

Osteomyelitis

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What is a Clinical Pathway?



An evidence-based guideline that decreases unnecessary variation and helps promote safe, effective, and consistent patient care.

Objectives of Pathway



- Engage in multi-specialty collaboration in management of acute hematogenous osteomyelitis
- Clarify appropriate indications and timing of imaging
- Consolidate sedated procedures in work-up & management whenever possible
- Optimize empiric and targeted therapy for antimicrobial stewardship
- Identify indications for biopsy +/- surgical drainage
- Tailor therapy for patients at high risk for complications to reduce adverse long-term outcomes
- Decrease length of stay

Why is Pathway Necessary?



- Acute hematogenous osteomyelitis is a relatively rare condition in children, but delayed diagnosis can result in significant morbidity
- Successful management requires coordination between multiple subspecialties including orthopedic surgery, infectious disease, and pediatric hospital medicine
- It is important to define and standardize which children with osteomyelitis would benefit from surgical intervention
- Prior to creation of this pathway, there was not a standardized approach at CT Children's for diagnosis or management

Background



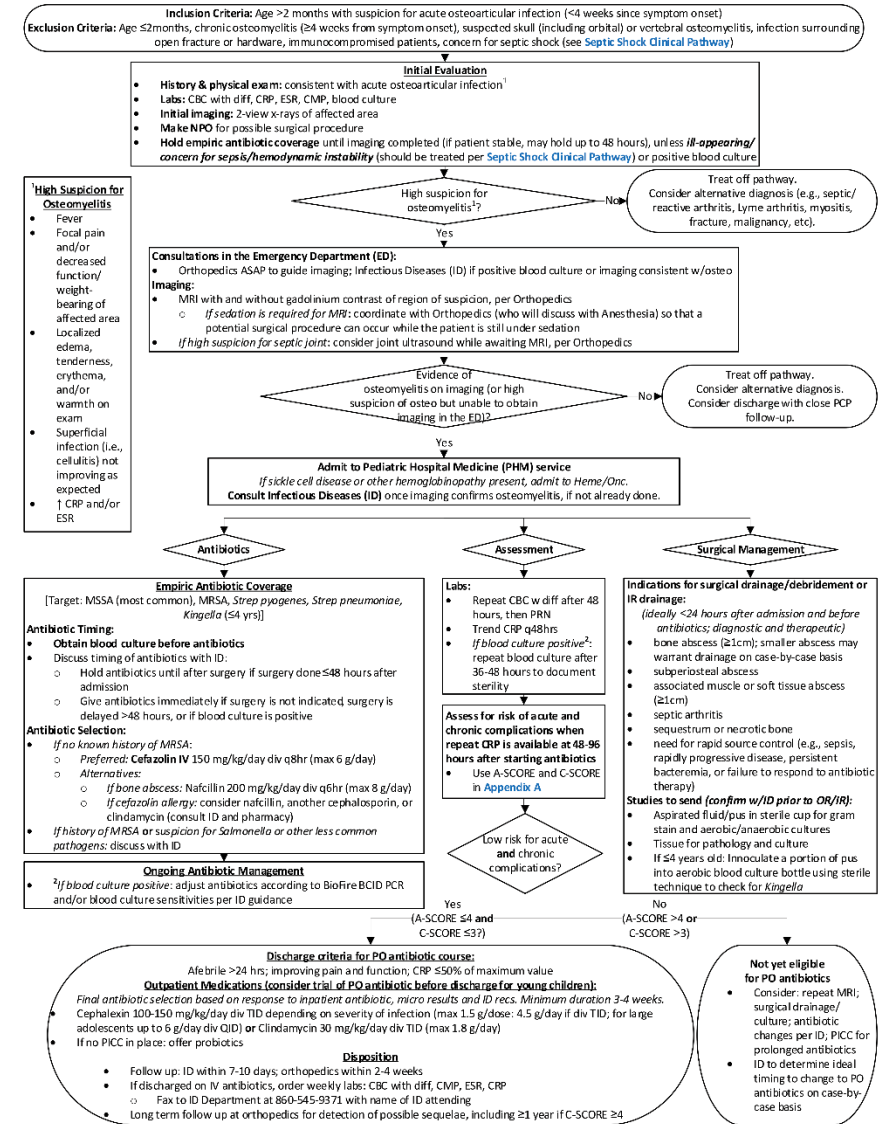
- The incidence of acute hematogenous osteomyelitis in children ranges from 1.2 to 13 per 100,000 children per year
- Fever and focal pain are the most common presenting symptoms, but children can present in septic shock
- Many other conditions can mimic osteomyelitis, including fracture, malignancy, transient synovitis, juvenile idiopathic arthritis, post-infectious arthritis, myositis, and septic arthritis, so proper work-up and imaging is crucial for proper diagnosis
- The role of surgical procedures can be controversial and often case-dependent
- Clinical prediction models can be utilized to predict acute and chronic complications from osteomyelitis, which in turn can guide proper therapy

CLINICAL PATHWAY: Osteomyelitis

THIS PATHWAY
SERVES AS A GUIDE
AND DOES NOT
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This is the Osteomyelitis Clinical Pathway.

We will be reviewing each component in the following slides.



Inclusion Criteria: Age >2 months with suspicion for acute osteoarticular infection (<4 weeks since symptom onset)

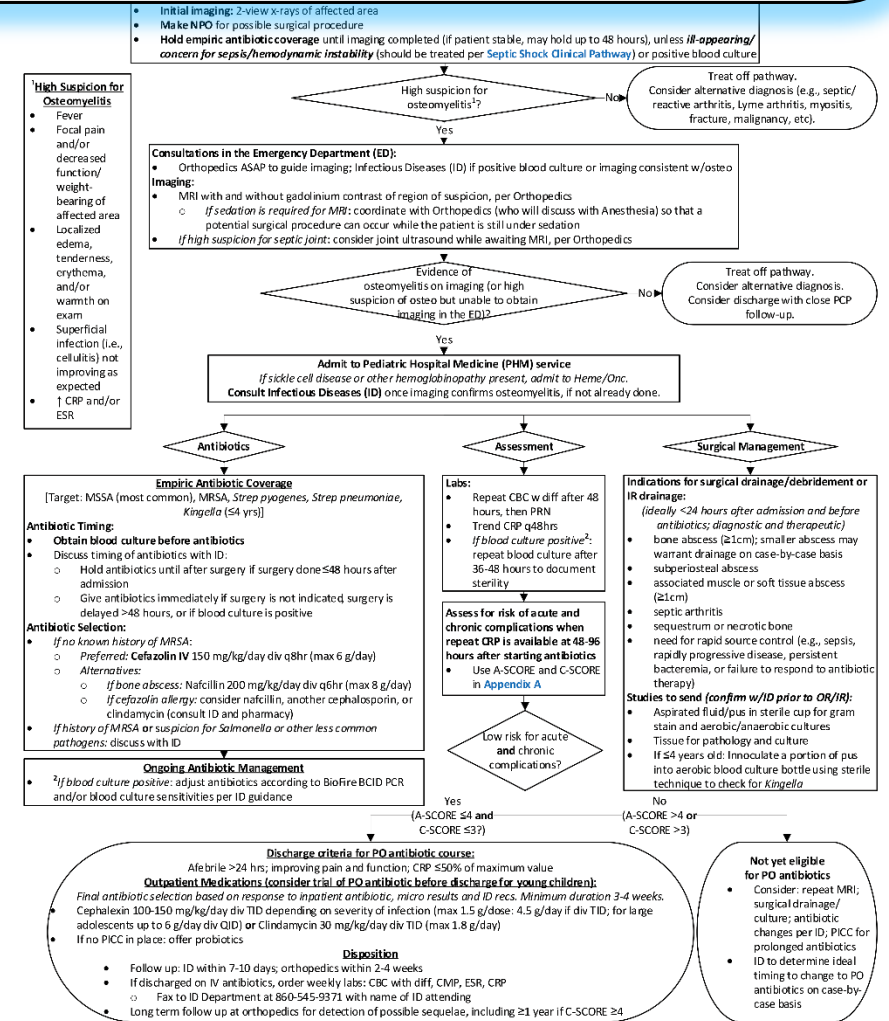
Exclusion Criteria: Age ≤2months, chronic osteomyelitis (≥4 weeks from symptom onset), suspected skull (including orbital) or vertebral osteomyelitis, infection surrounding open fracture or hardware, immunocompromised patients, concern for septic shock (see [Septic Shock Clinical Pathway](#))

Inclusion Criteria:

- Must be acute (<4 weeks) since onset of symptoms to qualify for pathway

Exclusions:

- If there are infections around the eye, refer to Preseptal and Orbital Cellulitis pathway
- Suspected osteomyelitis around a fracture/open hardware or in an immunocompromised patient requires individualized management off-pathway
- Patients presenting with concern for septic shock should first be managed according to the Septic Shock Clinical Pathway, especially because the source is likely to be unknown at time of presentation



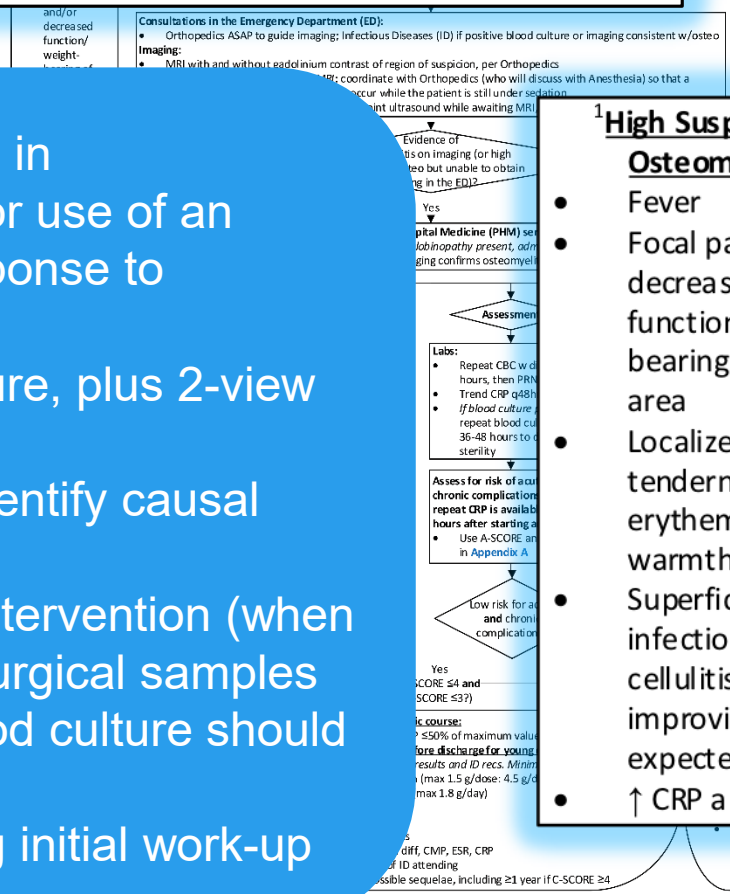
Initial Evaluation

- **History & physical exam:** consistent with acute osteoarticular infection¹
- **Labs:** CBC with diff, CRP, ESR, CMP, blood culture
- **Initial imaging:** 2-view x-rays of affected area
- **Make NPO** for possible surgical procedure
- **Hold empiric antibiotic coverage** until imaging completed (if patient stable, may hold up to 48 hours), unless **ill-appearing/ concern for sepsis/hemodynamic instability** (should be treated per **Septic Shock Clinical Pathway**) or positive blood culture

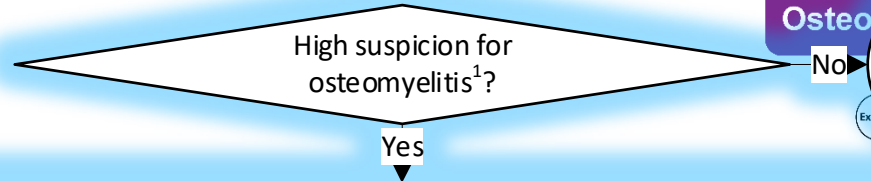
- **Presenting symptoms:** often include fever, focal pain (although in infants/toddlers, this may present as decreased weight bearing or use of an extremity), focal tenderness on exam, cellulitis without clear response to appropriate therapy
- **Initial work-up:** CBC with diff, CRP, ESR, CMP, and blood culture, plus 2-view x-rays (often normal early in the course of osteomyelitis)
- It is essential to collect a blood culture PRIOR to antibiotics to identify causal organism
- In stable patients, antibiotics can be held until AFTER surgical intervention (when indicated) to maximize the chance of isolating an organism on surgical samples
- Children who are unstable or already have a known positive blood culture should receive antibiotics promptly
- In case surgery is indicated, patient should be made NPO during initial work-up

High Suspicion for Osteomyelitis

- Fever
- Focal pain and/or decreased function/weight-bearing of affected area
- Localized edema, tenderness, erythema, and/or warmth on exam
- Superficial infection (i.e., cellulitis) not improving as expected
- ↑ CRP and/or ESR



CLINICAL PATHWAY: Osteomyelitis

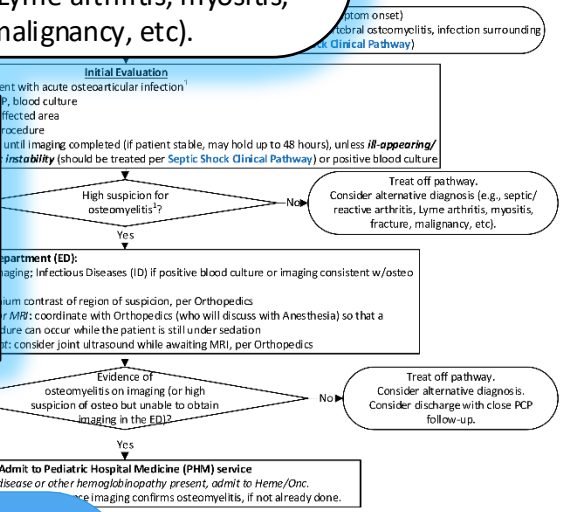


Consultations in the Emergency Department (ED):

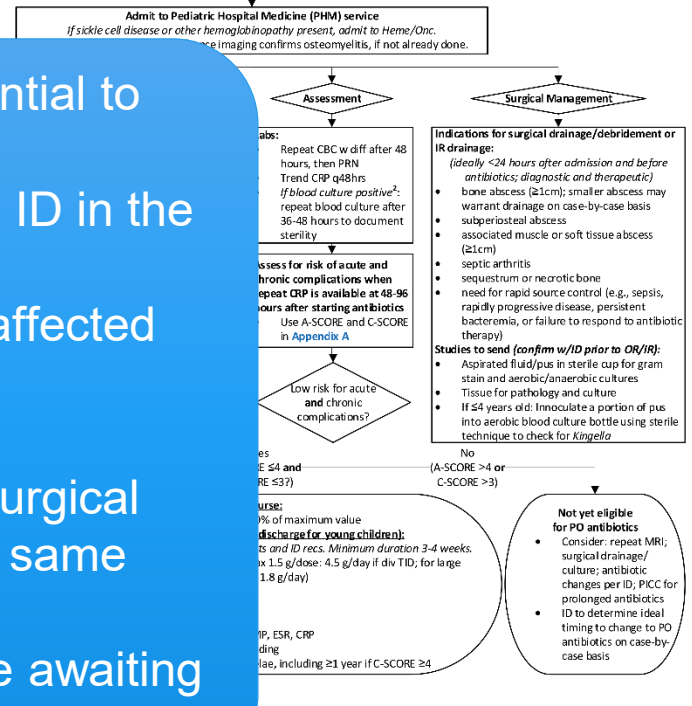
- Orthopedics ASAP to guide imaging; Infectious Diseases (ID) if positive blood culture or imaging consistent w/osteomyelitis

Imaging:

- MRI with and without gadolinium contrast of region of suspicion, per Orthopedics
 - *If sedation is required for MRI:* coordinate with Orthopedics (who will discuss with Anesthesia) so that a potential surgical procedure can occur while the patient is still under sedation
- *If high suspicion for septic joint:* consider joint ultrasound while awaiting MRI, per Orthopedics

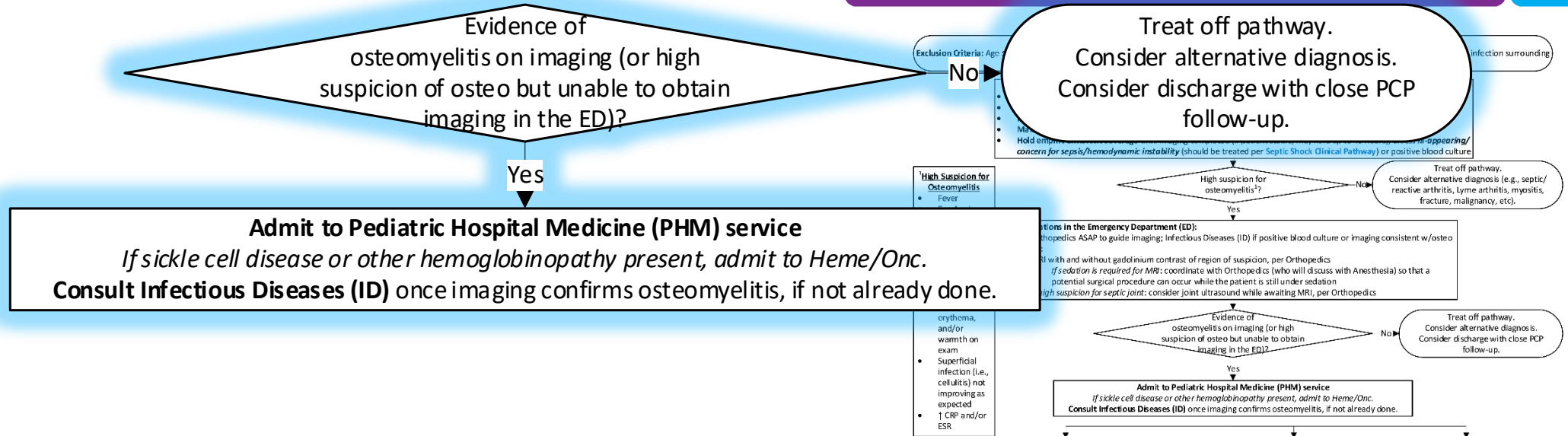


- Timely communication with orthopedic surgery in the ED is essential to help guide imaging
- If blood culture is already known to be positive, consultation with ID in the ED is essential
- Imaging should include an MRI with and without contrast of the affected region, with input from orthopedics
- For children who require sedation for imaging, coordination with orthopedics and anesthesia departments to tentatively plan for surgical intervention can enable both procedures to take place under the same sedation, which lowers the adverse effects of anesthesia
- If septic joint is suspected, joint ultrasound can be obtained while awaiting MRI

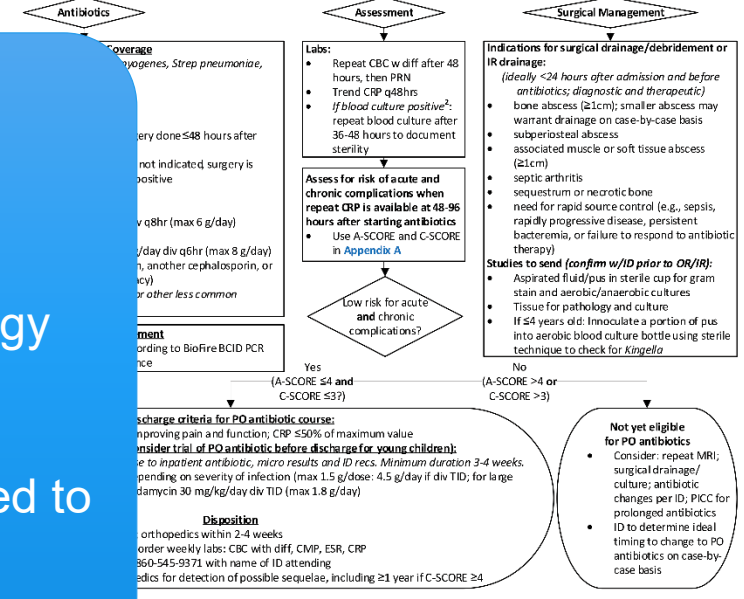


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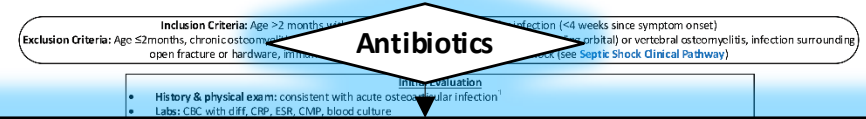
- If osteomyelitis is confirmed on MRI, patients shall be admitted to PHM with ongoing orthopedic surgery involvement and ID consultation (if not obtained in ED)
- Exception: patients with sickle cell disease or other hemoglobinopathy will be admitted to hematology/oncology instead
- If MRI is not able to be obtained in ED but there is high clinical suspicion for osteomyelitis, patient can be admitted to PHM while awaiting MRI



- Successful management of osteomyelitis requires antibiotic therapy +/- surgical intervention
- Blood cultures should ALWAYS be obtained prior to antibiotics to possibly identify the causal organism
- Staph aureus accounts for 78% of acute osteomyelitis (when an organism is isolated)
 - MSSA is the most common organism, but MRSA should be considered in some circumstances (e.g., previous MRSA infection, poor response to anti-MSSA therapy)
- Other common organisms include *Strep pyogenes*, *Strep pneumoniae*, and *Kingella* (most common age ≤ 4 years), and rarely Gram negative rods
- In stable patients where surgery is indicated, antibiotics can be held until AFTER samples are collected during surgery to maximize the chance of identifying an organism
- When surgical intervention is not indicated or the blood culture turns positive, antibiotics should be given immediately
- Cefazolin is the preferred antibiotic in patients without a history of MRSA
- ID service will help guide antibiotic therapy, which may change over time as culture data becomes available

CLINICAL PATHWAY:
Osteomyelitis

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Empiric Antibiotic Coverage
[Target: MSSA (most common), MRSA, *Strep pyogenes*, *Strep pneumoniae*, *Kingella* (≤4 yrs)]

Antibiotic Timing:

- Obtain blood culture before antibiotics
- Discuss timing of antibiotics with ID:
 - Hold antibiotics until after surgery if surgery done ≤48 hours after admission
 - Give antibiotics immediately if surgery is not indicated, surgery is delayed >48 hours, or if blood culture is positive

Antibiotic Selection:

- If no known history of MRSA:
 - Preferred: **Cefazolin IV** 150 mg/kg/day div q8hr (max 6 g/day)
 - Alternatives:
 - If bone abscess: Nafcillin 200 mg/kg/day div q6hr (max 8 g/day)
 - If cefazolin allergy: consider nafcillin, another cephalosporin, or clindamycin (consult ID and pharmacy)
- If history of MRSA or suspicion for *Salmonella* or other less common pathogens: discuss with ID

Ongoing Antibiotic Management

- ²If blood culture positive: adjust antibiotics according to BioFire BCID PCR and/or blood culture sensitivities per ID guidance

Disposition

- Follow up: ID within 7-10 days; orthopedics within 2-4 weeks
- If discharged on IV antibiotics, order weekly labs: CBC with diff, CMP, ESR, CRP
 - Fax to ID Department at 860-545-9371 with name of ID attending
- Long term follow up at orthopedics for detection of possible sequelae, including ≥1 year if C-SCORE ≥4

for PO antibiotics

- Consider: repeat MRI; surgical drainage/ culture; antibiotic changes per ID; PICC for prolonged antibiotics
- ID to determine ideal timing to change to PO antibiotics on case-by-case basis

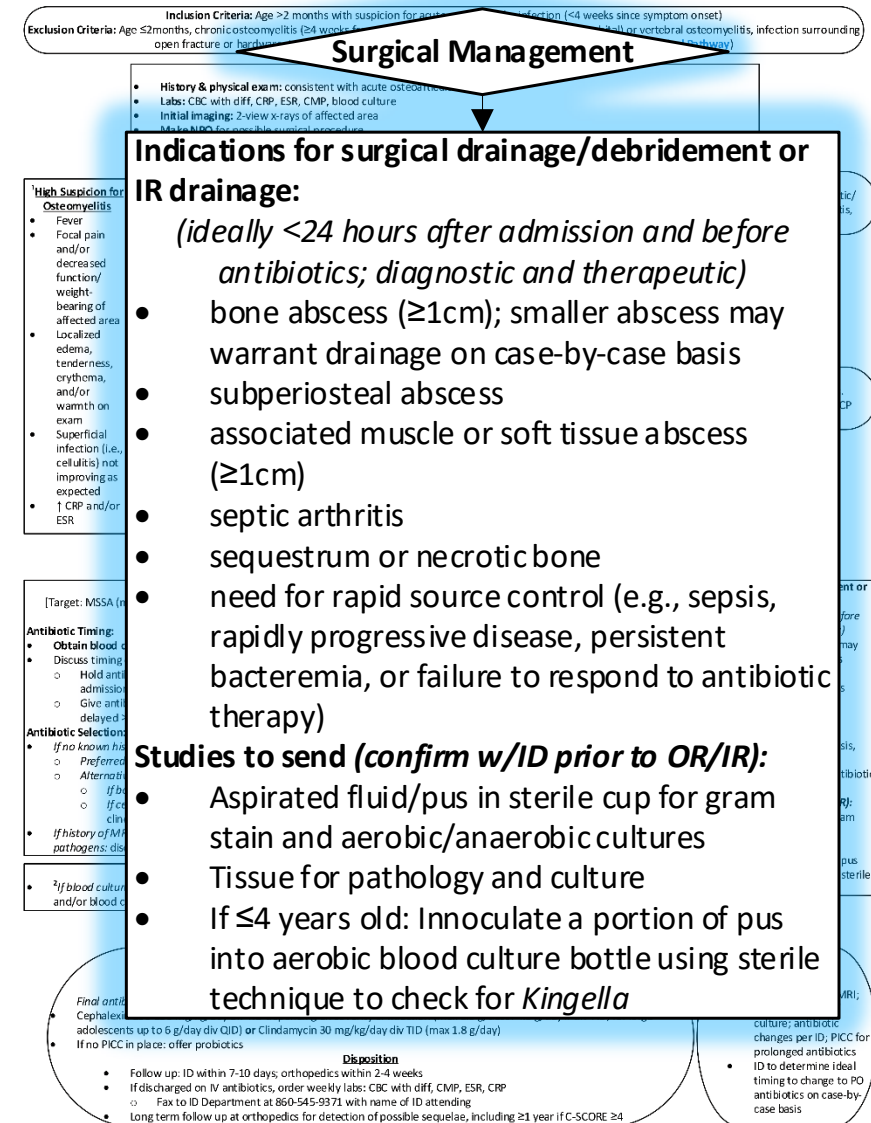
CONTACTS: EMILY HOGELAND, MD | IAN MICHELOW, MD | HASSAN EL CHEBIB, MD | MARK LEE, MD | ANAND SEKARAN, MD

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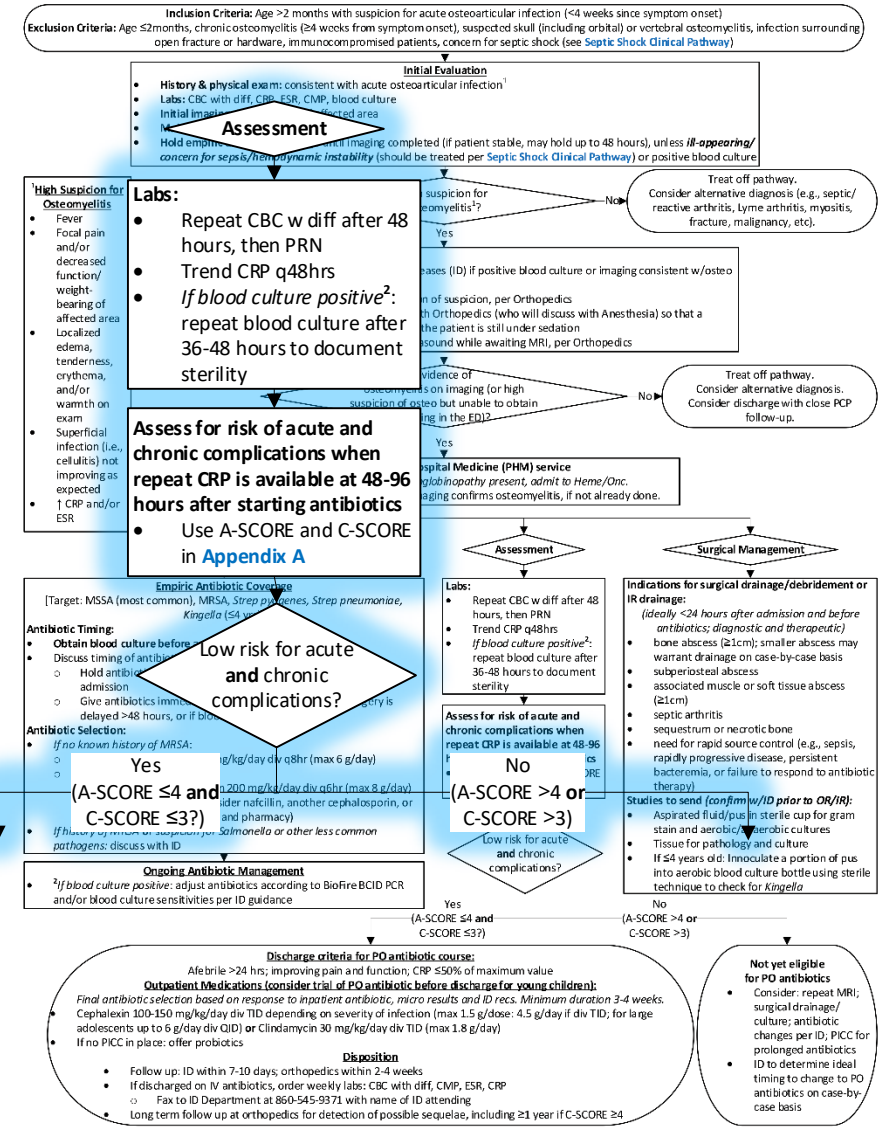
- The pathway lists the most common indications for surgical interventions (ideally performed within 24h of admission), to be discussed with orthopedics service
- Proper collection of culture specimens (in discussion with ID prior to procedure) can aid in isolating an organism and targeting antibiotic therapy
- Aspirated fluid can also be obtained in sterile cups for ease of handling.



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- Ongoing assessment includes clinical response to therapy and trending CBC and CRP to gauge response to therapy
- Risks for acute and chronic complications can be assessed with A-SCORE and C-SCORE and be done within 48-96 hours of starting antibiotics.
- This should be done by PHM or ID teams



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- 2 clinical scores (A-SCORE and C-SCORE) have been clinically shown to be superior to existing markers to predict complications of acute hematogenous osteomyelitis (Alhinai et al, 2020).
- Both scores have high negative predictive values and can help assist clinical decisions such as discharge readiness and transition to PO antibiotics

Acute and Chronic Scores for Complications of Osteomyelitis Risk Evaluation

A-SCORE: Acute Score for Complications of Osteomyelitis Risk Evaluation (≤4 has negative predictive value of ≥91%)	
Complication	A-SCORE Points
Bone abscess	2
Prolonged fever > 48 hours after starting antibiotics	2
Suppurative arthritis	3
Disseminated disease ¹	4
Delayed source control ²	4
Maximum score	15
A-SCORE interpretation	≤4 = low risk for acute complications

C-SCORE Chronic Score for Complications of Osteomyelitis Risk Evaluation (≤3 has negative predictive value of ≥95%)	
Complication	C-SCORE Points
CRP ≥ 10mg/dL at 2-4 days after starting antibiotics	1
Disseminated disease ¹	1
Bone drainage/debridement	2
Maximum score	4
C-SCORE interpretation	≤3 = low risk for chronic complications

¹**Disseminated disease:** multifocal infection, pneumonia, septic pulmonary embolism, deep vein thrombosis, or endocarditis

²**Delayed source control:** >72 hours after admission

- A-SCORE helps determine acute complications of osteomyelitis by taking into account the presence of bone abscess, prolonged fevers, suppurative arthritis, disseminated disease, and delayed source control
- C-SCORE helps determine chronic complications by taking into account CRP levels at 2-4 days after starting antibiotics, disseminated disease, and bone drainage/debridement

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C-SCORE Chronic Score for Complications of Osteomyelitis Risk Evaluation (≤3 has negative predictive value of ≥95%)	
Complication	C-SCORE Points
CRP ≥ 10mg/dL at 2-4 days after starting antibiotics	1
Disseminated disease ¹	1
Bone drainage/debridement	2
Maximum score	4
C-SCORE interpretation	≤3 = low risk for chronic complications

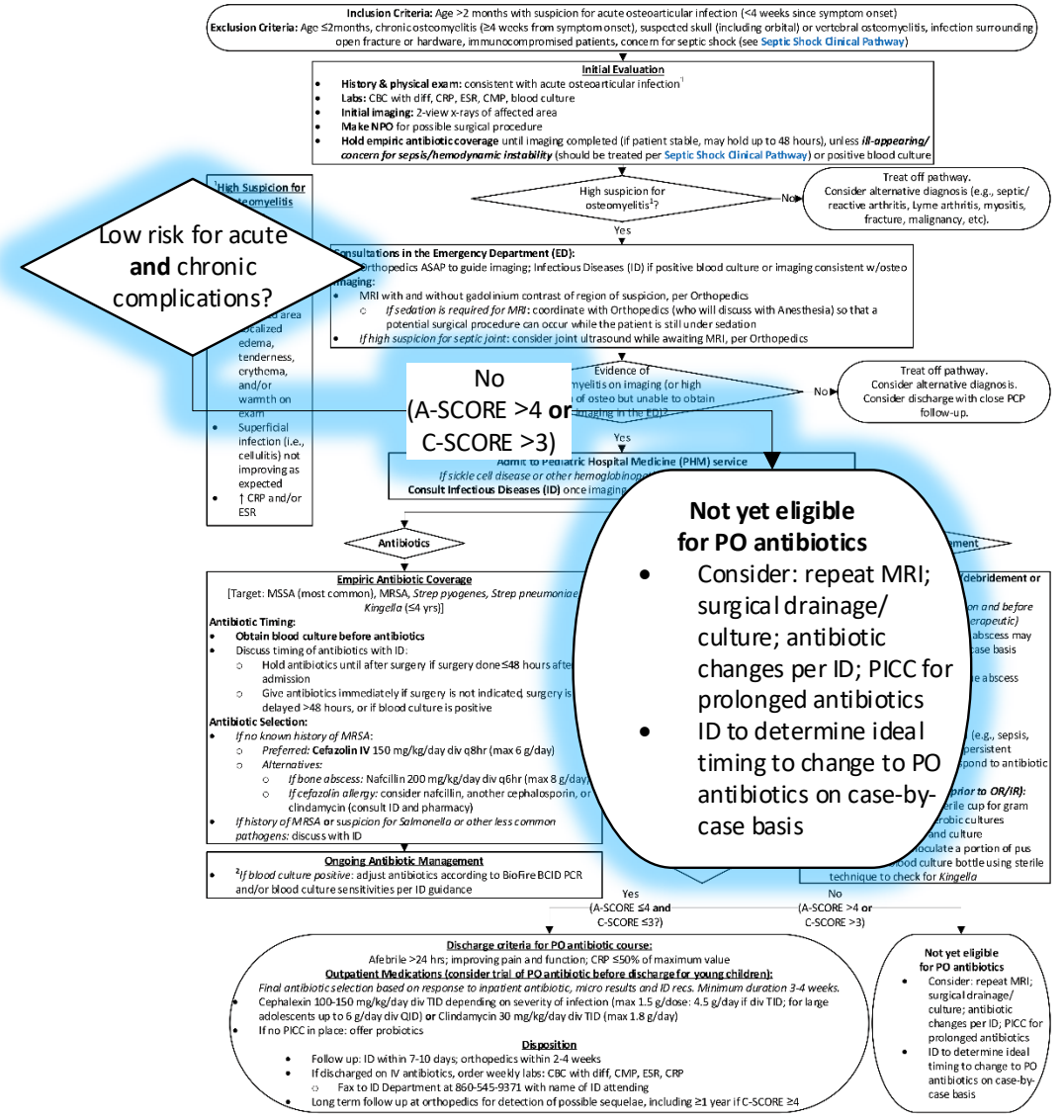
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- Children with a high A-SCORE (>4) OR C-SCORE (>3) are generally not eligible for transition to PO antibiotics, and may need further imaging or surgical intervention
- ID will guide transition to PO antibiotics on case-by-case basis, but PICC line may be necessary for long-term IV antibiotics



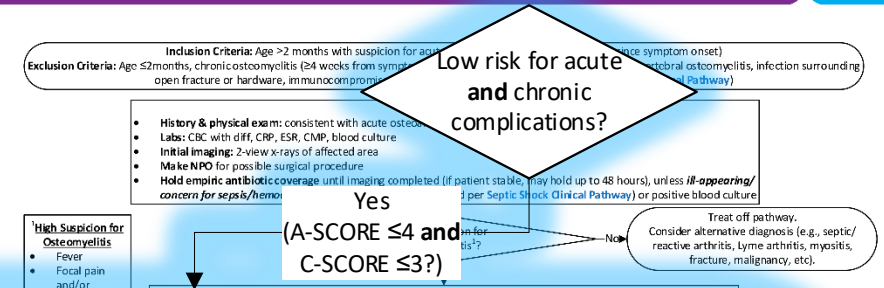
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- Children with low risks of both acute and chronic complications, and clinical improvement (based on fever curve, clinical exam, and CRP trend), are often eligible for PO antibiotics
- Antibiotic duration is generally 3-4 weeks, and antibiotic choice depends on response to therapy and any culture data available
- Patients should follow-up with ID and orthopedics as described



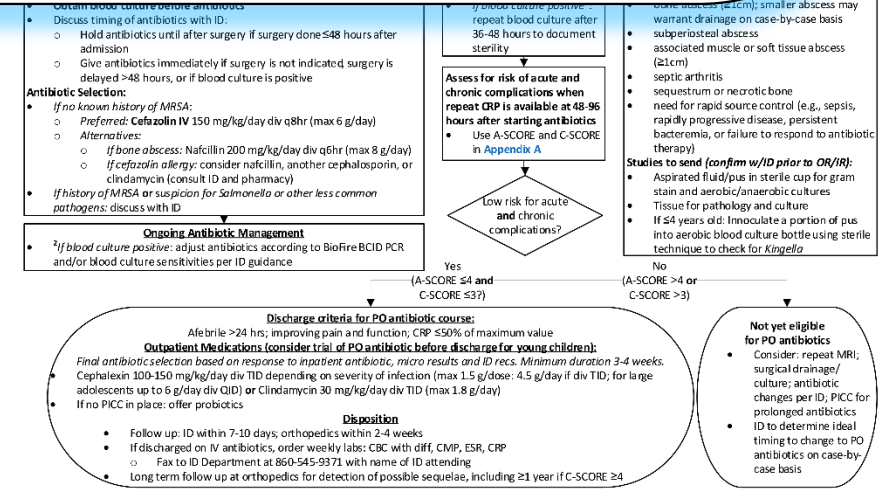
Discharge criteria for PO antibiotic course:
Afebrile >24 hrs; improving pain and function; CRP ≤50% of maximum value

Outpatient Medications (consider trial of PO antibiotic before discharge for young children):
Final antibiotic selection based on response to inpatient antibiotic, micro results and ID recs. Minimum duration 3-4 weeks.

- Cephalexin 100-150 mg/kg/day div TID depending on severity of infection (max 1.5 g/dose: 4.5 g/day if div TID; for large adolescents up to 6 g/day div QID) or Clindamycin 30 mg/kg/day div TID (max 1.8 g/day)
- If no PICC in place: offer probiotics

Disposition

- Follow up: ID within 7-10 days; orthopedics within 2-4 weeks
- If discharged on IV antibiotics, order weekly labs: CBC with diff, CMP, ESR, CRP
 - Fax to ID Department at 860-545-9371 with name of ID attending
- Long term follow up at orthopedics for detection of possible sequelae, including ≥1 year if C-SCORE ≥4



Review of Key Points



- Patients with high suspicion for acute hematogenous osteomyelitis should undergo lab work-up and imaging (MRI) for prompt diagnosis
- Coordination between PHM, ID, and orthopedics services is essential for all patients with osteomyelitis
- Isolation of the causal bacteria can guide appropriate therapy, which is optimized by blood cultures obtained PRIOR to antibiotics + surgical cultures obtained (when indicated)
- Antibiotic selection is usually empiric and guided against MSSA, but may be changed depending on clinical response and culture data
- Calculation of the A-SCORE and C-SCORE can help differentiate between which patients are eligible for transition to PO antibiotics vs. need for prolonged IV therapy with a PICC

- Percent of patients who undergo operative procedure for biopsy/drainage
- Patients who require sedation for initial MRI and who require surgical drainage or percent who undergo imaging and drainage under the same sedation
- Percent of patients treated per pathway:
 - Blood culture obtained prior to antibiotics
 - MRI obtained
 - Orthopedics and infectious disease consults (and notes) both obtained within 48h of admission
 - Initial antibiotics per pathway recommendation
 - Discharge antibiotics per pathway recommendations
- Length of stay (days)
- Duration of therapy (including outpatient antibiotics)

Pathway Contacts



- Emily Hogeland, MD
 - Pediatric Hospital Medicine
- Ian Michelow, MD
 - Infectious Diseases
- Hassan El Chebib, MD
 - Infectious Diseases
- Mark Lee, MD
 - Orthopedic Surgery
- Anand Sekaran, MD
 - Pediatric Hospital Medicine

References



1. Woods CR, Bradley JS, Chatterjee A, et al. Clinical Practice Guideline by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America: 2021 Guideline on Diagnosis and Management of Acute Hematogenous Osteomyelitis in Pediatrics. *J Pediatric Infect Dis Soc* 2021; 10:801.
2. Alhinai Z, Elahi M, Park S, et al. Prediction of Adverse Outcomes in Pediatric Acute Hematogenous Osteomyelitis. *Clin Infect Dis* 2020; 71:e454.

Thank You!



About Connecticut Children's Pathways Program

Clinical pathways guide the management of patients to optimize consistent use of evidence-based practice. Clinical pathways have been shown to improve guideline adherence and quality outcomes, while decreasing length of stay and cost. Here at Connecticut Children's, our Clinical Pathways Program aims to deliver evidence-based, high value care to the greatest number of children in a diversity of patient settings.

These pathways serve as a guide for providers and do not replace clinical judgment.