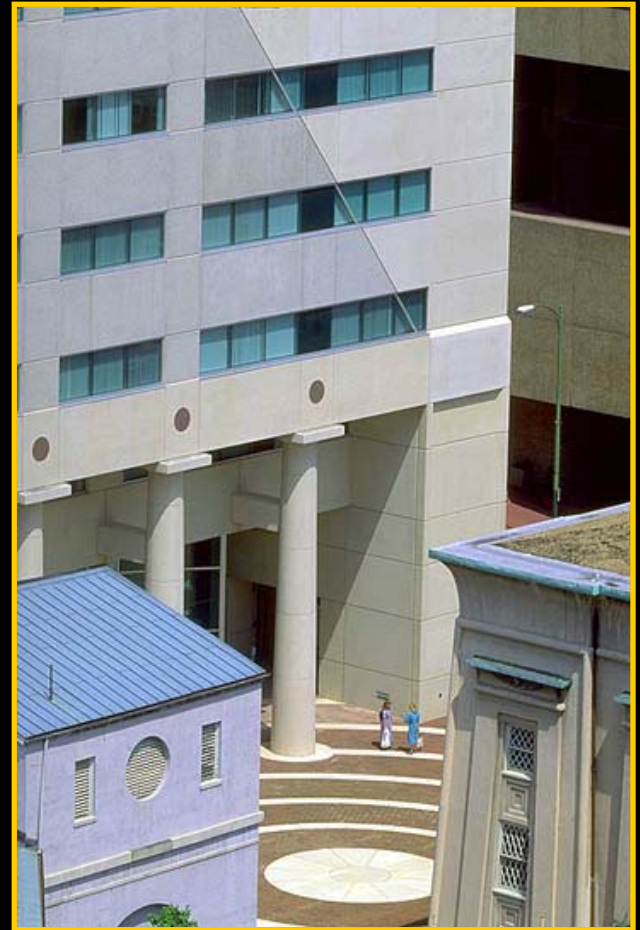


# ***Bone and Joint Infections***

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Associate Professor of Medicine,  
Epidemiology and Community Health  
Associate Hospital Epidemiologist  
Virginia Commonwealth University**



# Case

- 21 year old man complained of 3 days of flu-like illness with low grade fever, arthralgias and myalgias
- Over the following 24 hours he noted tender pustular lesions on his hands, feet, arms, legs and lower back
- He denied headache, photophobia, meningismus, genital lesions and penile discharge

# Case

- Physical examination:
  - Vitals: T 38.8C, P100, RR 14, BP130/72
  - General : appears uncomfortable
  - HEENT/Chest/Abdomen: all WNL
  - Genitals: normal, no,lesions, no penile discharge



**Pustular, tender, erythematous lesions**



**Pustular, tender, erythematous lesions**



**Pustular, tender, erythematous lesions**



**Swollen and tender PIP joint, 3<sup>rd</sup> digit of right hand**

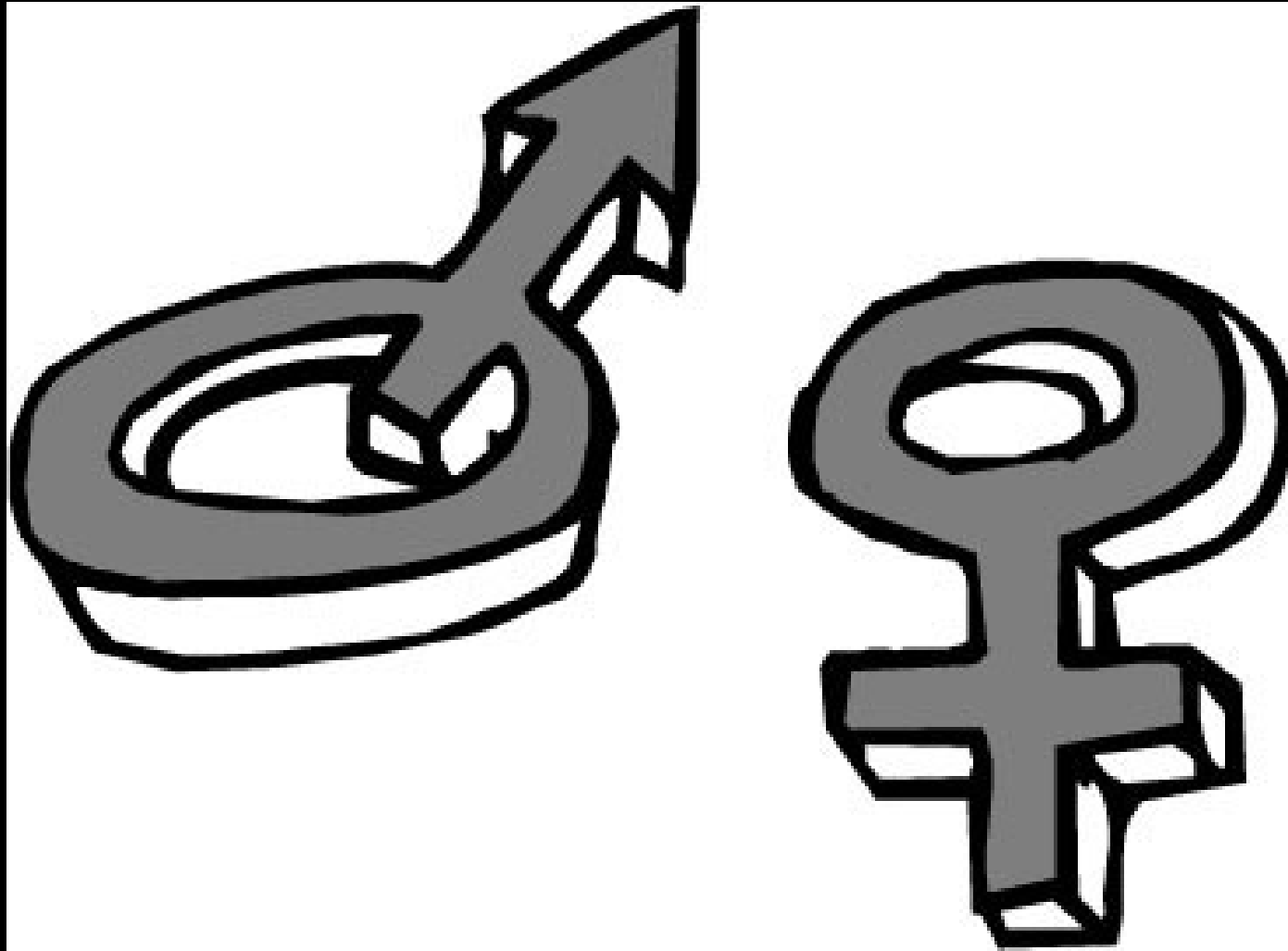


Extremities:  
swollen,  
tender,  
erythematous  
left knee



# ***Gonococccemia***

# When Mars Meets Venus....



Richmond, Virginia: Gonorrhea Rate Tops US Chart

*Times-Dispatch* (Richmond, Va.)

03.06.02; Tammie Smith

Richmond, Va., had the *highest gonorrhea rate in 2000 among US cities*, even though the actual number of cases declined from 1999. In 1999, Richmond had the nation's second-highest gonorrhea rate, just below Baltimore's. Baltimore dropped to third place in the 2000 calculations.

*Richmond's gonorrhea rate was 923.6 cases per 100,000 residents in 2000; this is about seven times the national average* of 131.6 cases per 100,000 people. In raw numbers, Richmond recorded 1,752 cases of gonorrhea in 2000, down from 1,827 the year before; however, greater declines in other high-ranking cities put *Richmond in the top spot.*

# *Neisseria gonorrhea*

- *Neisseria gonorrhoeae*, a gram-negative bacterium, was identified in 1879 by the German physician, Albert Neisser
- Causative agent of gonorrhea, one of the oldest recognized sexually transmitted diseases
- "gonorrhea" is derived from the Greek language and literally means "flow of seed"
  - This term was used to describe the white milky appearance of the purulent urethral discharge

# ***Gonococemia***

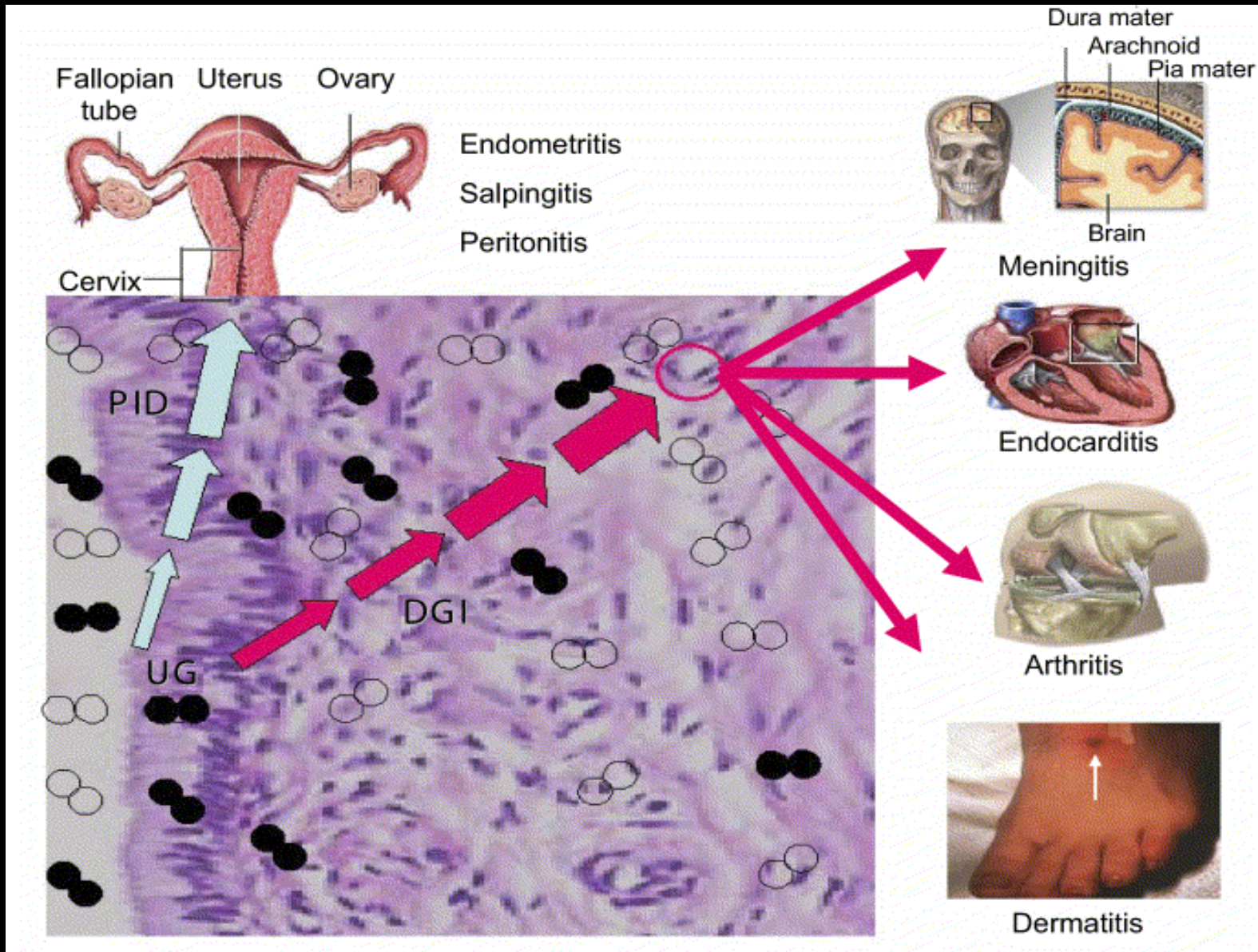


**Overt clinical signs of genital infection are frequently absent in disseminated gonococemia**

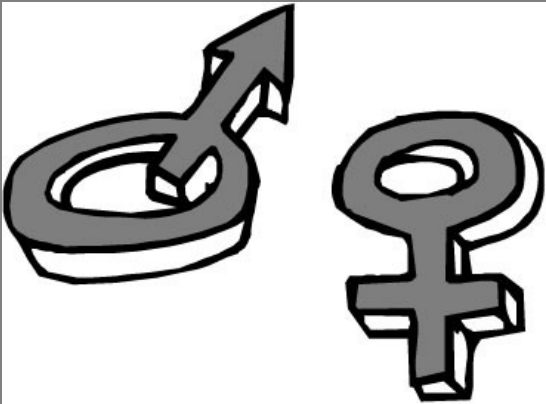

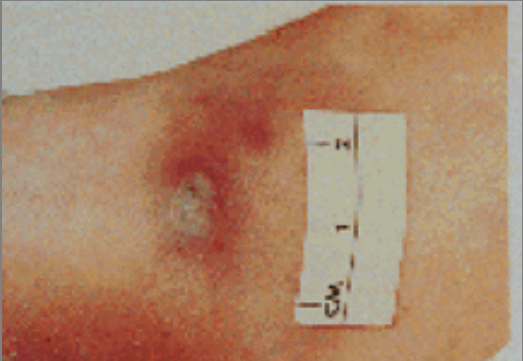
***N.gonorrhoea* is cultured from a mucosal site in 80% of the cases**



# The multiple potential paths of Gonococcal invasion



# Gonococchemia

Mode of Transmission	Clinical Manifestations	Dermatologic Manifestations
<p data-bbox="83 701 562 801">Person to person via sexual contact</p>  The image shows a male symbol (a circle with an arrow) and a female symbol (a circle with a cross) in a 3D, metallic style, representing sexual contact.	<ul data-bbox="710 429 1224 908" style="list-style-type: none"><li>•Fever</li><li>•Chills</li><li>•Joint pain: single or multiple joints (knee pain, wrist pain, ankle pain)</li><li>•Joint swelling (knees, wrists, ankles)</li></ul>  A close-up photograph of a person's hand and wrist, showing significant swelling and redness, particularly around the joint.	<ul data-bbox="1271 429 1818 872" style="list-style-type: none"><li>•Skin rash: begins as flat, pink-to-red macules, evolve into pustular papules and nodules</li><li>•Painful tendons of wrists, digits, heels</li></ul>  A photograph of a skin rash on a person's arm. It features a central pustule surrounded by a red, inflamed area. A small white ruler is placed next to it for scale.



# ***Gonococchemia***

Diagnostic Pearls	Management
<p>Ask about sexual activity!</p> <ul style="list-style-type: none"><li>• Intercourse and oral sex</li></ul>	<p><b>Treatment is usually with intravenous antibiotics:</b></p> <ul style="list-style-type: none"><li>• Ceftriaxone</li><li>• Levofloxacin</li></ul> <p><b>Concurrent treatment for chlamydia should be given</b></p> <ul style="list-style-type: none"><li>• Doxycycline</li><li>• Azithromycin</li></ul>
<ul style="list-style-type: none"><li>• Blood culture</li><li>• Skin lesion culture</li><li>• Culture of synovial fluid from joints</li><li>• Urethral discharge culture</li><li>• Culture from endocervix</li><li>• Throat culture</li><li>• Anal culture</li><li>• Cultures should be performed on <i>chocolate agar</i></li></ul>	



# Case

- 34 year old Caucasian man, complains of 2 day fatigue and increasing tenderness in his right knee
- He has a history of heroin and alcohol abuse
- HIV test was negative 2 months ago

# Case

- Temperature 38.2C, Pulse 78, RR 14, BP 140/90
- HEENT- unremarkable
- CHEST-clear
- Cardiac: no murmurs or gallops
- ABD-soft, normal bowel sounds

# Track Marks



# Physical Exam



## Panel 2: Characteristics of gonococcal and non-gonococcal bacterial arthritis

Characteristic	Gonococcal arthritis	Other bacterial arthritis
Patient profile	Young, healthy sexually active >female	Newborn or elderly; compromised host; rheumatoid or other systemic arthritis
Initial presentation	Migratory polyarthralgia; tenosynovitis, dermatitis	Single hot, swollen painful joint
Polyarticular	40–70%	10–20%
Recovery of bacteria	<50% synovial fluid, <10% blood	>90% synovial fluid, 50% blood
Response to antibiotics	Within a few days; outcome excellent	Takes weeks; joint drainage must be adequate; outcome often poor

### Causes of infectious arthritis

Organism	Clinical clues
Staphylococcus aureus	Healthy adults, skin breakdown, previously damaged joint (eg, rheumatoid arthritis), prosthetic joint
Streptococcal species	Healthy adults, splenic dysfunction
Neisseria gonorrhea	Healthy adults (particularly young, sexually active), associated tenosynovitis, vesicular pustules, late complement deficiency, negative synovial fluid culture and gram stain
Aerobic gram negative bacteria	Immune compromised hosts, gastrointestinal infection
Anaerobic gram negative bacteria	Immune compromised hosts, gastrointestinal infection
Mycobacterial species	Immune compromised hosts, recent travel to or residence in an endemic area
Fungal species (sporotrichosis, cryptococcus, blastomycosis)	Immune compromised hosts
Spirochete (Borellia burgdorferi)	Exposure to ticks, antecedent rash, knee joint involvement
Mycoplasma hominis	Immune compromised hosts with prior urinary tract manipulation

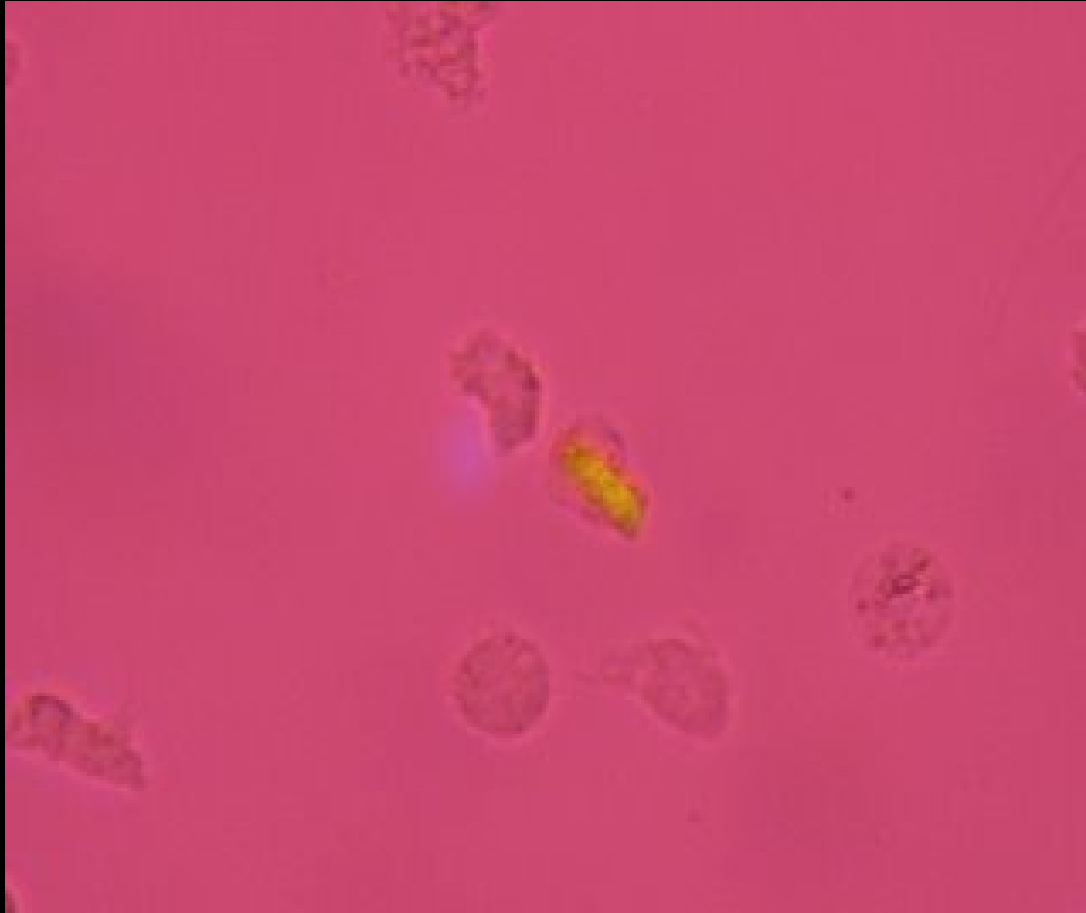


# Diagnostic Arthrocentesis

		WBC Cells/mL	PMN%	Glucose mg/dL	Protein g/dL
Normal	Clear	<150	<25	Serum glucose	1.3-1.8
Noninflammatory	Clear	<3,000	<25	Serum glucose	2-3.5
Inflammatory	Cloudy	>3,000	<75	<25	>4
Purulent	Cloudy	>50,000	>90	<25	>4
Hemorrhagic	Bloody	>2,000	~30	Serum glucose	1.3-1.8

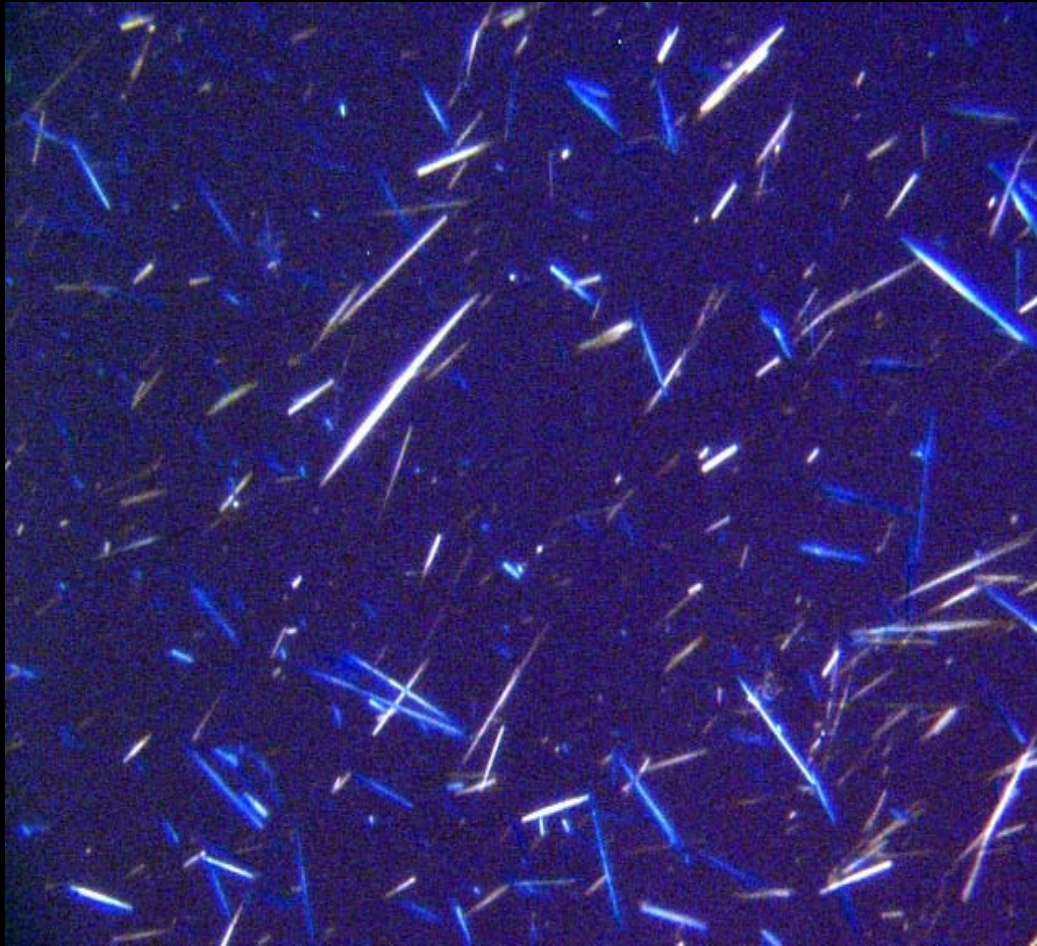


# Calcium Pyrophosphate



Pseudogout  
(CPPD) crystals  
are rhomboid-  
shaped, weakly  
positively  
birefringent

# Gout- Sodium Urate Crystals



The urate crystal is identified by strong negative birefringence under polarized microscopy and its needle-like morphology

# Case

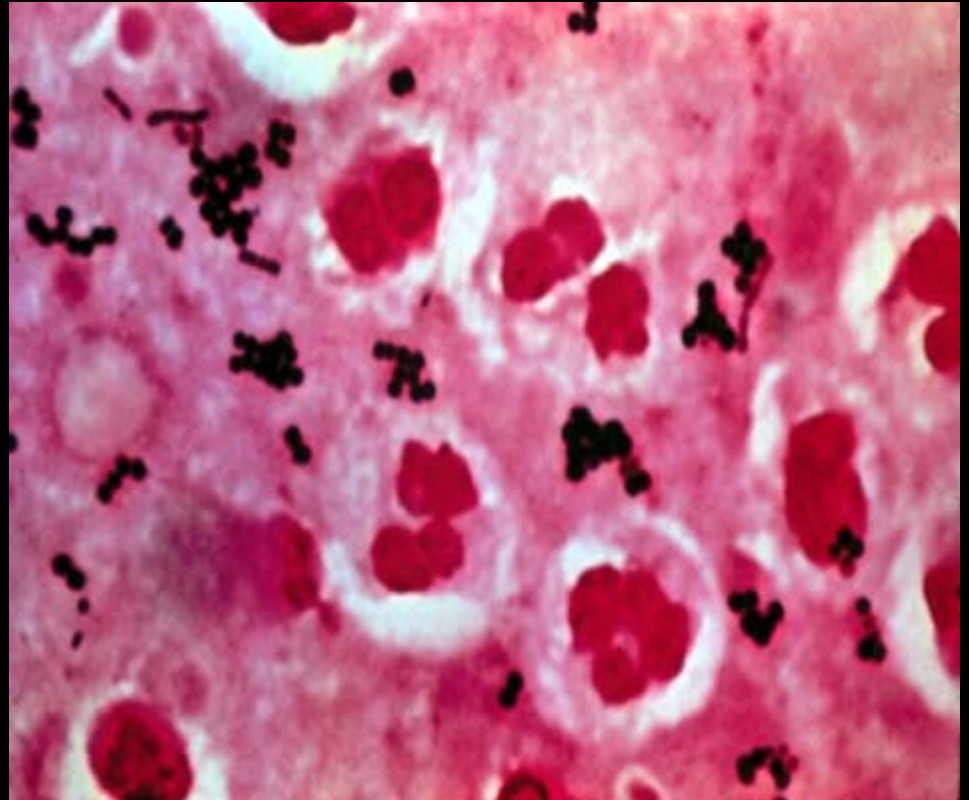
- 10 year old Caucasian boy complains of fevers up to 38.2C
- Worsening erythema and purulent drainage from the lower medial aspect of his right leg
- Symptoms evolved over several weeks
- The child is otherwise well and has no other medical conditions

# Case

- Temperature 38.3, P 86, RR 16, BP 142/82
- Well developed, well nourished man
- Medial aspect of right leg- swollen, erythematous, warm and tender, with purulent drainage from a small opening
- Remainder of the examination
  - Unremarkable

# Case

- WBC 14,800  
(83%PMN)
  - ESR 76 mm/hr
  - Gram stain of  
wound drainage
- 
- Blood cultures  
negative



# Case

- Radiograph
  - Radiolucencies can take 14-21 days to appears





# Radiographic Presentation



© AAP

[http://aapredbook.aappublications.org/content/images/large/2006/1/123\\_48.jpeg](http://aapredbook.aappublications.org/content/images/large/2006/1/123_48.jpeg)



# Radiographic Presentation

<http://nemsi.uchc.edu/images>

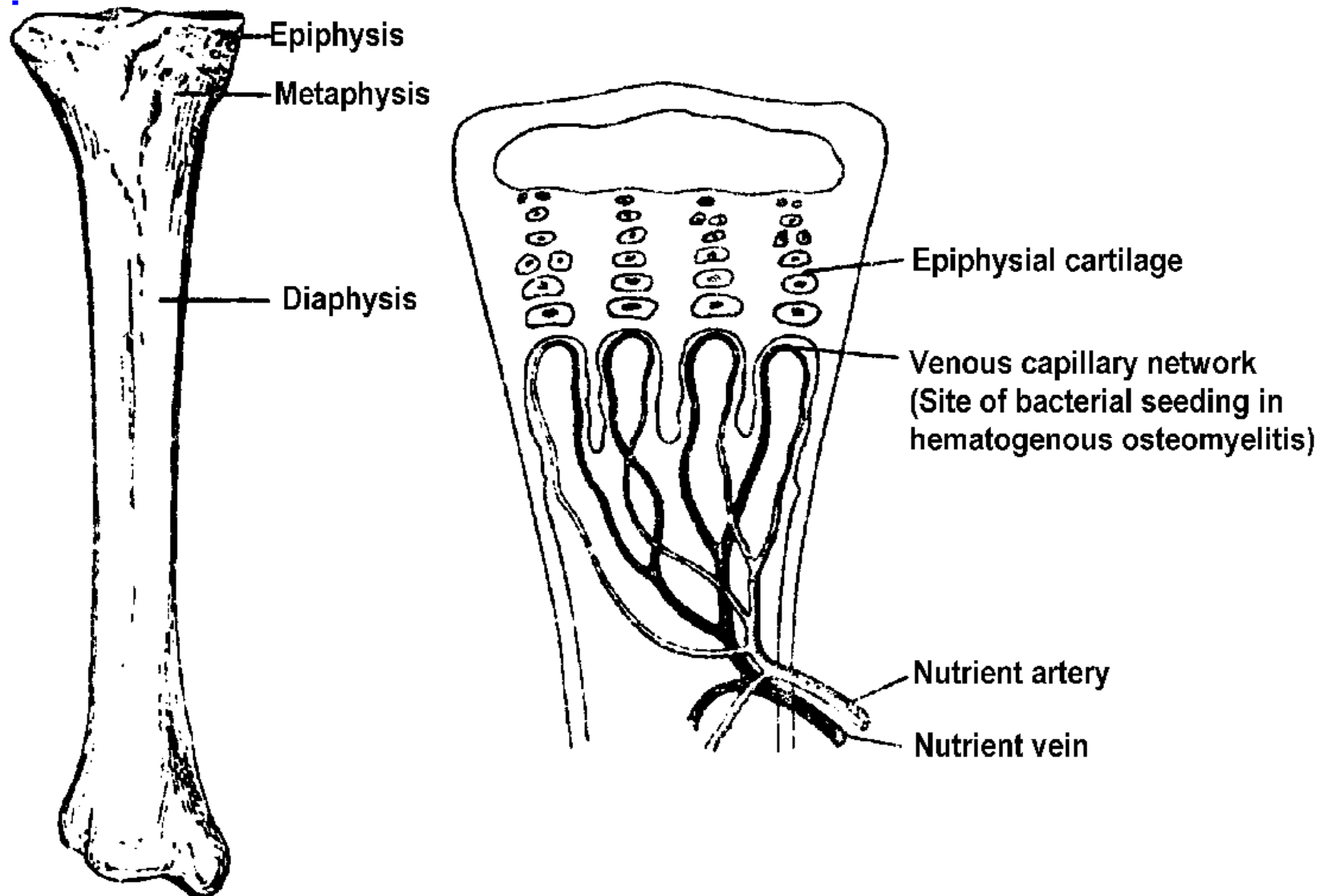


# Osteomyelitis

- Osteomyelitis is an acute or chronic inflammatory process of the bone and its structures secondary to infection with pyogenic organisms

# Osteomyelitis

- Hematogenous osteomyelitis
  - Infection by bacterial seeding from the blood
  - This condition occurs primarily in children
- Most common site is the rapidly growing and highly vascular metaphysis of growing bones
  - Slowing or sludging of blood flow as the vessels make sharp angles at the distal metaphysis predisposes the vessels to thrombosis and the bone itself to bacterial seeding
- Acute hematogenous osteomyelitis
  - slow clinical development and insidious onset



**Long bone anatomy and vasculature**

# Osteomyelitis

- Direct inoculation (contiguous-focus) osteomyelitis
  - Infection due to inoculation of organisms from direct trauma, spread from a contiguous focus of infection
  - Clinical manifestations of direct inoculation osteomyelitis
    - More localized than those of hematogenous osteomyelitis
    - Tend to involve multiple organisms
    - Common in diabetics



# Osteomyelitis

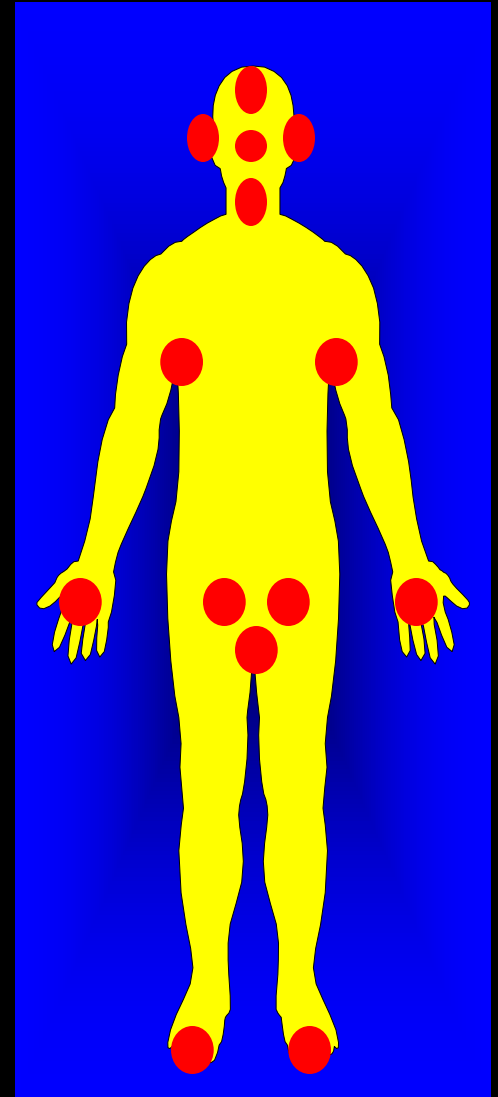
- Acute hematogenous osteomyelitis is primarily a disease in children
- Direct trauma and contiguous focus osteomyelitis are more common among adults and adolescents than in children
- Spinal osteomyelitis is more common in persons older than 45 years

# Organisms

- *Staphylococcus aureus*
- *S. epidermidis*
- *Streptococcus pyogenes*
- *Enterococcus* species
- Gram negative bacilli
- Anerobes

# *Staphylococcus aureus* skin colonization

*20% - 30 % of all adults are  
transiently or persistently  
colonized with S.aureus*



# Case

- 78 year old Caucasian man, S/P right TKR 2 years ago
- Present with increasing pain, tenderness and swelling of the prosthetic knee
  - He denies any trauma or incidents with the knee
- The patient is otherwise well
- Has a past history of DM and HTN, both well controlled



# Case

- T 98.7, pulse 80, RR16,
- Appeared stated age
- No distress
- Right knee with decreased ROM, swelling noted, no erythema
  - Pain on flexion and extension and on bearing weight

# Prosthetic Joint Infections

- Between 1%-5% of all prosthetic joints become infected
  - Significant morbidity
    - Protracted hospitalization
    - Potentially renewed disability
  - Significant cost
    - \$50,000-\$60,000 per episode

# Risk Factors

- Prior surgery at site of prosthesis
- Rheumatoid arthritis
- Immunocompromised states
- Diabetes mellitus
- Poor nutritional status
- Obesity
- Psoriasis
- Advanced age

•Gristina et al. J Bone Joint Surg Am. 1983;65 126-34

•Brause BD. Curr Opin Rheumatolog.1989. 1:194-98

•Hansen Ad et al. J Bone Joint Surg Am. 1998;80;910-922

# Pathogenesis

- Locally introduced (60-80%)
  - Operative contamination
  - Wound sepsis contiguous to the prosthesis
    - Common preceding events:
      - Delayed wound healing
      - Infected wound hematomas
      - Wound infection (SSI)
      - Suture abscesses
    - Coagulase negative staphylococci and *S. aureus* are common pathogens in these situations.

# Pathogenesis

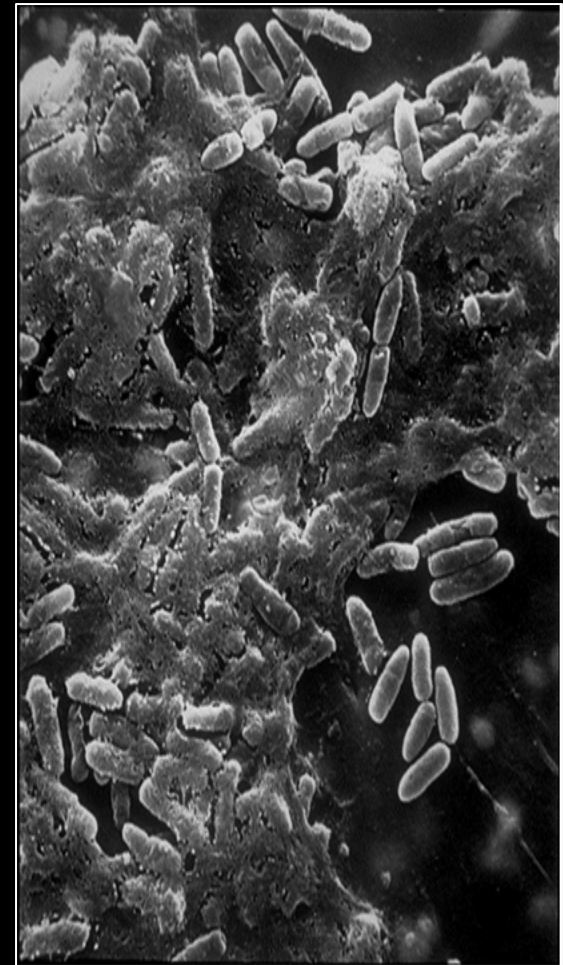
- Hematogenous (20-40%)
  - Any bacteremic episode may seed a prosthetic joint
    - *S.aureus* bacteremia leads to a 34% incidence of prosthetic joint infection
    - Dentogingival infections or manipulations
      - viridans streptococci and anaerobes
    - Genitourinary or gastrointestinal procedures or infections
      - Gram negative rods, enterococci, and anaerobes

# Pathogenesis

- Growth of virulent organisms ( *S. aureus*) usually indicates infection
- Growth of low-virulence microorganisms that are typical skin commensals (e.g., coagulase-negative staphylococci and *Propionibacterium acnes*) may be either contaminants or pathogens
  - Must consider other factors
    - Growth in more than one specimen
    - Short time to culture positivity
    - Positive Gram's stain
    - Presence of acute inflammation on histopathological examination
    - Radiographic manifestations

# Pathogenesis

- **Biofilms** are composed of populations or communities of microorganisms adhering to environmental surfaces and bioprosthetic materials
- These microorganisms are usually encased in an extracellular polysaccharide they synthesize



# Pathogenesis

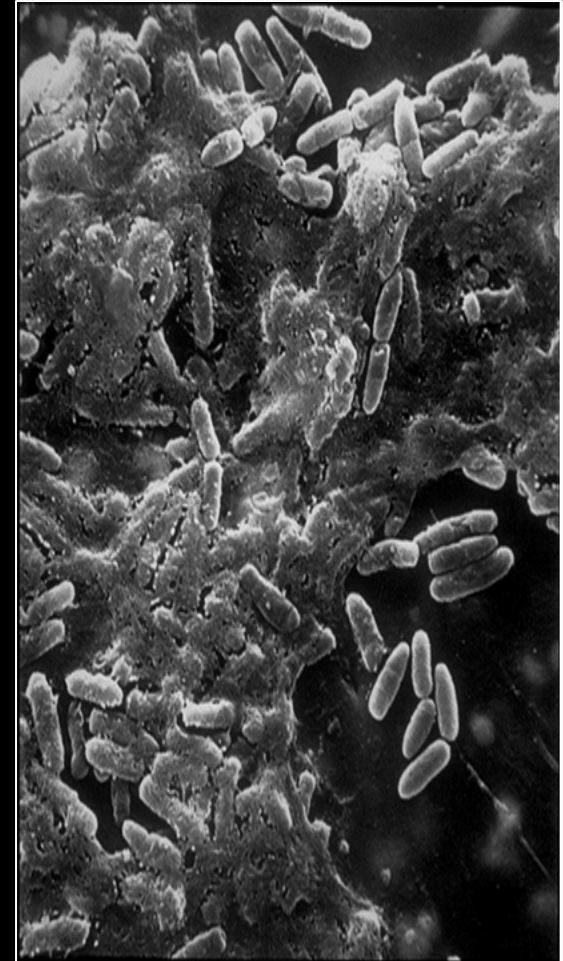
- Biofilms
  - Biofilm microbes are protected from antimicrobial agents and host immune responses





# Pathogenesis

- Biofilm producing organisms isolated from prosthetic hips
  - Coagulase negative staphylococci
  - Hemolytic streptococci
  - *P.mirabilis*
  - Bacteriodes species
  - *S.aureus*
  - Viridans streptococci
  - *E.coli*
  - *P. aeruginosa*



# Presenting Symptoms

Symptom	Frequency (%)
Joint Pain	95
Fever	43
Periarticular swelling	38
Wound or cutaneous sinus drainage	32

# Radiographic Presentation

- Plain radiographs are helpful to detect infection when viewed serially over time after implantation
  - Radiographic changes are typically related to the duration of infection
    - May take 3-6 months to manifest significant radiographic changes

# Radiographic Presentation

- Findings in prosthetic joint infections
  - Abnormal lucencies greater than 2mm in width at the bone cement interface
  - Changes in position of the prosthetic components
  - Cement fractures
  - Periosteal reaction
  - Motion of components on stress views

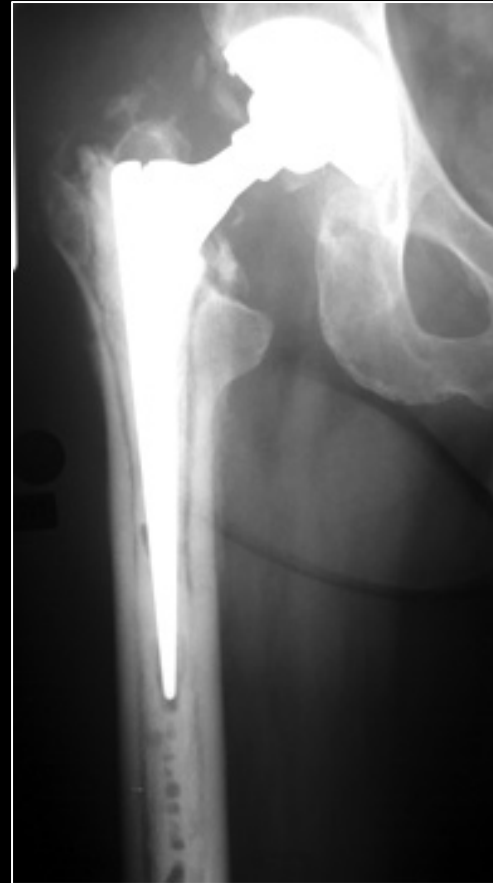
# Radiographic Presentation

- Normal prosthesis
  - 1-2mm lucent zones at cement interface
- Indicative/Diagnostic for loosening
  - > 2mm widening with progression
  - Cement fracture
  - Migration or change of position of component



# Radiographic Presentation

- Abnormally widened interfaces surrounding cement of femoral component, consistent with loosening



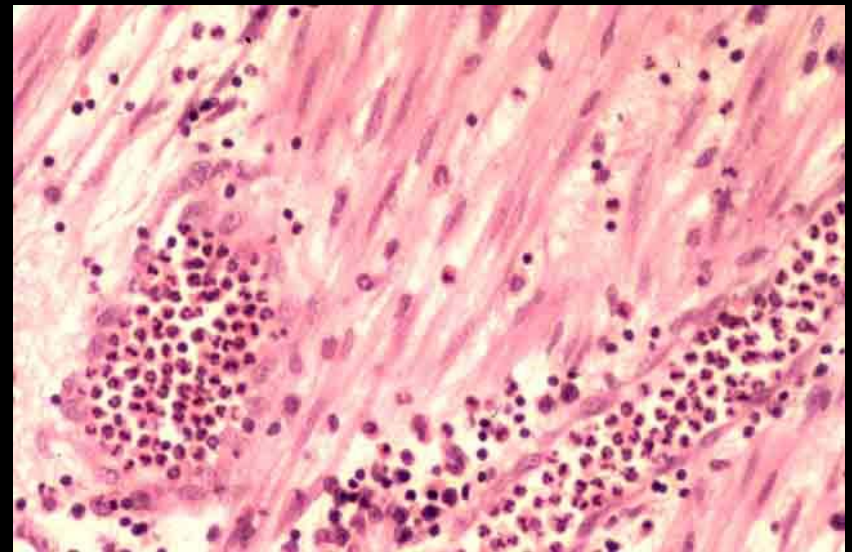
# Arthrocentesis

- Synovial-fluid leukocyte count  $>1700$  per cubic millimeter or a finding of more than 65 percent neutrophils
  - Sensitivity for prosthetic infection of 94 and 97 percent respectively



# Histopathology

- Periprosthetic tissue
  - Variable presence of PMN infiltrate
- **Single most accurate predictor of infection:**  
**Isolation of the pathogen by arthrocentesis or surgical debridement**





# Bacteriology of Prosthetic Joint Infections

Pathogens	Frequency (%)
Coagulase negative staphylococci	22
Staphylococcus aureus	22
Streptococci	14
Enterococci	7
Gram negative rods	25
Anaerobes	10

# Treatment

Goal of treating infection associated with a prosthetic joint is a pain-free, functional joint

# Surgical Therapy

- Debridement with retention of prosthesis
- One stage exchange of implant
- Two stage exchange of implant
  - With long interval (6-8 wks)
  - With short interval (2-4 wks)
- Implant removal without replacement

# Principles of Therapy

- Simple surgical drainage with retention of prosthesis followed by antibiotics
  - Success rate 20-36%
- Retention of Prostheses
  - Early (< 1 month) with debridement and retention of prosthesis, and 4-6 weeks of antibiotics
    - Success rate of 71%

•Fitzgerald RH et al. J Bone Joint Surg Am. 1977;59:847-855

•Crockarell et al. J Bone Joint Surg Am. 1998;80:1306-1313

•Brandt CM et al. CID. 1997;24:914-919

•Tsukayama et al. J Bone Joint Surg Am. 1996;78:512-523

•Mont MA et al. J Arthroplasty. 1997;12:426-433

# Principles of Therapy

- Two stage surgical procedure
  - 90% to 96% success with hips
  - 97% success with knees
    - Removal of prosthesis and cement
    - 6 week course of bactericidal antibiotic therapy preferably based on pathogen identification and susceptibility testing
    - Reimplantation of prosthesis at the conclusion of antibiotic therapy

•Windsor et al. J Bone Joint Surg Am. 1990;72:272-278

•Salavati et al. Clin Orthop.1982;170:62-75

•Lieberman et al. Clin Orthop. 1994;301:205-212

•Garvin et al.Orthop Clin North Am.1988;19:605-610

# Antibiotic Therapy Principles

- Important Antibiotic Properties:
  - Antimicrobial agents should have bactericidal activity against surface-adhering, slow-growing, and biofilm-producing microorganisms
    - Rifampin has effective antimicrobial properties within a biofilm
    - Rifampin should never be administered alone
      - staphylococci rapidly develop resistance

# Case

- A 25 year old woman (G2P1) at 20 weeks gestation was in her usual state of good health until 2 weeks prior to hospital presentation.
- She developed progressive inter-scapular pain followed by lower extremity paresthesias.
- On the day of admission she noted severe weakness in both legs which developed over the course of 3-4 hours, resulting in the inability to ambulate.
- She also reported urinary hesitancy for 2-3 days prior to admission, with loss of bladder control on the day of admission.

# Case

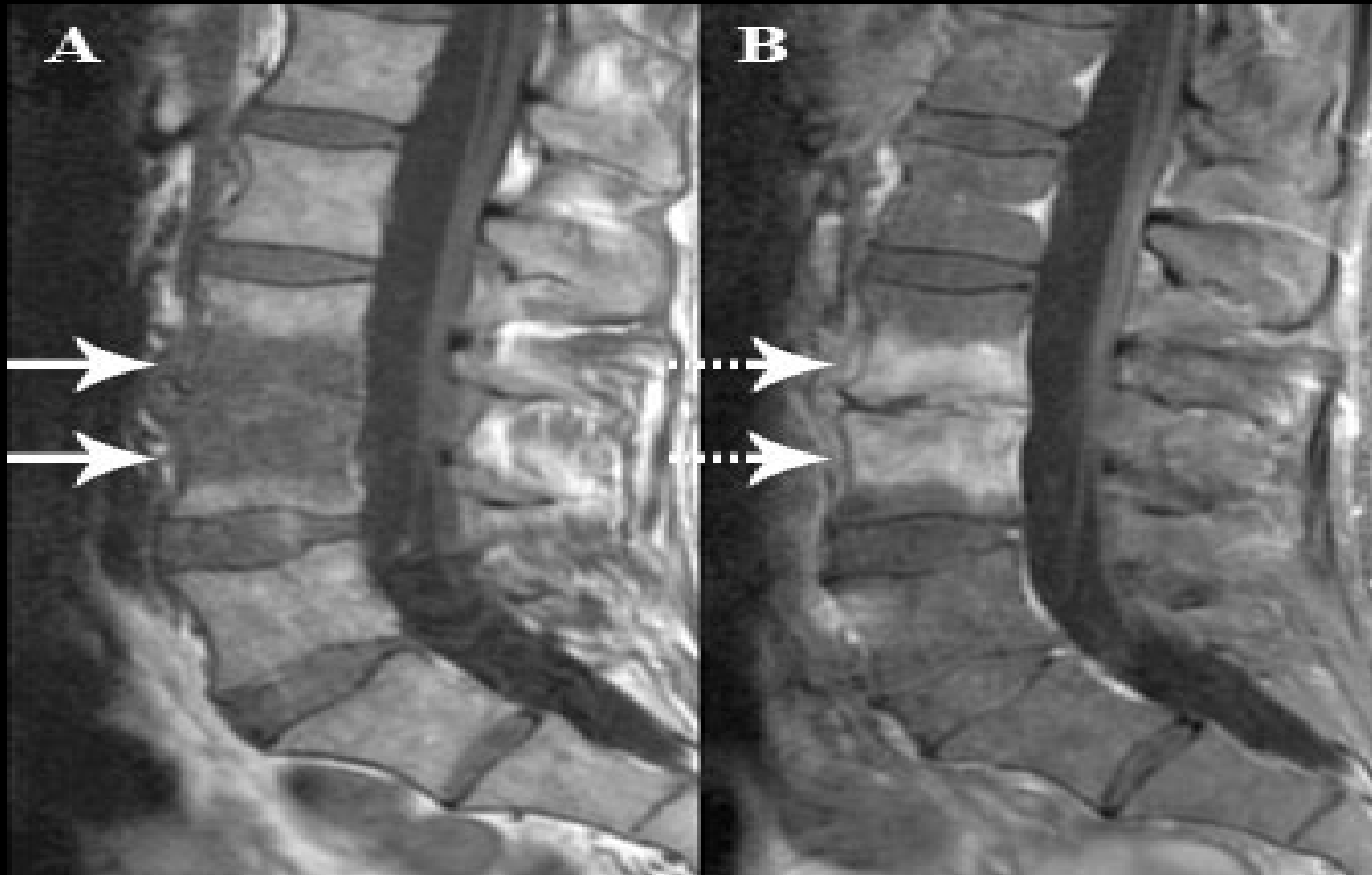
- BP 134/82, T 97.8°F, P 76/minute, RR 18/minute
- Awake, alert
- She was unable to stand or ambulate  
Physical exam revealed ascending sensory deficits to the T4 region below her breasts. Ankle reflexes were absent bilaterally



# MRI



# Vertebral Osteomyelitis and Spinal Epidural Abscess



# Vertebral Osteomyelitis

- Vertebral osteomyelitis is primarily a disease of adults
- Potential sources of hematogenous or contiguous spread of infection
- In many patients, however, the primary site of infection cannot be identified

# Vertebral Osteomyelitis- Organisms

- Typical organisms
  - *S. aureus*- 50%+
  - Enteric gram-negative bacilli, particularly after urinary tract instrumentation
  - *Pseudomonas aeruginosa* and *Candida* spp are frequently associated with intravascular access or injection drug use
  - Groups B and G hemolytic streptococci, especially in patients with diabetes mellitus

# Vertebral Osteomyelitis

## "Red flags" for a potentially serious underlying cause for low back pain

Recent significant trauma, or milder trauma age >50
Unexplained weight loss
Unexplained fever
Immunosuppression
History of cancer
Intravenous (IV) drug use
Osteoporosis, prolonged use of corticosteroids
Age >70
Focal neurologic deficit progressive or disabling symptoms
Duration greater than 6 weeks

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# Vertebral Osteomyelitis

- Magnetic resonance imaging (MRI) is the most sensitive radiologic technique to detect vertebral osteomyelitis



# Vertebral Osteomyelitis-treatment

- IV antibiotics
  - 6 weeks or more
- Surgery is necessary in a minority of patients with vertebral osteomyelitis
  - Progression of disease despite adequate directed or empiric antimicrobial therapy
  - Threatened or actual cord compression due to vertebral collapse and/or spinal instability
  - Drainage of epidural or paravertebral abscesses

The End