiotics 1-2 weeks if feasible
  – If negative repeat percutaneous or consider open procedure (open procedure higher yield)

Pott’s Disease
• Clinically:
  – More indolent than pyogenic osteomyelitis
  – Constitutional symptoms common
  – Anterior collapse may lead to gibbus deformity
• Radiographic:
  – Thoracic>lumbar with anterior involvement
  – Relative sparing of the disc space until later
  – Multi-level disease, large paraspinal abscesses
• Treatment:
  – Conventional TB therapy, 6-12 months
  – Surgery often not necessary

Septic Arthritis: Clinical Pearls
• Synovial fluid cell counts: No diagnostic threshold
  – Higher probability of SA if WBC >50,000/mm³
  – Lower cell counts do not exclude septic arthritis
• More subtle presentations in immunocompromised hosts and with indolent organisms
  – Subacute history
  – Lower synovial fluid cell counts
• Negative cultures and/or delayed culture positivity:
  – think Gonococcus, HACEK, Lyme, Mycoplasma

Polyarthritis
• 10-20% of septic arthritis is polyarticular:
• Associated with bacteremia/sepsis
  – Staph aureus most common (look for endocarditis)
• Streptobacillus moniliformis
  – Rat bite fever (fever/rash)
  – Polyarthritis, usually symmetric
  – If bitten in Asia – Spirillum minus
  – Rx: penicillin
• Consider also:
  – gonococcal, viral, non-infectious
Gonococcal Arthritis

- Tenosynovitis, arthralgias, skin lesions
  - Especially extensor surface tenosynovitis
  - Migratory arthralgias
- Purulent arthritis
  - May be polyarticular, knees most common
  - Lower synovial fluid cell counts more common
- Asymptomatic mucosal phase predisposes
  - Dissemination more common in women
- Highest yield diagnosis: mucosal site sampling (cervical, urethral)
  - Blood (<30%) and synovial fluid (<50%) cultures lower yield
  - Compatible clinical syndrome

Viral arthritides

- Symmetric polyarthritides, often involving small joints, often associated with fever and rash
- Diagnose serologically (+IgM or 4 fold rise in IgG titer)

<table>
<thead>
<tr>
<th>Most common viruses to cause arthritis</th>
<th>Clinical and Epidemiologic Clues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubella</td>
<td>Non-immune (non-US born): See cervical lymphadenopathy, fever; rash</td>
</tr>
<tr>
<td>Parvovirus B19</td>
<td>More common in women; history of exposure to young children, often a teacher or parent; Hands most common; can be severe</td>
</tr>
<tr>
<td>Hepatitis B Virus</td>
<td>Serum sickness like reaction, resolves with development of jaundice; also polyarteritis nodosa (PAN)</td>
</tr>
<tr>
<td>Hepatitis C Virus</td>
<td>Immune complex arthritis associated with cryoglobulinemia</td>
</tr>
<tr>
<td>Varicella (eg Chikungunya)</td>
<td>Travel to endemic areas</td>
</tr>
</tbody>
</table>

Crystalline arthritis: clinical pearls

- Acute gout flare mimics septic arthritis (fever)
  - Clues: rapid onset (hours), history of gout, alcohol, CKD, diuretics, elevated uric acid
  - Synovial WBC 10,000-100,000/mm³
- Crystalline disease and septic arthritis can coexist (esp. CPPD)
  - CPPD rarely has cell count >30,000

Masquerading as Infection...

- Other noninfectious causes of arthritis:
  - Reactive arthritis
    - Following enteric or genitourinary infection
    - Asymmetric mono or oligo-arthritis affecting knees/ankles
    - Associated features: arthritic (tendon insertion), dactylitis (sausage digits), mucosal lesions, urethritis, conjunctivitis/uveitis, skin lesions
    - Keratodema blennorrhagica
  - Still’s disease
  - Sarcoid (Loefgren’s)
  - Polymyalgia rheumatica
  - Many others….

Osteofixation Infections

- 44 year old woman, previously healthy, suffered a right ankle closed pilon fracture
  - Open reduction and internal fixation
  - Impaired wound healing
    - Chronically discharging wound despite courses of cephalexin and trimethoprim-sulfamethoxazole
  - 3 months after ORIF, wound culture grows methicillin-susceptible Staph aureus
**Case #2: Vote**

What are your next steps?
A. Nafcillin followed by long-term trimethoprim- sulfamethoxazole
B. Hardware removal; six weeks of oxacillin
C. Hardware removal; six weeks of oxacillin and rifampin
D. Debridement without hardware removal; six weeks of oxacillin and rifampin
E. Debridement and hardware replacement; six weeks of oxacillin and rifampin

**Osteofixation Infections**

- Infection risk as high as 25% and varies based on:
  - Open fractures (type and inoculum of bacterial contamination)
  - Severity of fracture (Gustilo grade)
  - Severity of soft tissue injury
  - Fracture location (lower extremity higher risk)
  - Timely antibiotic prophylaxis for open fractures
  - Usual host risk factors

**Prosthetic Joint Infection**

- **Prosthetic Joint Infection (PJI): Clinical presentations**
  - Early surgical site infection (< 3months)
    - Acute onset of fever, joint pain, swelling
    - Caused by virulent organisms (Staph aureus)
  - Delayed / Subacute infection (3 – 24 months)
    - Insidious onset of pain; fever is uncommon
    - Less virulent organisms: e.g. Coagulase-negative Staph, Cutibacterium
  - Acute hematogenous infection
    - Acute onset of fever, joint pain, swelling in previously healed and pain-free joint
    - Hematogenous seeding, virulent organisms (Staph aureus, Streptococcus)

- **Chronic PJI: diagnostic pearls**
  - ESR/CRP may be minimally elevated
  - Plain films often normal or may show periprosthetic lucency
  - Synovial fluid aspiration the best test
    - Lower cell counts than in native joints or acute PJI (> 3000 WBCs per μL)
    - Yield of synovial fluid culture 50-60%
      - Reduced by prior antibiotics
    - Coagulase-negative Staph can be considered pathogenic if in >1 culture and compatible cell counts
Case #3

- A 57 year old woman with a history of diabetes, hypothyroidism, and anxiety has undergone total hip replacement. Three weeks postoperatively, she developed erythema, swelling, and incisional drainage. She was taken back to the operative room, where she was found to have purulent infection within the joint pseudocapsule. The polyethylene liner was exchanged but acetabular and femoral components were secure and maintained in place. Operative cultures have grown methicillin-sensitive Staph aureus.

Case #3: Vote

You are asked to provide recommendations about antimicrobial management

A. Nafcillin for six weeks
B. Cefazolin and rifampin for six weeks
C. Cefazolin for four weeks followed by minocycline for two months
D. Cefazolin and rifampin for four weeks followed by minocycline and rifampin for two months
E. Vancomycin for six weeks followed by doxycycline for six months

PJI Management

<table>
<thead>
<tr>
<th>Surgical Procedure</th>
<th>Most appropriate for:</th>
<th>Antimicrobial Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debride and retain with exchange of polyethylene liner</td>
<td>Acute infections (early and late); well fixed components</td>
<td>2-8 weeks IV antibiotics; 3-6 months oral*, including rifampin if Staph</td>
</tr>
<tr>
<td>1 stage exchange (hips)</td>
<td>Acute infections; subacute infections with healthy soft tissues; sensitive organisms</td>
<td>2-8 weeks IV antibiotics; 3-6 months oral*, including rifampin if Staph</td>
</tr>
<tr>
<td>2 stage exchange “Spacer” utilizing antibiotics in cement</td>
<td>Chronic infections</td>
<td>6 weeks IV or highly bioavailable oral</td>
</tr>
</tbody>
</table>

*3 months for hips; 6 months for knees

Case #4

- A 63 year old woman with rheumatoid arthritis is anticipating knee arthroplasty. She takes methotrexate, hydroxychloroquine and low dose prednisone (2.5 mg daily). She has a history of recurrent urinary tract infections. She asks how she might prevent infection after knee replacement.

Case #4: Vote

What do you advise?

A. Stop methotrexate and prednisone two weeks preoperatively
B. Screen for Staph aureus colonization; decolonize if present
C. Screening UA and urine culture, treat if positive
D. 48 hours perioperative prophylaxis with cefazolin
E. Amoxicillin prior to dental procedures for 2 years postoperatively

Prevention of PJI

- Immunosuppressives:
  - Stop TNF agents, no need to stop DMARDs or low dose prednisone
- Surgical antibiotic prophylaxis: one dose prior to surgery
- Urinary tract infections:
  - Diagnose and treat symptomatic UTI; no role to screen for asymptomatic bacteriuria
- Dental prophylaxis: No more!
- Staph aureus decolonization reduces surgical site infection
Case #5

- 56 year old man presents to ED with 1-2 week history of atraumatic right knee pain and swelling and low grade fevers; weight bearing is now very uncomfortable.
- He has poorly controlled diabetes. One month ago he travelled to the Dominican Republic where he swam in the ocean, recalls receiving several insect bites. He owns a pet kitten, last saw a dentist three months ago, and denies injection drug use.
- On exam, he has pain with passive range of motion and a moderate effusion.
- ESR 68  CRP 17 mg/dL
- Synovial fluid: 45,000 WBCs (82% neutrophils)
- Negative gram stain

**Microbiology of Musculoskeletal Infections**

**Case #5: Vote**

Culture growth at 3 days incubation

What is the most likely organism?

A. Stenotrophomonas maltophilia  
B. Salmonella heidelberg  
C. Staphylococcus aureus  
D. Kingella kingae  
E. Pasteurella canis

**Microbiology of Bone and Joint Infections: clinical and epidemiologic clues (1)**

<table>
<thead>
<tr>
<th>Gram Negative Organisms</th>
<th>Clinical Clues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>Immunosuppressed host, indwelling line, history of infection/drug use (IDU)</td>
</tr>
<tr>
<td>HACEK organisms</td>
<td>Human bite wounds (Eikenella corrodens)</td>
</tr>
<tr>
<td>Kingella kingae (in HACEK)</td>
<td>Common in children &lt;4yo.</td>
</tr>
<tr>
<td>Pasteurella species</td>
<td>Cat or dog bite</td>
</tr>
<tr>
<td>Salmonella species</td>
<td>Sickle cell disease, diabetes, immunocompromise \ Reptile exposure. Travel to developing world or unsafe food hygiene. +/- antecedent GI illness</td>
</tr>
<tr>
<td>Brucella species</td>
<td>Consumption of unpasteurized dairy; travel to endemic areas (Latin America, Mediterranean and Middle East); Sacroiliitis and spondylodiscitis</td>
</tr>
<tr>
<td>Stenotrophomonas (Stenotroph)</td>
<td>Rat bite</td>
</tr>
</tbody>
</table>

**Microbiology of Bone and Joint Infections: clinical and epidemiologic clues (2)**

<table>
<thead>
<tr>
<th>Other bacteria and mycobacteria</th>
<th>Clinical Clues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neisseria gonorrhoeae</td>
<td>Triad of Tenosynovitis, Dermatitis, Arthritis</td>
</tr>
<tr>
<td>Mycoplasma species</td>
<td>Humoral immunodeficiency (CVID, XLA) Postpartum women. Difficult to grow in routine culture. &quot;Fried egg&quot; morphology in culture</td>
</tr>
<tr>
<td>Nontuberculous mycobacteria</td>
<td>Subacute monoarthritis of large joints (knee most common) with large effusions.</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>Subacute to chronic meningitis, long bone osteomyelitis (osteitis). Sarcoidosis.</td>
</tr>
<tr>
<td>Non-tuberculous mycobacteria</td>
<td>Environmental water exposure (fishermen, fish tanks). Tendinopathy of hands</td>
</tr>
</tbody>
</table>

**Microbiology of Bone and Joint Infections: clinical and epidemiologic clues (3)**

<table>
<thead>
<tr>
<th>Fungal Infections</th>
<th>Clinical Clues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Candida species</td>
<td>Common in immunocompromised host (IDU)</td>
</tr>
<tr>
<td>Molds</td>
<td>Molds are fast (bacterial) vs. slow (molds)</td>
</tr>
<tr>
<td>Coccidioides species, Blastomyces dermatitidis, Histoplasma capsulatum</td>
<td>Subacute to chronic meningitis, long bone osteomyelitis, and vertebral disease. Usually associated with asymptomatic or asymptomatic pulmonary findings (esp. cutaneous) Immunocompromised host</td>
</tr>
</tbody>
</table>
Thank you!