Osteomyelitis:

- **Hematogenous Osteomyelitis**
  - Metaphyseal long bone (more common in children)
  - Vertebral spine (Spondylodiscitis)
  - 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 → intraosseous abscess
- “Penumbra sign” on MRI
  - Granulation tissue lining abscess 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

Disclosures of Financial Relationships with Relevant Commercial Interests

- None
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

Case #2

- 56 year old woman from New Hampshire with rheumatoid arthritis on infliximab has had chronic knee pain; she underwent steroid injection two months ago. Two weeks ago she had worsening knee pain and progressive discomfort with ambulation.
- ESR 74  CRP 53 mg/dL
- Synovial fluid analysis: 42,000 WBCs (91% neutrophils), negative gram stain, and positive birefringent crystals
- Synovial fluid cultures are negative at 48 hours

Case #2: Vote

What do you do next?
A. Start vancomycin, place PICC line for four weeks of IV antimicrobial therapy
B. Start vancomycin and ceftriaxone; ask for orthopedic surgical consultation
C. Treat with colchicine
D. Intra-articular corticosteroid therapy
E. Start empiric doxycycline
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
  - 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

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
  - May be polyarticular, knees most common
  - Lower synovial fluid cell counts more common
- Asymptomatic mucosal phase predisposes
- Highest yield diagnosis: mucosal site sampling (cervical, urethral)
  - Blood (<30%) and synovial fluid (<50%) cultures lower yield
  - Compatible clinical syndrome

Viral arthropitides

Most common viruses to cause arthritis

<table>
<thead>
<tr>
<th>Virus</th>
<th>Clinical and Epidemiologic Clue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubella</td>
<td>Clin-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>Alphaviruses (esp. 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
  - Asymptomatic mono or oligo-arthritis affecting knees/ankles
  - Associated features: enthesitis (tendon insertion), dactylitis (sausage digits), mucosal lesions, uveitis, conjunctivitis/uveitis, skin lesions (keratoderma blennorrhagica)
  - Still's disease
  - Sarcoid (Loeffgren's)
  - Polymyalgia rheumatica
  - Many others....
Prosthetic Joint Infection (PJI): Clinical presentations

- Early surgical site infection (< 3 months)
  - 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
- Late acute infection (>2 years)
  - Acute onset of fever, joint pain, swelling
  - 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, atrial fibrillation, 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 levofloxacin 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>Debrid and retain with exchange of polyethylene liner</td>
<td>Acute infections (early and late); well fixed components</td>
<td>2-6 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>2-6 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 sinus tracts Resistant organisms</td>
<td>6 weeks IV or highly bioavailable oral</td>
</tr>
</tbody>
</table>

*3 months for hips; 6 months for knees
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>Immunocompromised host, indwelling line, history of injection-drug use (IDU).</td>
</tr>
<tr>
<td>HACEK organisms</td>
<td>Human bite wounds (Eikenella corrodens), recent dental procedure or infection.</td>
</tr>
<tr>
<td>Yersinia enterocolitica in HACEK</td>
<td>Common in children &lt;6yo. Grows poorly in routine culture (diagnose by pcr).</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>
</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>Acinetobacter species</td>
<td>Toxin of Serratia, Dermatitis, Arthritis.</td>
</tr>
<tr>
<td>Mycoplasma species</td>
<td>Human immunodeficiency (HIV), RA, Pneumonia, women. Difficult to grow in routine culture. “fried-egg” morphology in culture.</td>
</tr>
<tr>
<td>Borrelia burgdorferi (Lyme)</td>
<td>Northeast and Upper Midwest with tick exposure. Subacute monarthropathy of large joints (knee most common) with large effusions.</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>Subacute to chronic infections including vertebral osteomyelitis (Pott’s) and septic arthritis.</td>
</tr>
<tr>
<td>Non-tubulous mycobacteria</td>
<td>Environmental water exposure (Subarctic, fish tanks). Tenosynovitis 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>Seen in immunocompromised hosts, IDU.</td>
</tr>
<tr>
<td>Molds</td>
<td>Madura foot (barnfoot walking) Environmental contamination (eg. open fracture with soil contamination) immunocompromised hosts, (neuropaenia).</td>
</tr>
<tr>
<td>Coccioides species, Blastomyces dermatitidis, Histoplasma capsulatum var (frequent)</td>
<td>Subacute to chronic monarthropathy, long bone osteomyelitis, and visceral disease. Usually associated with symptomatic or asymptomatic pulmonary findings (esp. skin). Immunocompromised host.</td>
</tr>
</tbody>
</table>

Thank you!