Acute Osteomyelitis and Septic Arthritis

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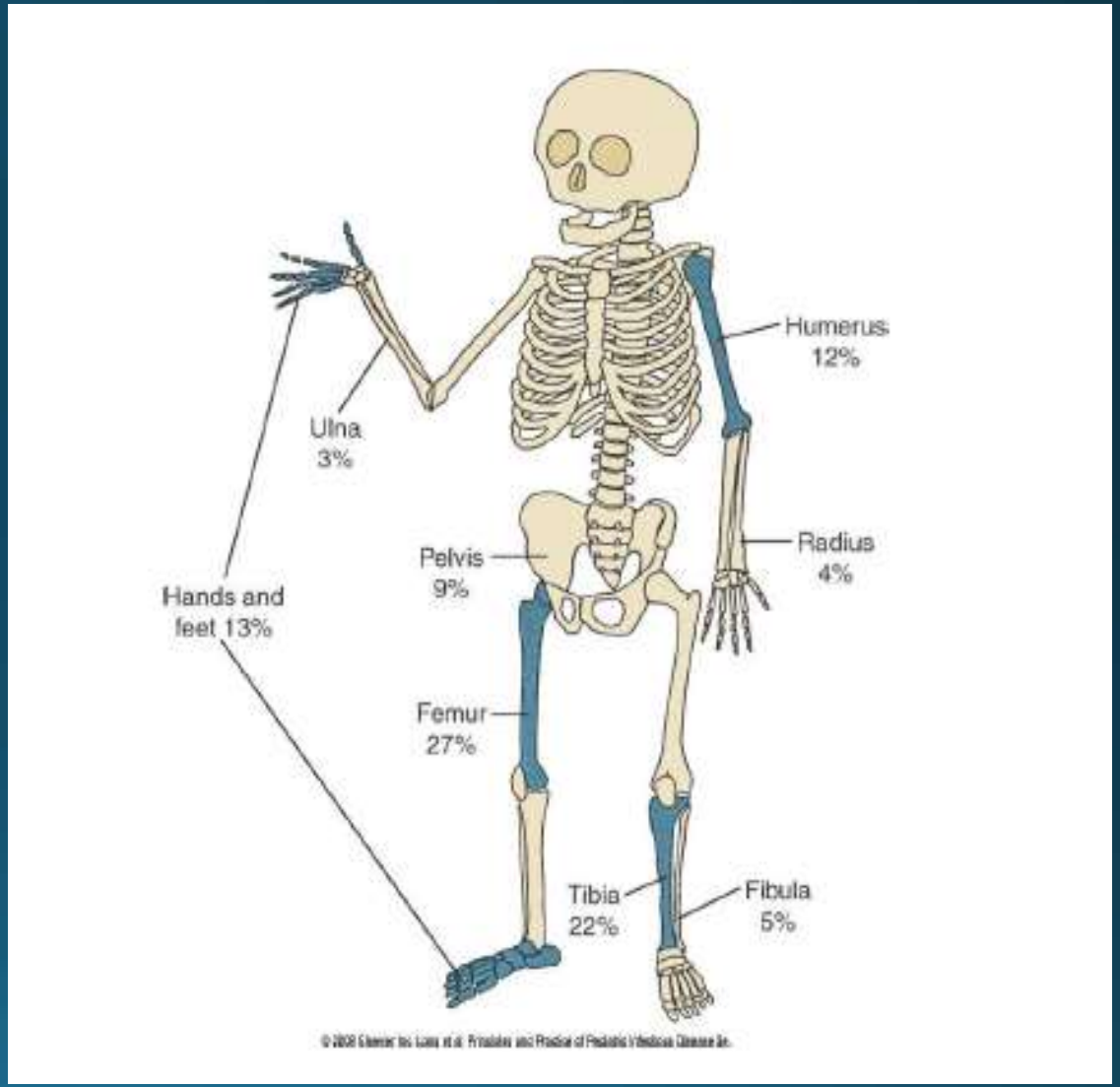


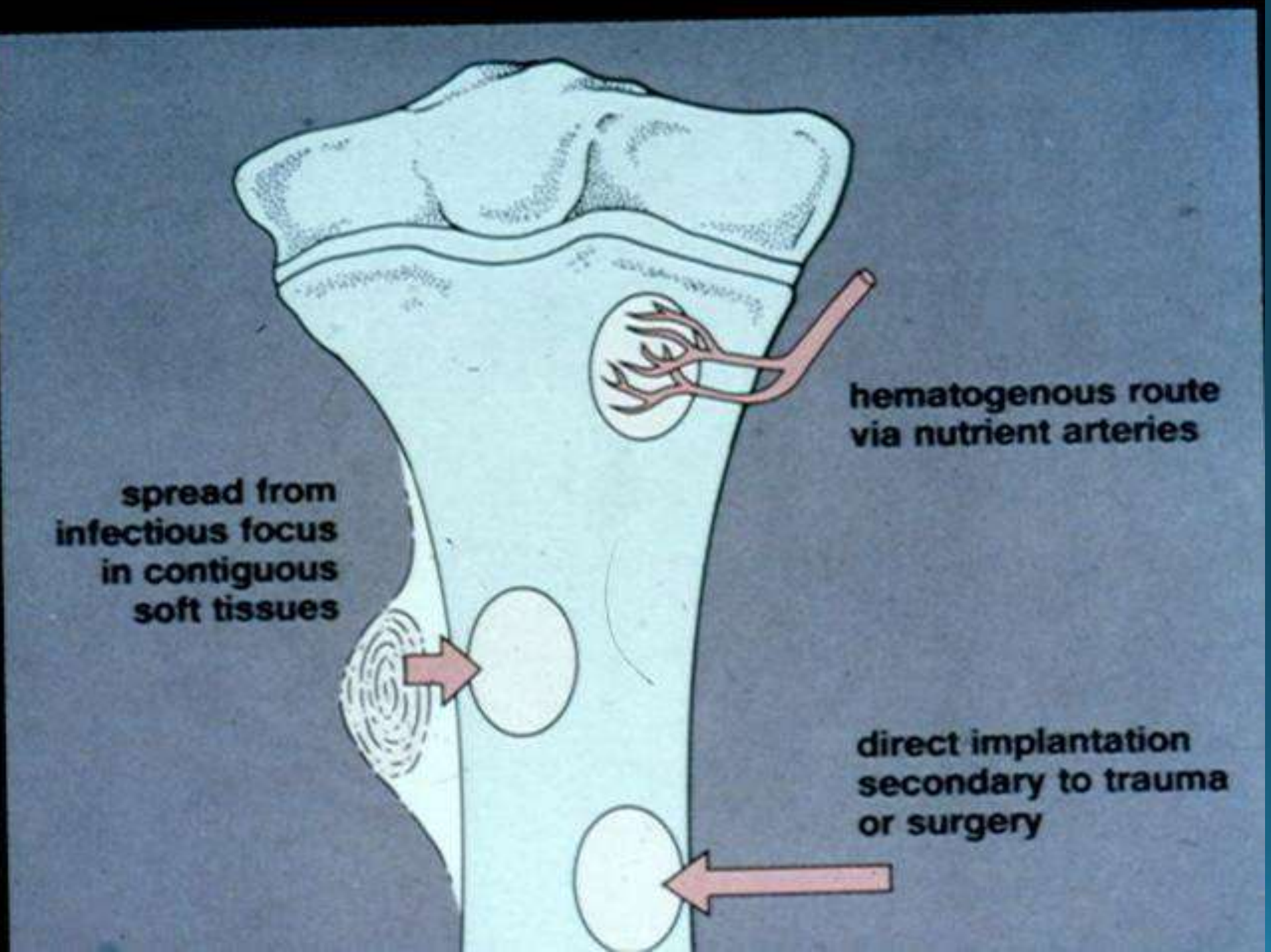
Osteomyelitis

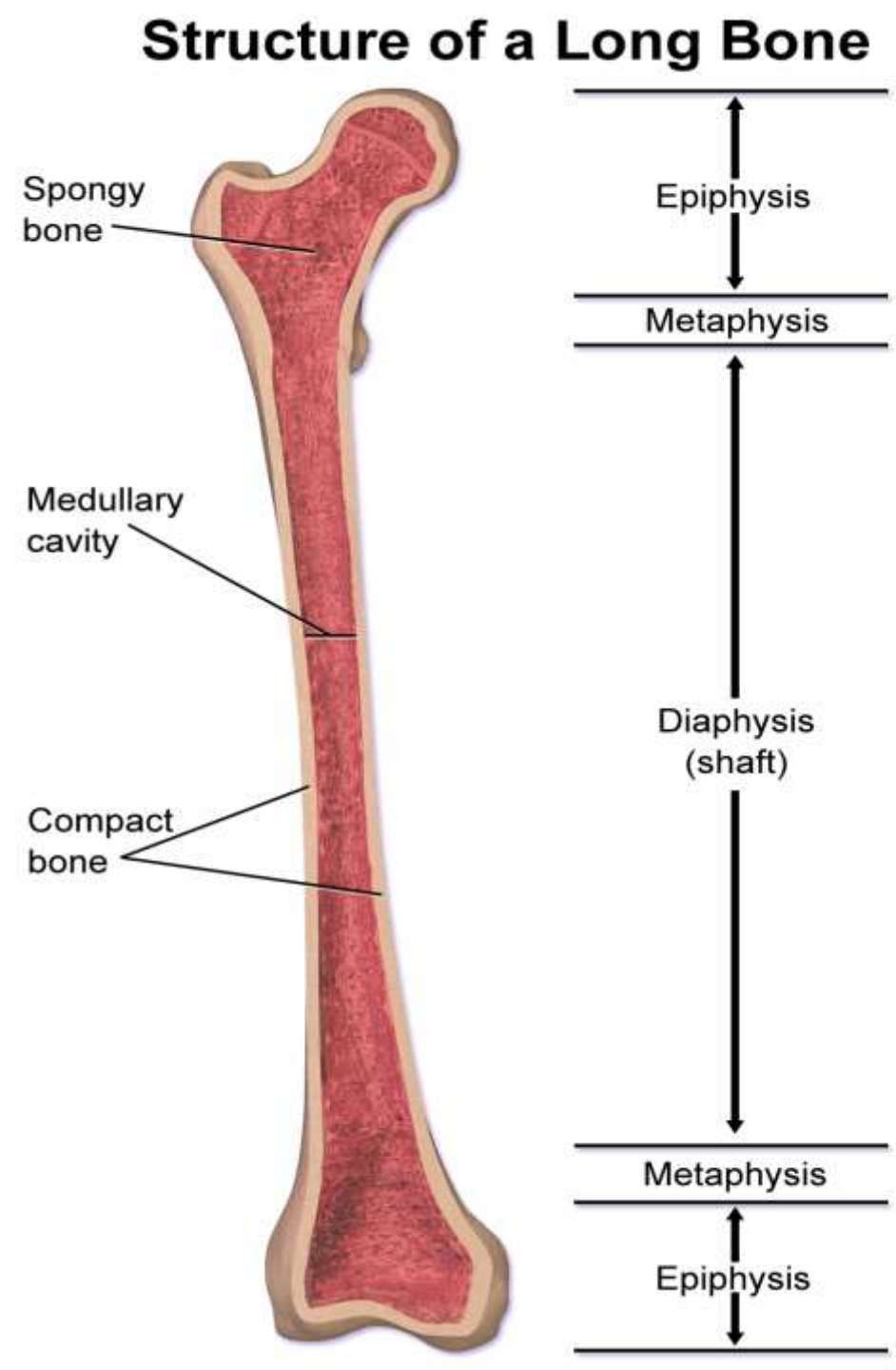
Classification

- Duration -------- Acute or Chronic
- Route of infection- Hematogenous or Exogenous
- Host response----- Pyogenic or Granulomatous

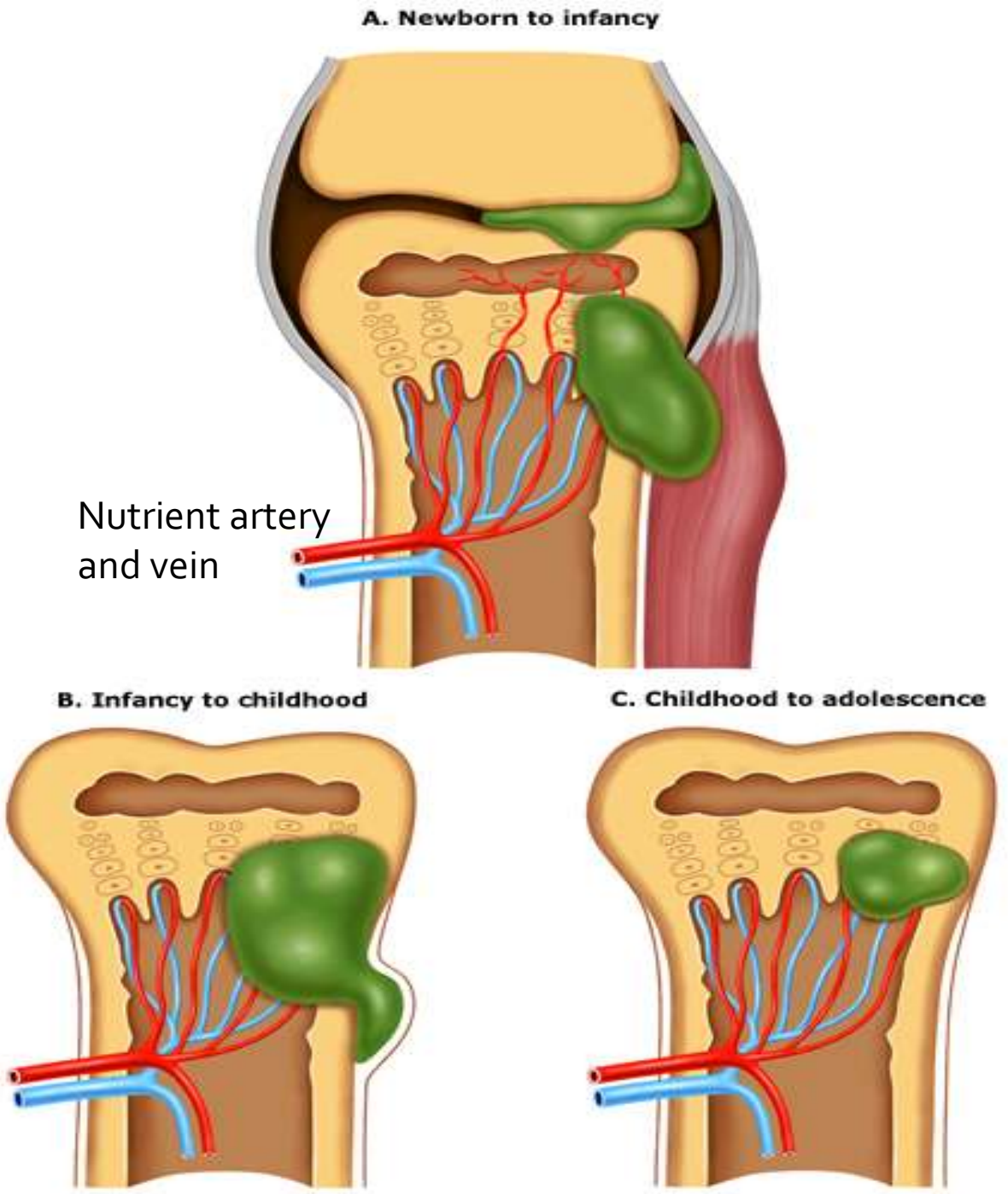
- Most cases of Osteomyelitis are Acute Hematogenous Osteomyelitis.

Source of Infection





Structure of long bone



young infants and neonates

- joint capsule extends to metaphysis
- rupture of the infection leads to septic arthritis.

older infants and young children

- thicker cortex and denser periosteum are barrier to infection
- Local tenderness from subperiosteal edema or abscess is the rule.

late childhood and adolescence

- well localized and rarely penetrates the bony cortex.
- windowing or drilling, are necessary to obtain infected material.

Osteomyelitis

- Pathogenesis
  - Organisms enter bone through nutrient artery
  - Bacteria are deposited in metaphyseal capillary Loops
  - Organisms proliferate and inflammation spreads
  - Transphyseal vessels in young children facilitate spread to the epiphysis causing growth issues.

Osteomyelitis

Pathogenesis:

- **Primary focus** of infection
- **Then---Spread** of infection with pus formation
- **Then---** Formation of **subperiosteal abscess**
- **Then--- Pus tracks** toward skin to form **a sinus**
- **Then---** Bone infarction **(Sequestrum)**
- **Then---** New bone formation **(involucrum)**

Epidemiology of Osteomyelitis

- 50% of cases occur in children < 5 yrs.
- Boys are 2x more likely affected
- 33% of children have history of trauma to affected bone
- all bones (long bone)
- Usual site metaphysis of growing bone

Pathogens by Age

Neonates:

- **Staph aureus**, Group B Strep, E coli

Infants:

- ***S. aureus***
- *Streptococcus agalactiae (GBS)*
- Gram negative enteric bacteria

Children ≤ 3 years old

- ***S. aureus***
- *Kingella kingae*
- *Streptococcus pneumoniae**
- *Streptococcus pyogenes*
- *Haemophilus influenzae type b**

Children > 3 years old

- ***S. aureus*** *N. gonorrhoeae (adolescent)*
- *S. pyogenes*

Staphylococcus aureus is the most common organism recovered.85%

** (in the) unvaccinated or incompletely vaccinated child*

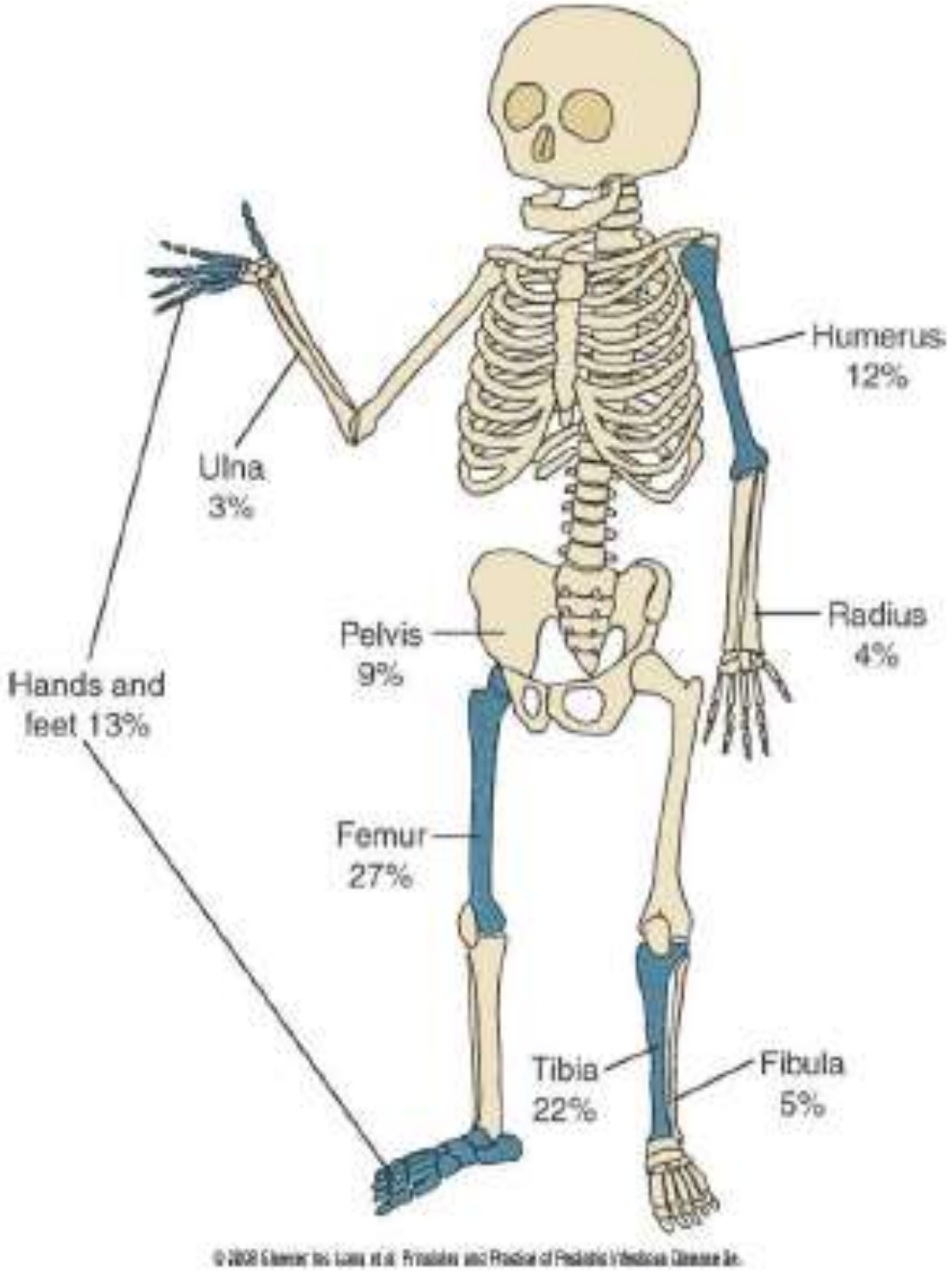
Unusual Pathogens in Osteomyelitis

- *Salmonella sp.*
  - Sickle cell disease
- *Bartonella henselae:*
  - Diaphyseal lesions common
  - May look like bone tumor
- *Serratia sp. or Aspergillus sp.*
  - Consider Chronic Granulomatous Disease (CGD)
- *Mycobacterium tuberculosis*
  - Spine involved in 50% of cases of musculoskeletal disease

MOST COMMON CLINICAL ASSOCIATION	MICROORGANISM
Frequent microorganism in any type of osteomyelitis	*Staphylococcus aureus* (susceptible or resistant to methicillin)
Foreign body–associated infection	Coagulase-negative staphylococci, other skin flora, atypical mycobacteria
Common in nosocomial infections	*Enterobacteriaceae*, *Pseudomonas aeruginosa*, *Candida* spp.
Decubitus ulcer	*S. aureus*, streptococci and/or anaerobic bacteria
Sickle cell disease	*Salmonella* spp., *S. aureus*, or *Streptococcus pneumoniae*
Exposure to kittens	*Bartonella henselae*
Human or animal bites	*Pasteurella multocida* or *Eikenella corrodens*
Immunocompromised patients	*Aspergillus* spp., *Candida albicans*, or *Mycobacteria* spp.
Populations in which tuberculosis is prevalent	*Mycobacterium tuberculosis*
Populations in which these pathogens are endemic	*Brucella* spp., *Coxiella burnetii*, fungi found in specific geographic areas (coccidioidomycosis, blastomycosis, histoplasmosis)

MICROORGANISMS ISOLATED FROM PATIENTS WITH OSTEOMYELITIS AND THEIR CLINICAL ASSOCIATIONS

- Children who are not immunized are at risk for :
  - *Haemophilus influenzae type b*
  - *Streptococcus pneumoniae*



Sites of Infection

Methicillin-susceptible *S. aureus MSSA* vs. Methicillin-resistant *S. aureus MRSA*

- MRSA Osteomyelitis is worse than MSSA Osteomyelitis
  - Subperiosteal abscess is more common in MRSA infections
  - Thrombosis seen with MRSA bone infections

Clinical Characteristics of Acute Osteomyelitis

- History of:
  - Skin lesion----infection
  - Sore throat----URTI
  - Trauma

Clinical Characteristics of Acute Osteomyelitis

- Fever
- Pain (point tenderness)
- Refusal to move affected extremity (pseudo paralysis)
- Systemic symptoms may be absent

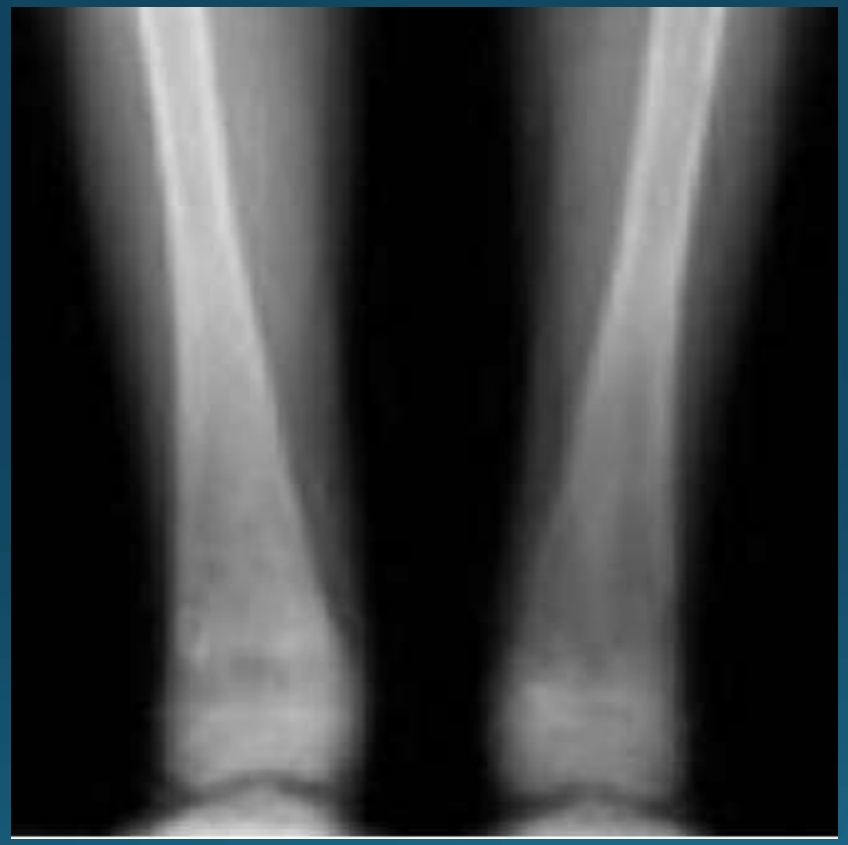
Physical Examination in Acute Osteomyelitis

- Focal swelling
- Warmth
- Redness
- Fistulous tract (rare)

Differential Diagnosis of Osteomyelitis

- Septic Arthritis
- Acute monoarticular rheumatoid arthritis
- Sickle cell crisis: Bone infarction in child with hemoglobinopathy
- Neurologic disorder (if infant not moving limb)
- Trauma
- Malignancy: Ewing's Sarcoma
- Gaucher's disease

Gaucher's disease



Bone infarction due to infiltration of Gaucher cells in the intramedullary space

Laboratory Diagnosis

- ESR – Elevated in 90%
  - Peaks at 3-5 days after treatment initiated
  - Normal after 3 weeks on treatment
  - Failure of ESR to decrease during the second week of treatment may indicate a need for surgical drainage or the development of chronic osteomyelitis
- CRP- Elevated in 98%
  - Peaks at 2nd day after treatment initiated
  - Normal at 7-10 days on treatment
- CBC: WBC normal or elevated

Laboratory Tests:

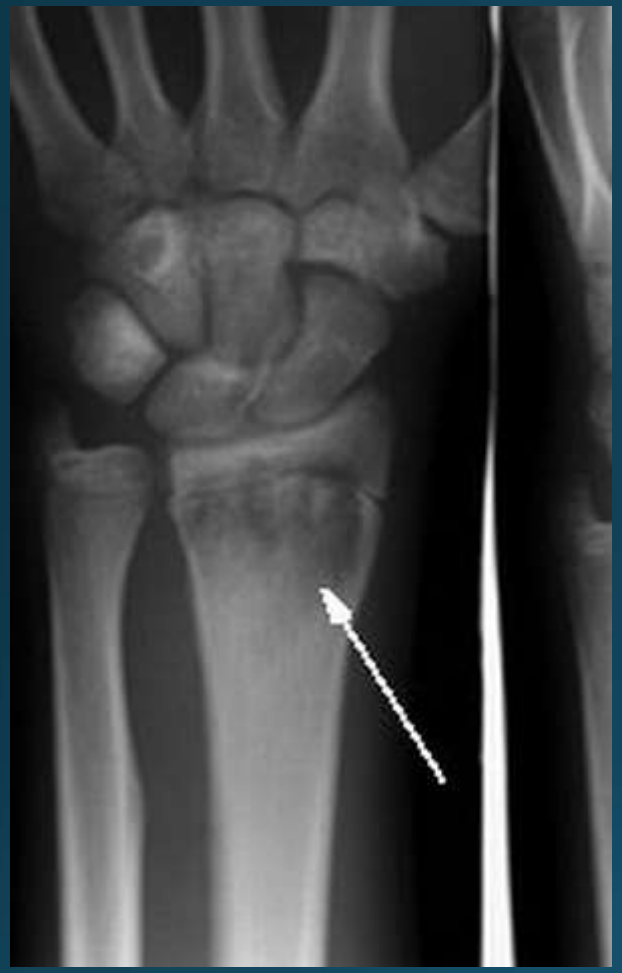
- CBC
- ESR+CRP
- Blood culture (+ve in 50-70%)
- Aspiration (Gram stain + culture and sensitivity)

Laboratory Diagnosis

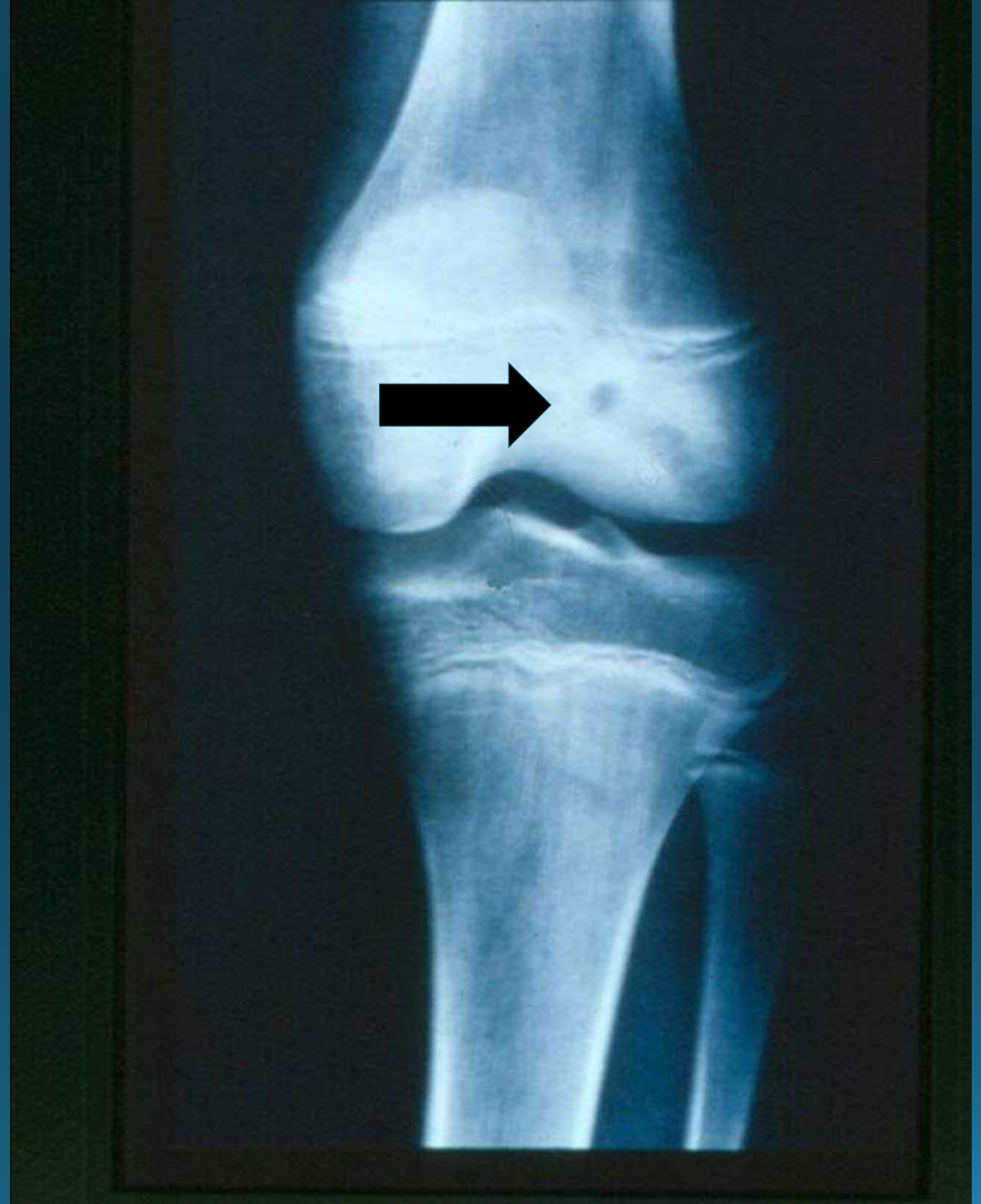
- With the increase in prevalence of MRSA –cultures are VERY important.
- Bacteriologic diagnosis can be made in 50- 80% of cases – enhanced by sending multiple cultures (blood and bone)
- **Bone abscess cultures WILL grow, even if patient has received several days of intravenous antibiotics prior to drainage.**

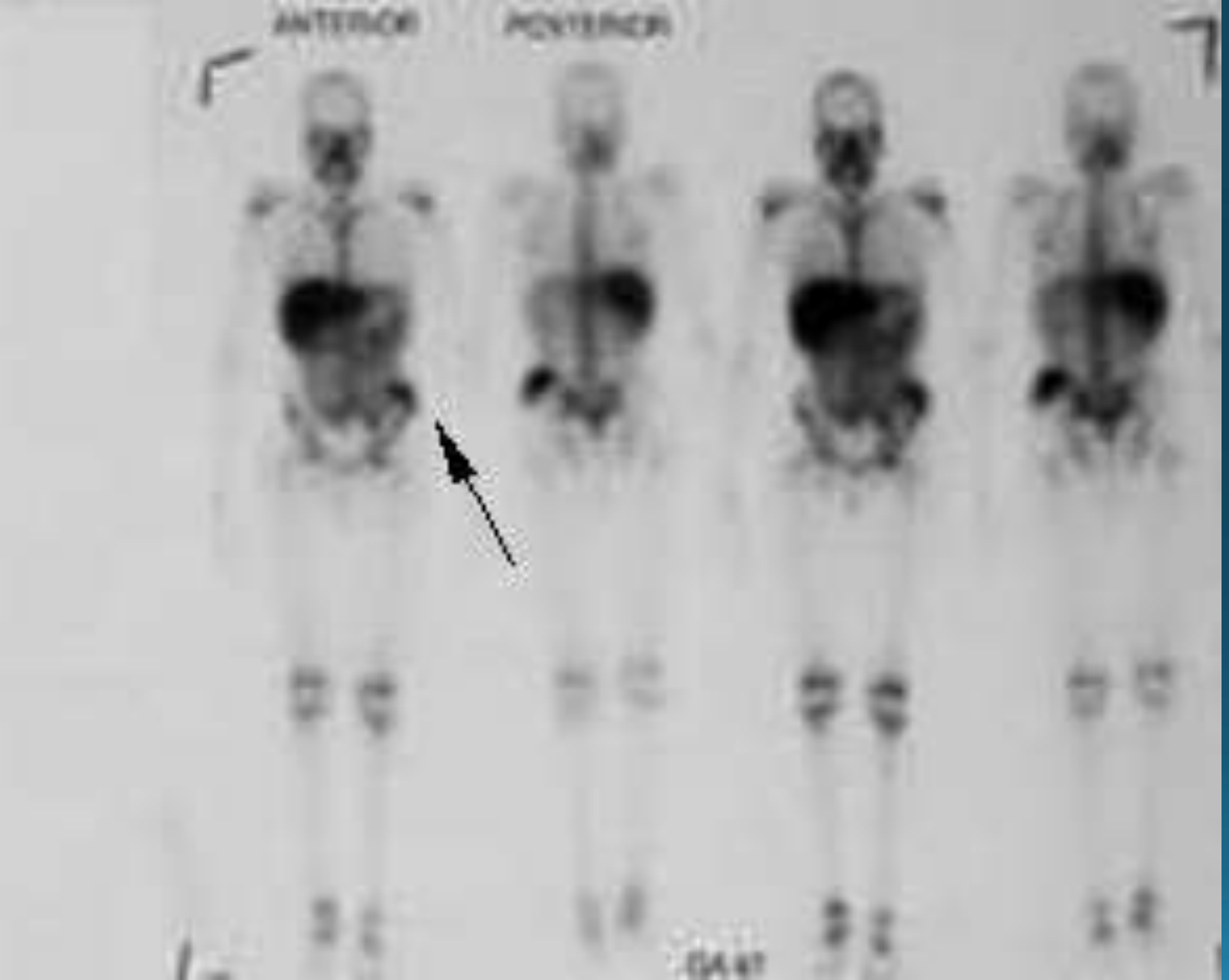
Radiologic Diagnosis

- Plain radiographs:
  - show lytic lesions and periosteal new bone formation
  - Takes 10-20 days after onset of symptoms
- Bone scans:
  - Particularly useful if multi-focal osteomyelitis is suspected
  - Sensitive but not specific
- MRI (test of choice)
- Computed tomography



Bony erosion of the anterior calcaneus and cuboid, suggestive of osteomyelitis





Bone Scan:

Focal area of increased uptake representing osteomyelitis in the region of the left iliac crest (arrow).

Treatment

- Medical:
  - The use of appropriate antibiotics early is critical for successful Rx
- Beta-lactam antibiotics are effective
- Clindamycin achieves high concentration in bone
- Vancomycin shows good bone penetration in animals however antimicrobial activity may be diminished due to conditions within bone
- Aminoglycosides offer less aid due to poor activity in areas of hypoxia and acidosis
- Fluoroquinolones have excellent bone penetration (>18 yrs old)

Osteomyelitis Empiric therapy

- Neonate:
  - Vancomycin or nafcillin **plus** cefotaxime
- ≤ 3 years
  - Vancomycin or nafcillin or clindamycin **plus** a third generation cephalosporin
- > 3 years
  - Vancomycin or nafcillin or clindamycin

Acute Osteomyelitis Duration of Treatment

- Historical data show < 3 weeks of treatment is associated with unacceptably high rates of relapse
- Duration usually ranges from 4-6 weeks
- Sequential IV to po antibiotic therapy is generally successful

Criteria for Changing to Oral Antibiotics

- Patient is improving
- Laboratory values are normalizing
- There is an oral antibiotic that has activity against the organism or the same spectrum of activity as the IV antibiotic
- Child can take large frequent doses of oral medicine
- Good f/u with a reliable family and PMD

Criteria for Changing to Oral Antibiotics

- Sometimes this can be done as early as a few days after initiation of IV therapy
- Try to avoid sending patient home with PICC line if patient meets criteria on previous slide
- There are good data to support treatment of childhood Acute Osteomyelitis
- with transition from IV to po therapy.
- Monitor child closely for response to treatment and for drug toxicity

Oral Antibiotic Doses for AHO

Antibiotic	Dose (mg/kg/dose)	Dose interval
Amoxicillin	25	q 6 hours
Cephalexin	25-37.5	q 6 hours
Dicloxacillin	25	q 6 hours
Clindamycin	10	q 8 hours

Note: Dose of beta- lactam antibiotics is 2-3x “normal” dose, dose of clindamycin is the upper end of “usual” dose

Acute Osteomyelitis Treatment

- If organism is MSSA or MRSA susceptible to clindamycin, discontinue vancomycin :

- Preferred antibiotics for MSSA:
  - IV Nafcillin or oxacillin, transition to PO dicloxacillin
  - IV Cefazolin, transition to PO cephalexin
  - IV Clindamycin transition to PO Clindamycin

Acute Osteomyelitis Treatment

- Treatment of other organisms depends on the ID and susceptibility pattern
- *K. kingae* is generally susceptible to all beta lactam antibiotics but is not susceptible to vancomycin or clindamycin

Complications

- Septicemia & metastatic abscesses
- Septic arthritis
- Growth disturbance (children)
- Pathological fracture
- Chronic osteomyelitis

Chronic Osteomyelitis

Chronic Osteomyelitis

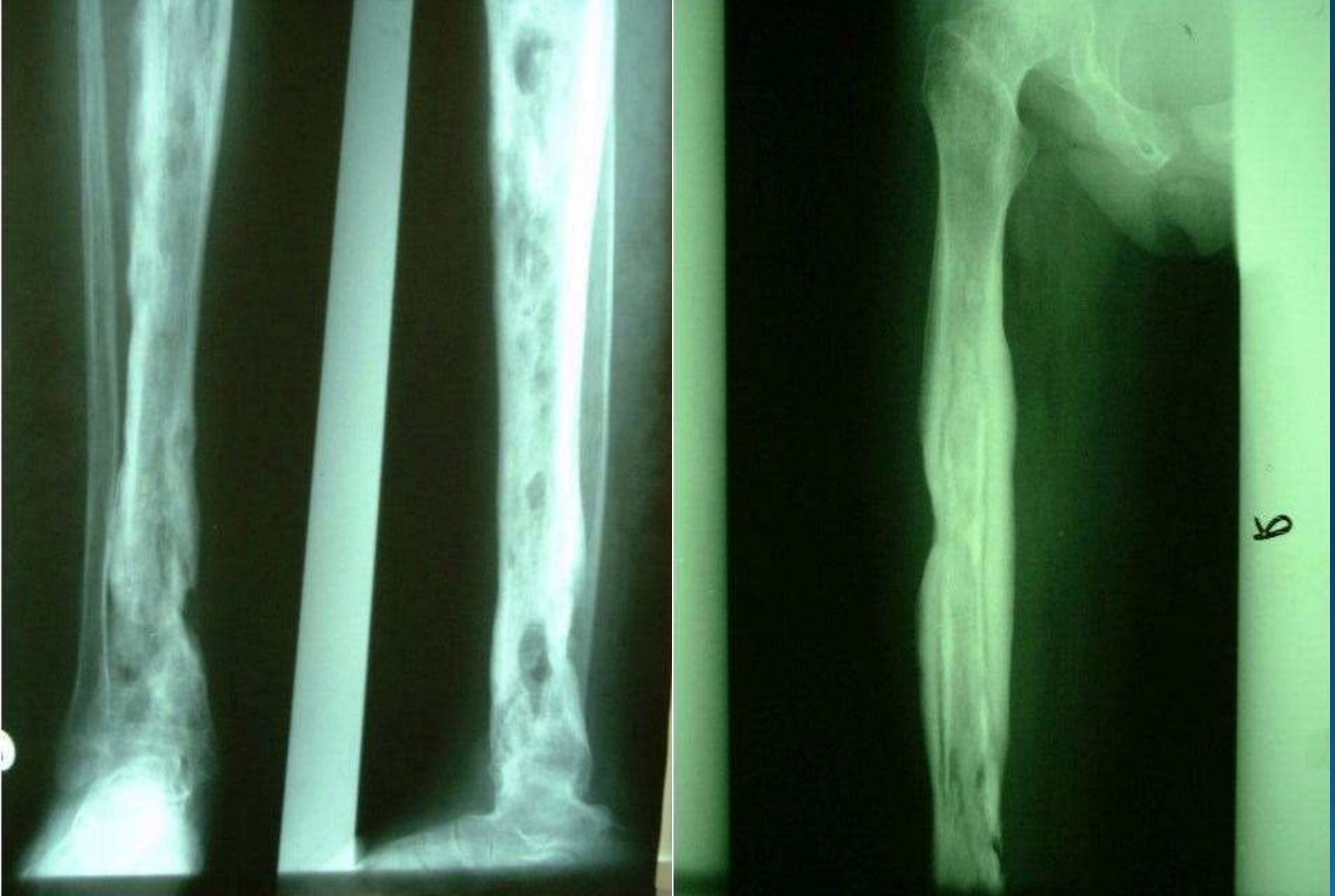
- Defined as S&S > 2 weeks + radiologic+ microscopic evidence.
- Uncommon if Acute Osteomyelitis treated well.
- DDX:
  - nonbacterial osteomyelitis (eg, chronic recurrent multifocal osteomyelitis)
  - Langerhans cell histiocytosis
  - large cell lymphoma
  - primary bone tumor

Chronic Osteomyelitis

- *S. aureus or* Polymicrobial
- Biopsy and culture of bone important (fistula tract cultures not helpful)
- Relapse rate is high
- Antibiotic treatment should be prolonged (4-6 months)
- Surgical treatment often necessary

Chronic Osteomyelitis

- Diagnosis:
  - C/P:
    - develop after surgical procedure, major trauma or unsuccessful treatment of Acute Osteomyelitis
    - Sinus tract
  - Acute Phase reactants usually mildly elevated but can be normal.
  - X ray:
    - Bone rarefaction surrounded by the dense sclerosis, sequestration and cavity formation
  - CT or MRI could differentiate acute from chronic osteomyelitis:
    - thickening of the fibular cortex
    - sinus tract that contain
    - sequestrum.



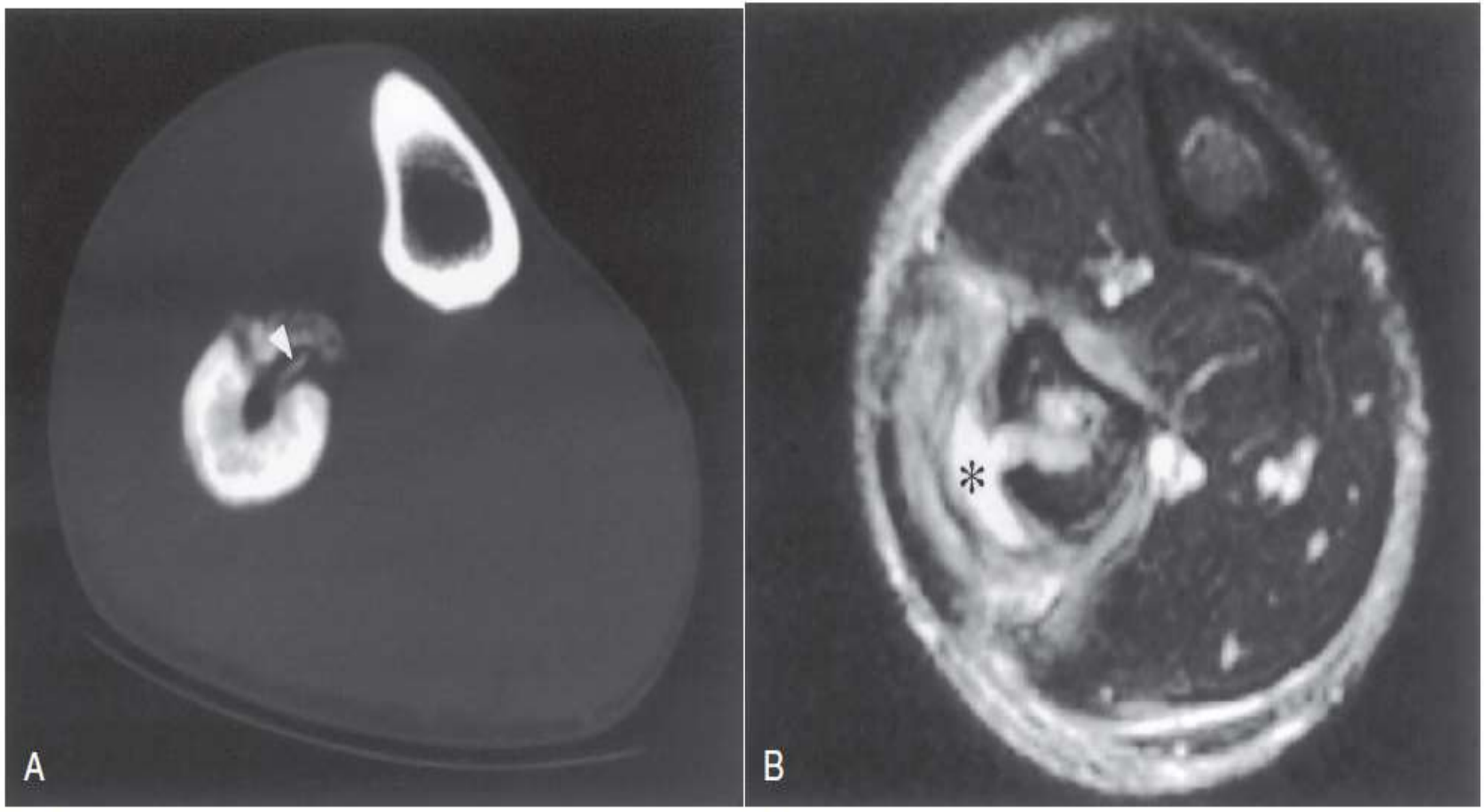
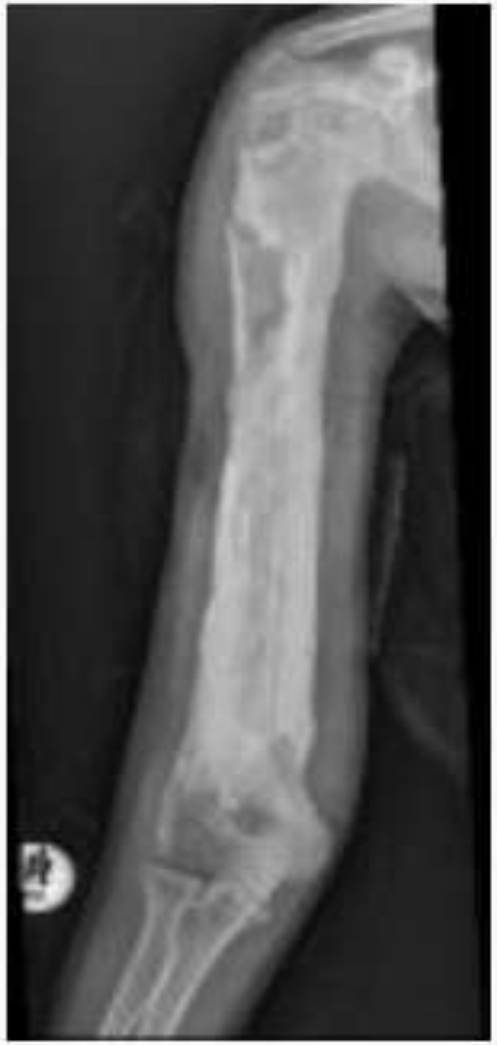
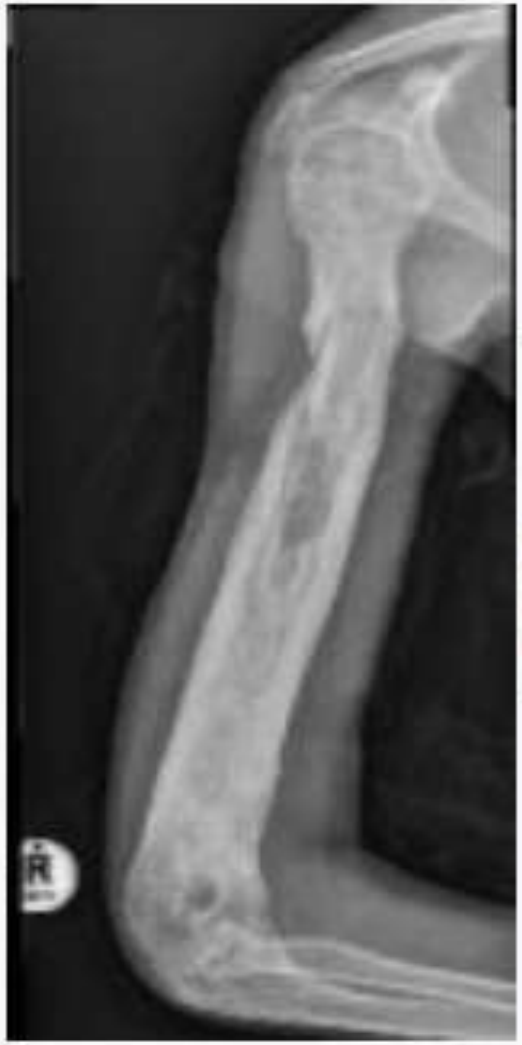


FIGURE 55-7 ■ Chronic osteomyelitis. **A,** CT reveals thickening of the fibular cortex and a sinus tract that contains a sequestrum *(arrowhead)*. **B,** T2-weighted axial MR image from a different level shows a lateral sinus tract through the cortex communicating with a soft tissue abscess *(asterisk)*. Edema is surrounding the entire fibula. (Courtesy Leanne Seeger, MD.)



Chronic osteomyelitis of right humerus



Lateral x ray. Note the sequestrum appearing as a *'bone - within - a - bone'*

The **sequestrum** removed at operation. A window through the surrounding *involucrum* had to be cut to allow access.

Chronic Osteomyelitis

- Treatment:
  - Removing devitalized bone
  - Long-term antibiotics, 4-12 months duration
  - The duration of therapy is determined on a case-by-case basis.
  - D/C IV therapy after a four-week interval during which all bony changes are indicative of healing (eg, increased bone density, decrease in the size of lytic areas in bone).
  - May need repeated surgical debridement and bone grafting
  - Obtain radiographs monthly

Chronic Osteomyelitis

- Adjunctive measures:
  - ? local irrigation with antimicrobial solutions with or without detergents
- surgical implantation of beads impregnated with antibiotics, have not been shown conclusively to affect outcome. (usually gentamicin, tobramycin, and vancomycin)
  - local antibiotic delivery via implantable pumps
  - suction vacuum devices
  - bone grafts, skin grafts, and muscle flaps to eliminate dead space and improve vascularity.

Complications

- **Recurrence & Recurrence & Recurrence**
- Pathological fractures
- Growth disturbance
- Amyloid disease
- Epidermoid carcinoma of the fistula


Thank
You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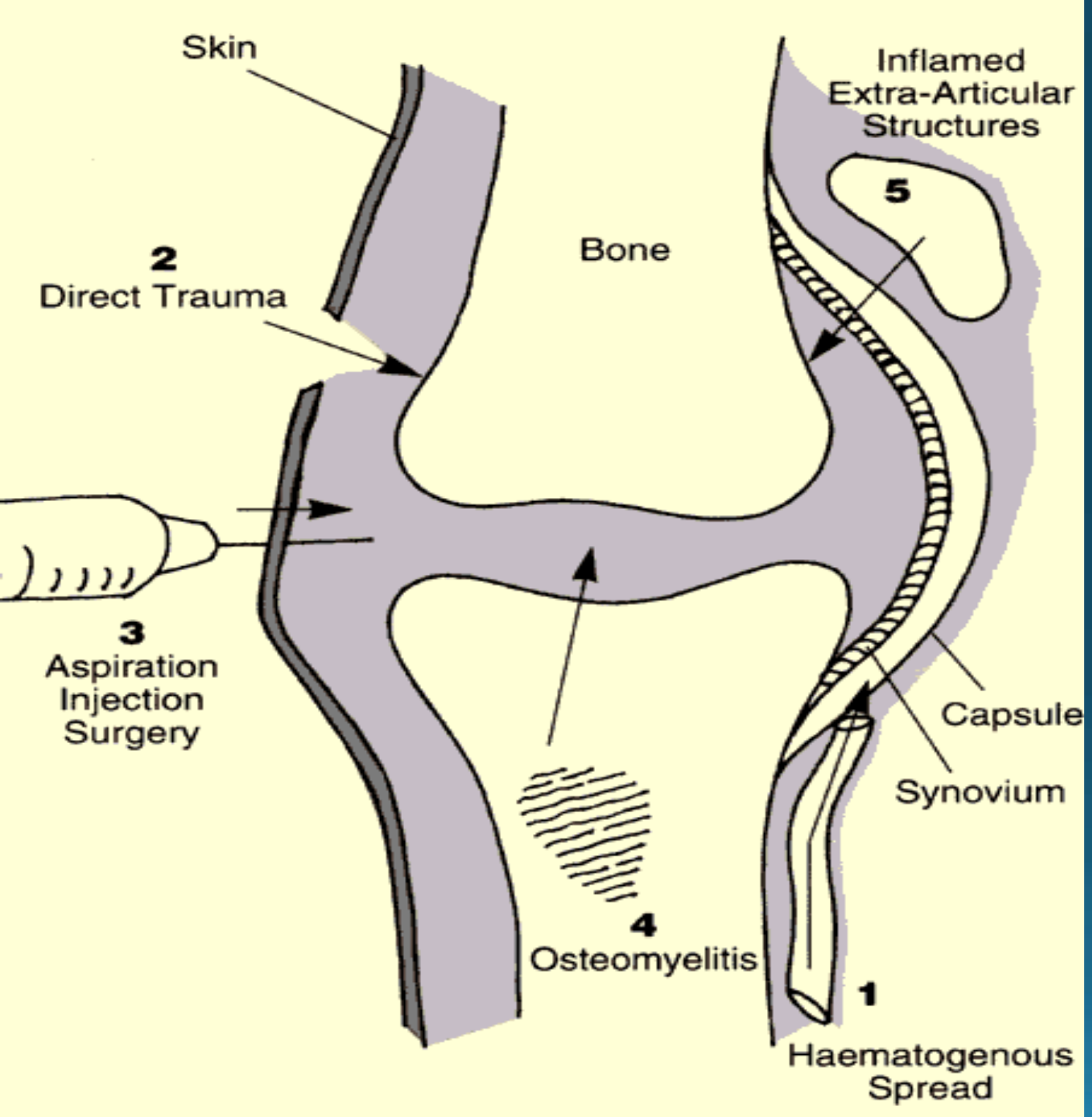
Septic (Pyogenic) Arithrtis

Septic Arthritis Epidemiology

- Occurs at all ages with peak< 3yrs
- Risk Factors:
  - Trauma
  - Recent URI
  - Hemoglobinopathy
  - Immunodeficiency
  - IV Drug Abuse
  - Diabetes
  - Rheumatoid Arthritis



Route of infection

1. **dissemination of pathogens via the blood, from distant site…. (most common)**
2. entry via penetrating trauma
3. entry via iatrogenic means
4. dissemination from an acute osteomylitic focus
5. dissemination from adjacent soft tissue infection

Septic Arthritis: Clinical Presentation

- Systemic Sx: fever, irritability, malaise, anorexia
- Pain is an early manifestation
- Progression presents with erythema and swelling
- Upper extremity: refusal to move arm
- Lower extremity: limp, refusal to walk
- Exam shows: decreased ROM
- Warm, tender, swollen joint

Septic Arthritis

- Usually (90%) monoarticular
- Polyarticular with certain organisms

Septic Arthritis: Organisms

Staphylococcus aureus is the most common cause of septic arthritis.

Pathogens by Age

Infants:

- ***S. aureus*, *Streptococcus agalactiae (GBS)*, Gram negative enteric bacteria**

Children ≤ 3 years old

- ***S. aureus*, *Kingella kingae*, *Streptococcus pneumoniae**, *Streptococcus pyogenes*, *Haemophilus influenzae type b***

Children > 3 years old

- ***S. aureus*, *N. gonorrhoeae (adolescent)*, *S. pyogenes***

** in the unvaccinated or incompletely vaccinated child*

Site	#	%
Knee	467	41
Hip	287	25
Ankle	143	13
Elbow	116	10
Shoulder	53	5
Other: SI/hands/feet	70	6

Table 81-1 Bone and Joint Infections. Gutierrez, KM. Principles and Practice of Pediatric Infectious Disease 3rd ed. Long, Pickering and Prober. P 483 Churchill Livingstone Elsevier Limited 2008

Sites of Septic Arthritis in 1050 children

In general, children with pyogenic arthritis have higher fever and higher markers of inflammation compared to children with transient synovitis

An example of one scoring system*

1. Fever
2. Non- weight bearing
3. ESR> 40
4. WBC > 12,000

If 0 predictors: Risk <0.2% of pyogenic arthritis
If 1 predictor: Risk 3.0% "
If 2 predictors: Risk 40% "
If 3 predictors: Risk 93% "
If 4 predictors: Risk 99% "

*Kocher MS, Zurakowski D, Kasser JR. Differentiating between septic arthritis and transient synovitis of the hip in children: an evidence-based clinical prediction algorithm. J Bone Joint Surg Am 1999;81:1662.

Laboratory Diagnosis of Septic Arthritis

- Elevated ESR, CRP and WBC
- Synovial fluid analysis:
  - WBC most helpful
  - Protein and glucose not specific-
  - Culture is positive in 50-60%
- Blood culture-positive in 40%

Joint Fluid

Diagnosis	WBC/mm3	%PMNs
Normal	<150	<25
Bacterial Arthritis	>50,000	>90
TB Arthritis	10,000-20,000	>50
Lyme Arthritis*	40,000-80,000	>75
Viral Arthritis	3,000-50,000	<50
JIA and RF	25,000-50,000	>70

*Wide range of counts reported.

Septic Arthritis: Imaging

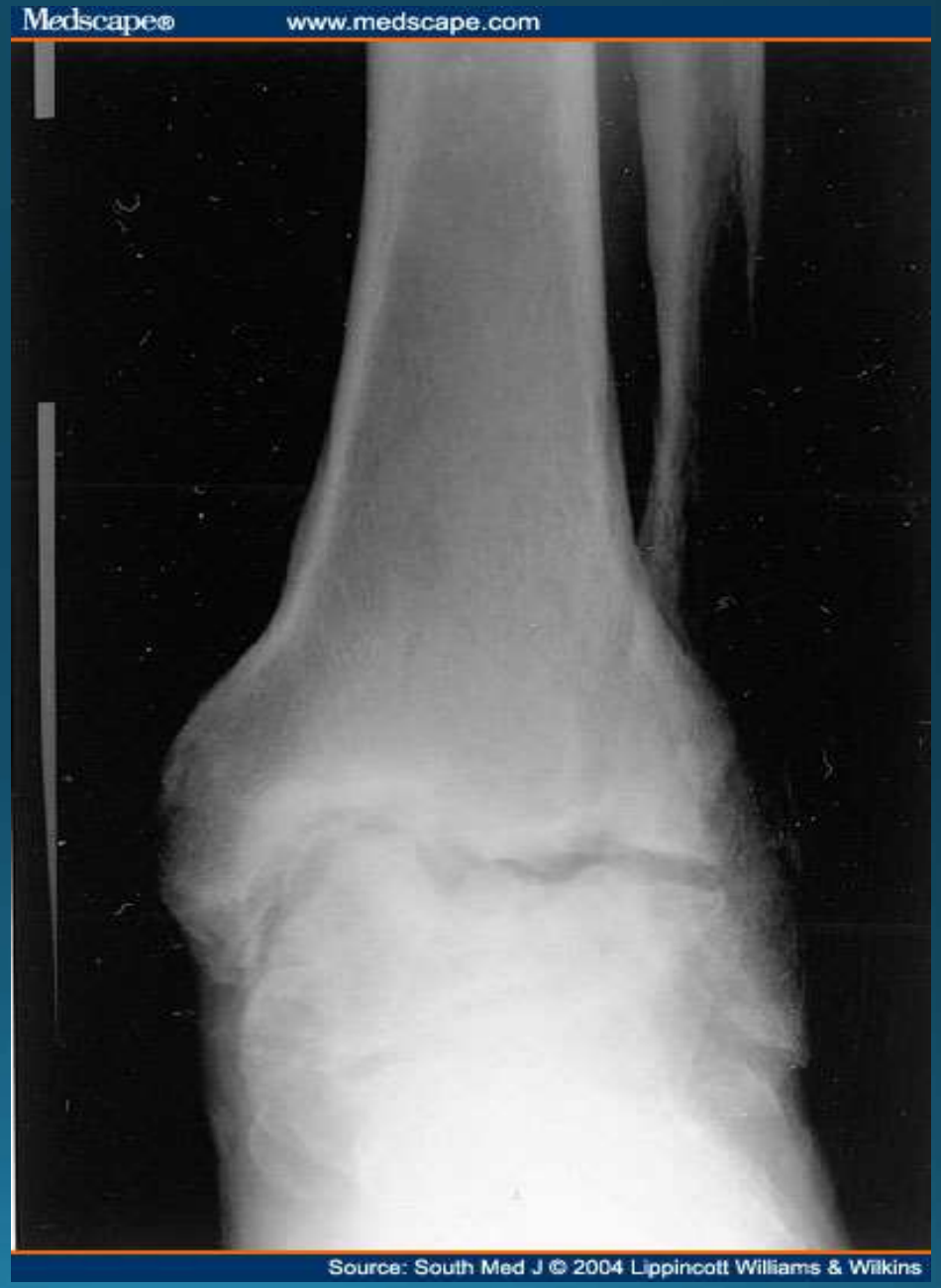
- Limited role for X ray:
  - Soft tissue swelling and widening of the joint space can be seen early on plain films
  - Erosion of the subchondral bone can be present 2-4 weeks after onset of symptoms
- **MRI is very sensitive,** CT is helpful and bone scan shows increased activity in the blood phase and increased bony uptake on both sides of the joint

Septic Arthritis: Imaging

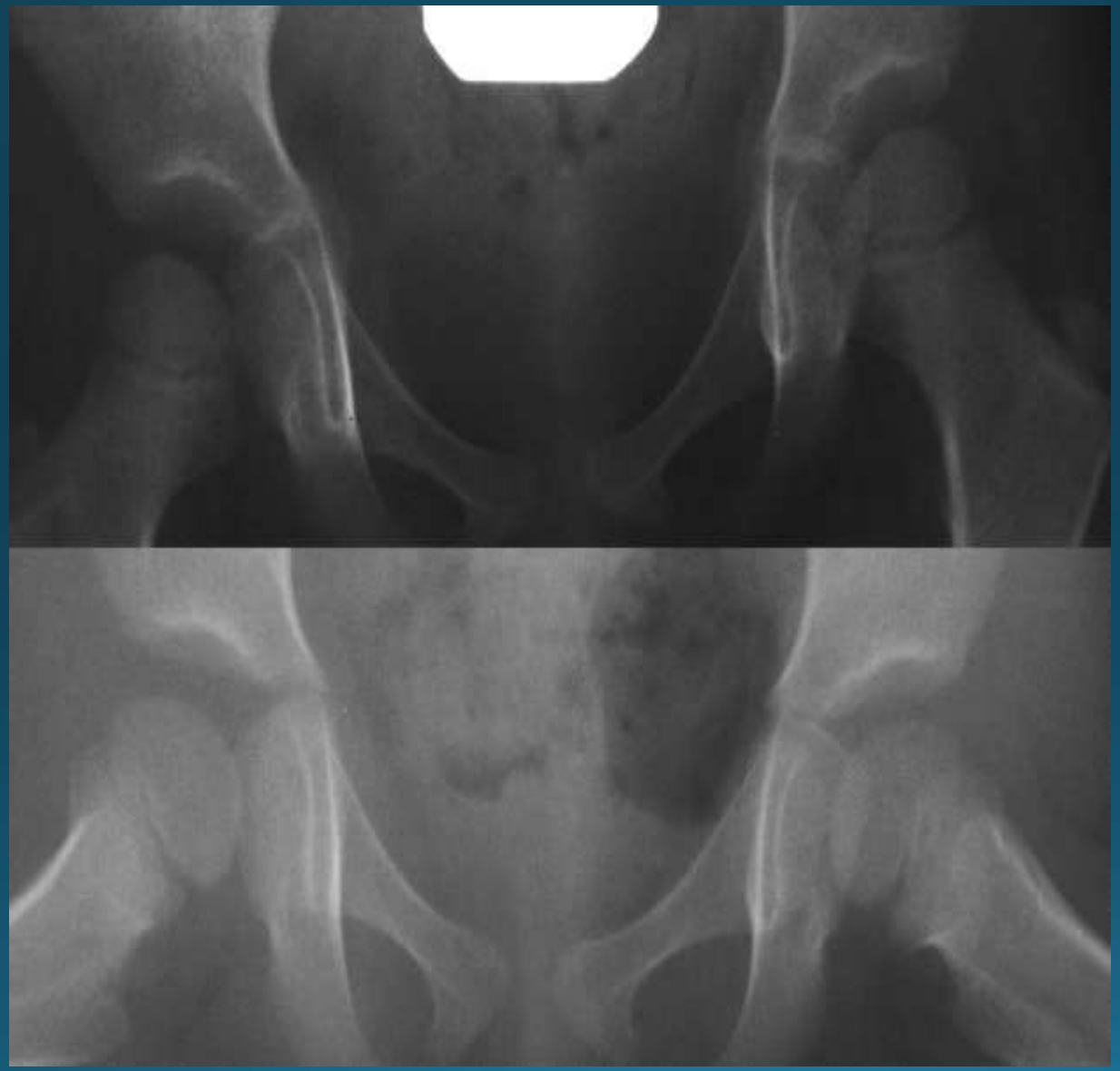
Ultrasonography

- The presence of fluid is not specific for joint infection
- Helps to differentiate : septic arthritis from some conditions (e.g., soft tissue abscesses, tenosynovitis) in which treatment may differ.
- Can be used to:
  - Define the extent of septic arthritis
  - Help guide treatment.

Septic arthritis of the ankle with erosion of margins



widening of the joint space



Treatment of Septic Arthritis

- **Surgical** drainage and debridement :
  - To decompress the joint space so that blood flow is not compromised and removal of inflammatory debris decreases the inflammatory destruction
  - **Mandatory for septic arthritis of the hip and shoulder.**
  - without decompression the blood supply to the head of the femur or humorous may lead to avascular necrosis (surgical emergency)

Deferential diagnosis

- **Osteomyelitis**:
- **An acute haemarthrosis** :
  - Post-traumatic or due to a haemophilic bleed.
- **Transient toxic synovitis**
  - Milder.
  - Diagnosis of exclusion.
- **Rheumatic fever**

Treatment of Septic Arthritis

- **Medical**:
  - Neonates:
    - Same as Acute Osteomyelitis
  - Children ≤ 5 years:
    - Antistaphylococcal antibiotic plus cefotaxime or cefuroxime
  - Children > 5 years
    - Antistaphylococcal antibiotic

Septic Arthritis: Empiric Antibiotic Therapy*

Age	Likely Pathogen	Antibiotic Selection
>5 yrs	*S. aureus* *S. pyogenes* *Neiserria gonorrhoeae (adolescent)*	Nafcillin *or* Clindamycin *or* Vancomycin Ceftriaxone
<5 yrs	*S. aureus* *H. influenzae (* type b if not immunized) *Kingella kingae* *S. pyogenes* *S. pneumoniae*	Nafcillin *or* Clindamycin *or* Vancomycin *plus* Cefotaxime *or* Ceftriaxone *or*
Neonate	*S. aureus* Group B streptococcus Enteric gram negatives	Nafcillin *or* Vancomycin *plus* Gentamicin or Cefotaxime

Treatment of Septic Arthritis

- Antimicrobial therapy should be given intravenously until:
  - infection controlled
  - inflammatory markers are normalizing
  - no further need for surgical interventions
  - physical examination is improving.

- Transition from intravenously to oral therapy follows same guidelines as for Acute Osteomyelitis.

- Total duration 4 weeks.

Prognosis of Septic Arthritis

- 10-25% of children have residual joint dysfunction
  - Abnormalities of bone growth
  - Limitations to joint mobility
  - Unstable articulation of the joint
- May not be evident for months to years after infection

Poor prognostic factors of Septic Arthritis

- Risk factors:
  - Age < 6 months
  - Infection of the adjacent bone (less likely in younger children due to epiphysis barrier)
  - Infection of the hip or shoulder
  - Delay of > 4 days in decompression and antimicrobial Rx
  - Prolonged time to sterilization of synovial fluid
  - *S. aureus* and *H. influenzae* carry higher risks than *N. gonorrhoeae* and *N. meningitidis*

Thank you

استخدم المنديل عند السعال أو العطس لتغطية الفم والأنف به، وتخلص منه في سلة النفايات ثم أغسل يديك جيداً أو استخدم أعلى الذراع وليس اليدين

Cover your mouth and nose with a tissue when you cough or sneeze. Put used tissue in the waste basket and wash your hands thoroughly. If you don't have a tissue, cough or sneeze into your upper sleeve or elbow, not your hands

Most common causes of bacterial arthritis in children children according to age

Age group	Most common bacteria
<3 months	*Staphylococcus aureus* (MSSA and MRSA)
	Group B streptococcus (*Streptococcus agalactiae*)
	Gram negative bacilli
	Neisseria gonorrhea
3 months to 3 years	*S. aureus* (MSSA and MRSA)
	Kingella kingae
	Group A streptococcus (*S. pyogenes*)
	Streptococcus pneumoniae
	Haemophilus influenzae type b (Hib) (in incompletely immunized children in regions with low Hib immunization rates)
>3 years	*S. aureus* (MSSA and MRSA)
	Group A streptococcus
	S. pneumoniae
	N. gonorrhea (in sexually active adolescents)

MSSA: methicillin-susceptible *S. aureus*; MRSA: methicillin-resistant *S. aureus*.

Gram-positive bacteria	
Staphylococcus aureus	All ages; may cause polyarticular infection; MRSA may be associated with venous thromboembolism and pulmonary disease; possible associated skin or soft tissue infection
Coagulase-negative staphylococci	Most common cause of bacterial arthritis associated with prosthetic joints
Group A streptococcus (S. pyogenes)	Concurrent varicella zoster virus infection
Streptococcus pneumoniae (pneumococcus)	Children younger than two years of age; children older than two years of age with underlying medical condition (eg, sickle cell disease, immunodeficiency, etc)
Group B streptococcus (Streptococcus agalactiae)	Infants younger than three months of age
Nocardia asteroides	Chronic monoarticular arthritis with a granulomatous reaction

Gram-negative bacteria	
Haemophilus influenzae type b (Hib)	Incompletely immunized children in areas with low Hib immunization rates
Neisseria gonorrhoeae	Newborns; usually affects joints below the hip; may cause polyarticular infection
	Sexually active adolescents; usually occurs as part of disseminated infection with fever and rash; in girls may precede onset of menses
Neisseria meningitidis	May cause polyarticular infection; associated rash
Salmonella species	Children with sickle cell disease or related hemoglobinopathies
Pseudomonas aeruginosa	Puncture wounds; injectable drug use
Borrelia burgdorferi (Lyme disease)	Tick bite; history of erythema migrans rash; travel to or living in an endemic area; intermittent inflammatory arthritis
Brucella	Travel to or living in an endemic area; ingestion of unpasteurized dairy products; chronic monoarticular arthritis with a granulomatous reaction
Mycobacteria (tuberculosis and atypical species)	Chronic monoarticular arthritis with a granulomatous reaction

SYNOVIAL FLUID FINDINGS

	Normal	Osteoarthritis	Rheumatoid and other inflammatory arthritides	Septic arthritis
Gross appearance	Clear	Clear	Opaque	Opaque
Volume (ml)	0–1	1–10	5–50	5–50
Viscosity	High	High	Low	Low
Total white cell count/mm^3	<200	200–10,000	5000–75,000	>50,000
% Polymorphonuclear cells	<25%	<50%	>50%	>75%

Pathogens causing osteomyelitis in patients with other risk factors:

- Trauma
  - Mixed gram negative, gram positive and anaerobic bacteria

- IV Drug Abuse
  - Sternal osteomyelitis with *S. aureus*, *P. aeruginosa*, *Candida* species

Pathogens causing osteomyelitis in patients with other risk factors:

- Diabetes
  - Mixed: *S. aureus* is usually present, coagulase negative staphylococci, streptococci, enterobacteraciae, anaerobes

Criteria for Changing to Oral Antibiotics

- Patient is improving
- Laboratory values are normalizing
- There is an oral antibiotic that has activity against the organism or the same spectrum of activity as the IV antibiotic
- Child can take large frequent doses of oral medicine
- Good f/u with a reliable family and PMD

Criteria for Changing to Oral Antibiotics

- Sometimes this can be done as early as a few days after initiation of IV therapy
- Try to avoid sending patient home with PICC line if patient meets criteria on previous slide
- There are good data to support treatment of childhood Acute Osteomyelitis
- with transition from IV to po therapy.
- Monitor child closely for response to treatment and for drug toxicity

Oral Antibiotic Doses for AHO

Antibiotic	Dose (mg/kg/dose)	Dose interval
Amoxicillin	25	q 6 hours
Cephalexin	25-37.5	q 6 hours
Dicloxacillin	25	q 6 hours
Clindamycin	10	q 8 hours

Note: Dose of beta- lactam antibiotics is 2-3x “normal” dose, dose of clindamycin is the upper end of “usual” dose