Diabetic Foot Ulcers
& Osteomyelitis

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Objectives: Diabetic Foot Ulcers
• List three risk factors associated with diabetic foot ulcers.
• Differentiate between mild and moderate-severe diabetic foot ulcers.
  – Identify common microorganisms involved in each category.
  – Suggest two appropriate antimicrobials for each category.
• Identify what coverage is necessary and an appropriate antibiotic regimen for life-threatening infections.

Diabetic Foot Ulcers
• Pathogenesis
  – Most common cause for hospitalization of the diabetic patient
  – ~43% of diabetic patients have first hospital admission or diagnosis of diabetes because of a foot ulcer/infection
  – Three factors
    • Neuropathy
    • Angiopathy
    • Immunopathy
Diabetic Foot Ulcers (cont.)

Risk Factors
- DM > 10yrs
- Male sex
- Poor glucose control
- CV, retinal, or renal complications
- Peripheral neuropathy
- Altered biomechanics
- Peripheral vascular disease
- History of foot ulcer or amputation
- Accidental trauma

Diabetic Foot Ulcers (cont.)

- Wound care
  - Ongoing debridement
  - Adequate application of dressings and frequent dressing changes
    - Moist healing environment
    - Careful selection of dressing depending on wound stage
  - Off-loading
    - Goal: reduce pressure, but maintain ambulation
    - Various casts allow for even distribution of pressure across plantar surface of foot
  - Hyperbaric oxygen
  - Advanced technologies

Diabetic Foot Ulcer Infection

- Classification
  - Mild
    - No systemic signs and/or symptoms
    - <2 cm of surrounding cellulitis
  - Moderate-Severe
    - Systemic signs/symptoms of infection
    - >2 cm of surrounding cellulitis
    - Significant drainage
    - Prominent ischemia

Diabetic Foot Ulcer Infection (cont.)

**Etiology**

**Mild**
- *S. aureus*
- streptococci
- Gram-negatives and anaerobes uncommon

* Deep tissue culture if possible (otherwise – try discharge)

**Moderate-Severe**
- Polymicrobial
- *S. aureus*
- *S. agalactiae*
- Enterococcus spp.
- Gram-negative bacilli
- May also be – *Peptostreptococcus* and *Bacteroides*


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Diabetic Foot Ulcer Infection (cont.)

**Treatment**

**Mild**
- Clindamycin
- Cephalexin
- Amox/clav
- Dicloxacillin
- Cefazolin
- Nafcillin

* Usually 2 weeks of therapy

**Moderate-Severe**
- FQ + clindamycin or metronidazole
- Amoxicillin/sulbactam
- Piperacillin/tazobactam
- Ticarcillin/clavulanate
- Cefoxitin

MRSA – vancomycin, linezolid, daptomycin

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Diabetic Foot Ulcer Infection (cont.)

**Treatment for Life-threatening Infection**
- Must have pseudomonal coverage
- Ampicillin/sulbactam + aminoglycoside
- Piperacillin/tazobactam + aminoglycoside
- Ampicillin + clindamycin + aminoglycoside
- Imipenem/cilastatin + aminoglycoside

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Diabetic Foot Ulcer Infection (cont.)

- Route of Antimicrobial Administration
  - IV therapy for severe infections or poor GI absorption
  - Oral antibiotics for mild-moderate infections when appropriate
  - Other routes occasionally used


Diabetic Foot Ulcers (cont.)

- Prevention
  - Tight glycemic control
  - Patient education
    - Daily inspection, well-fitted socks and shoes, keep feet dry and warm, wash daily, neatly trimmed toenails, well-moisturized
    - Exercise, proper nutrition, smoking cessation


Objectives: Osteomyelitis

- Differentiate between hematogenous and contiguous osteomyelitis.
  - Identify common microorganisms causing osteomyelitis in each category.
  - Suggest two appropriate antimicrobial regimens for each category.
- List criteria for oral therapy and identify two types of possible candidates for oral therapy.
Osteomyelitis
Inflammation of bone marrow and surrounding bone

• Three categories of infection:
  – Hematogenous
  – Contiguous
  – Infection due to vascular insufficiency
    • Present in up to 60% of diabetic patients with moderate-severe foot infections

• Classified as:
  – Acute
    • Several days to 1 week
  OR
  – Chronic
    • Debatable
    • Symptoms > 1 month before therapy
    • Relapse of initial infection

Osteomyelitis (cont.)

Edema and inflammation associated with infectious process can compromise blood flow → necrosis
Necrosis can lead to sequestra (dead bone that has separated from healthy bone)
Osteomyelitis (cont.)

Diagnosis
- X-rays – no changes until 10-14d after onset of infection
- Bone scanning (technetium or gallium)
- ESR
- WBC
- Bacteriologic diagnosis – bone aspiration

Osteomyelitis (cont.)

Treatment Considerations
- Prognosis differs between acute and chronic
- Presence of foreign materials
- Appropriate antibiotic…adequate dose…sufficient amount of time
- Early antimicrobial therapy may eliminate need for surgery

Hematogenous Osteomyelitis
- Spread through bloodstream
- Most common in children (< 16 y.o.)
- Usually involves long bones and joints
- Risk factors
  - Prematurity, respiratory distress syndrome, sickle cell disease, puncture wounds to feet
- Vertebral osteomyelitis – patients > 50 y.o.
  - > 50% of cases in IVDU
Hematogenous Osteomyelitis (cont.)

Clinical Findings
- Significant tenderness, pain, swelling, fever, chills, decreased motion, malaise
- Elevated ESR, WBC
- Neonatal – decreased limb motion, edema over affected area
- Vertebreal – severe back pain, fever or night sweats, weight loss

Hematogenous Osteomyelitis (cont.)

Etiology
- Neonatal – S. aureus, S. agalactiae, E. coli
- Children – S. aureus, H. influenzae type b, rarely Salmonella
- Vertebral – S. aureus, E. coli, M. tuberculosis
  – IVDU – 88% gram negatives; P. aeruginosa, Klebsiella, Enterobacter, Serratia, staphylococci, streptococci

Hematogenous Osteomyelitis (cont.)

Treatment (usually 4 weeks)
- Neonatal – cefazolin 100mg/kg/day IV
- Children – cefuroxime 100mg/kg/day IV, nafcillin 40mg/kg/day IV, cefazolin 100mg/kg/day IV
  – May switch to oral after tenderness, redness, swelling, and fever have resolved
- Adults – nafcillin 2g IV q4h or cefazolin 2g IV q8h
  – If vertebral, switch to cephalosporin
Hematogenous Osteomyelitis (cont.)
Treatment – Special Populations
• Sickle Cell Disease – nafcillin plus ampicillin, third-generation cephalosporin, chloramphenicol, or ciprofloxacin (adults)
• IVDU – ceftazidime 2g IV q8h plus and aminoglycoside for at least 4 – 6 weeks

Contiguous Osteomyelitis
• Direct entrance of the organisms from an outside source or spread from adjacent tissue
• Most common in patients > 50 y.o.
• Risk factors
  – Hip or femoral or tibial shaft fracture, soft-tissue infection of fingers/toes, possibly infected teeth

Contiguous Osteomyelitis (cont.)
Clinical Findings
• Depend on precipitating cause
• Surgery or bone trauma – symptoms within 1 month; pain, less commonly fever and increased WBC count
• Localized tenderness, warmth, edema, erythema over site
Contiguous Osteomyelitis (cont.)

Etiology
• *S. aureus* most common, but frequently multiple organisms
• *P. aeruginosa, Proteus, Streptococcus, E. coli, S. epidermidis,* and anaerobes
• Strong correlation between puncture wounds of the feet and gram-negatives, specifically *P. aeruginosa*

Contiguous Osteomyelitis (cont.)

• Subcategory of patients with vascular insufficiency
  – Usually 50 –70 y.o. with diabetes
  – Almost always include multiple organisms
  • *Staphylococcus, Streptococcus, Enterococcus, Enterobacteriaceae,* anaerobes (*Bacteroides* spp.)

Contiguous Osteomyelitis (cont.)

Treatment (usually 6 weeks)
• Nafcillin 2g IV q4h plus ceftazidime 2g IV q8h; ticarcillin/clavulanate 3.1g IV q4h initially
  – Therapy may be modified once results of cultures are obtained
• Pts. with vascular insufficiency – very difficult to manage
  – Same initial therapy
  – If suspect anaerobes, use cefoxitin or clindamycin in place of the nafcillin
**Chronic Osteomyelitis**

- Surgery has important role
  - Remove all sequestra, necrotic areas
- Parenteral therapy for 4 – 6 weeks, followed by 1 – 2 months of oral treatment
- Therapy should be based on results from bone aspirate

**Osteomyelitis: Oral Therapy?**

- Criteria for oral outpatient therapy
  - Confirmed osteomyelitis, organism identified, antibiotic sensitivity determined, suitable oral agent, compliance
- Candidates for oral outpatient therapy
  - Children with good response to IV, adults without diabetes or PVD

**Osteomyelitis: Monitoring**

- WBC – 1-2x/week until normal
- ESR – weekly until normal (may take several weeks)
- Clinical signs of inflammation (redness, swelling, tenderness, pain, fever) – daily
- If all normal at the end of treatment ➞ clinical cure
- No relapse for one year ➞ complete cure
Prophylaxis in Bone Surgery

- IV antibiotics 30 minutes prior to incision of skin and for no longer than 24 hours after the operation
  - Orthopedic surgery for closed fractures – antistaphylococcal penicillins or first- or second-generation cephalosporins
  - Complex fractures with extensive soft tissue damage – broader antimicrobial coverage for longer duration