# Osteomyelitis

Emily Hogeland, MD
Ian Michelow, MD
Hassan El Chebib, MD
Mark Lee, MD

Connecticut Children's

# 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

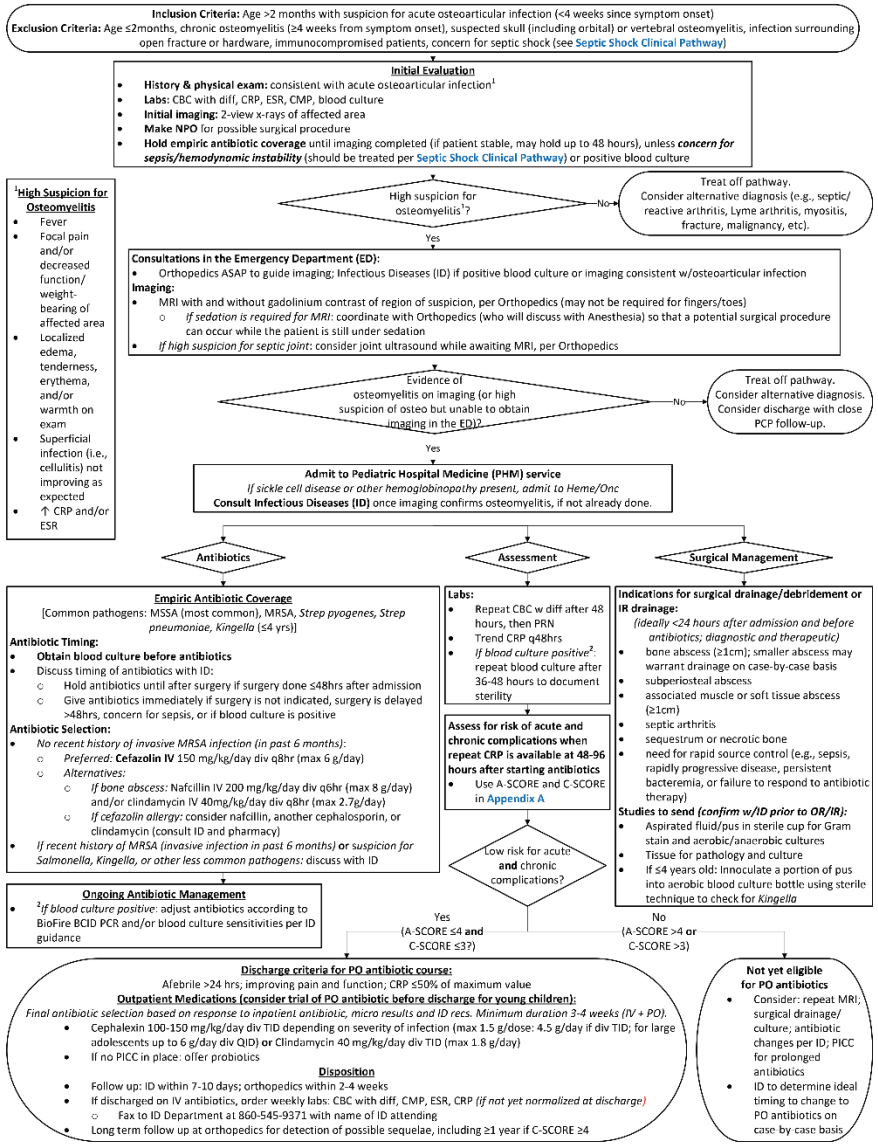
This is the Osteomyelitis Clinical Pathway.

We will be reviewing each component in the following slides.

*CLINICAL PATHWAY:*

# Osteomyelitis

THIS PATHWAY SERVES AS A GUIDE AND DOES NOT REPLACE CLINICAL JUDGMENT.

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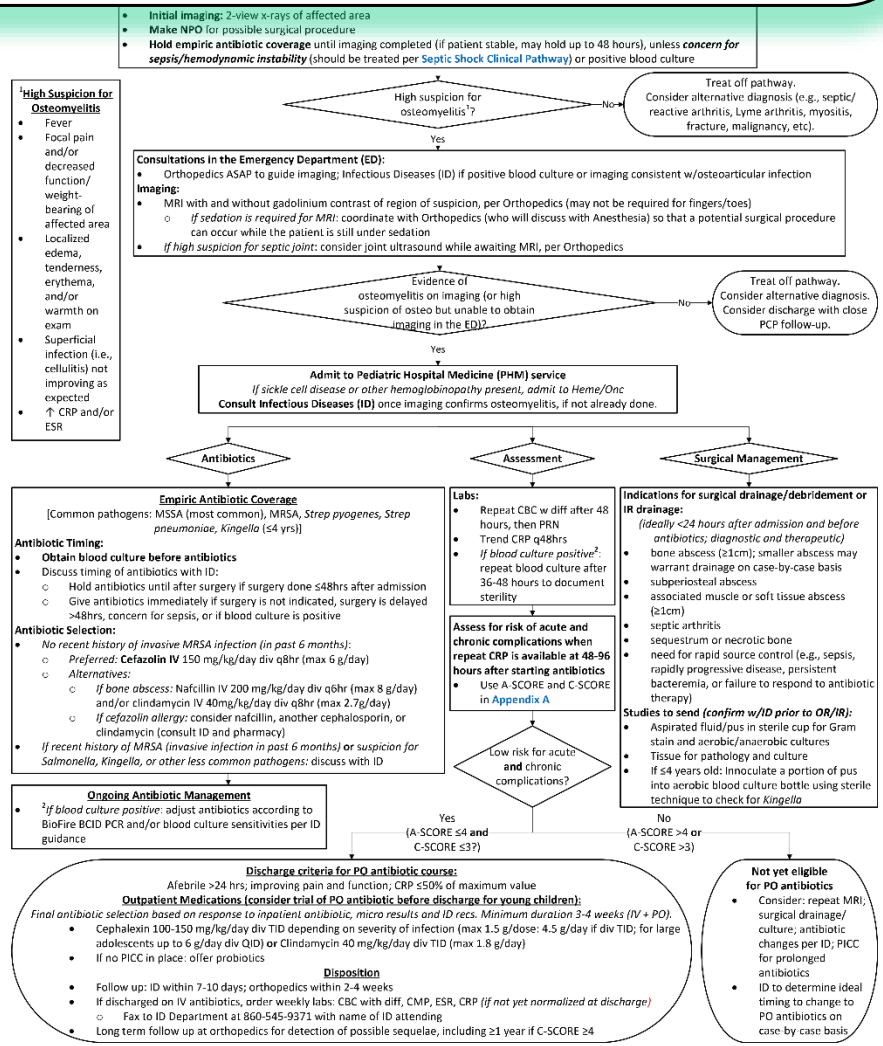
**Inclusion Criteria:** Age >2 months with suspicion for acute osteoarticular infection (<4 weeks since symptom onset)
**Exclusion Criteria:** Age ≤2months, chronic osteomyelitis (≥4 weeks from symptom onset), suspected skull (including orbital) or vertebral osteomyelitis, infection surrounding open 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

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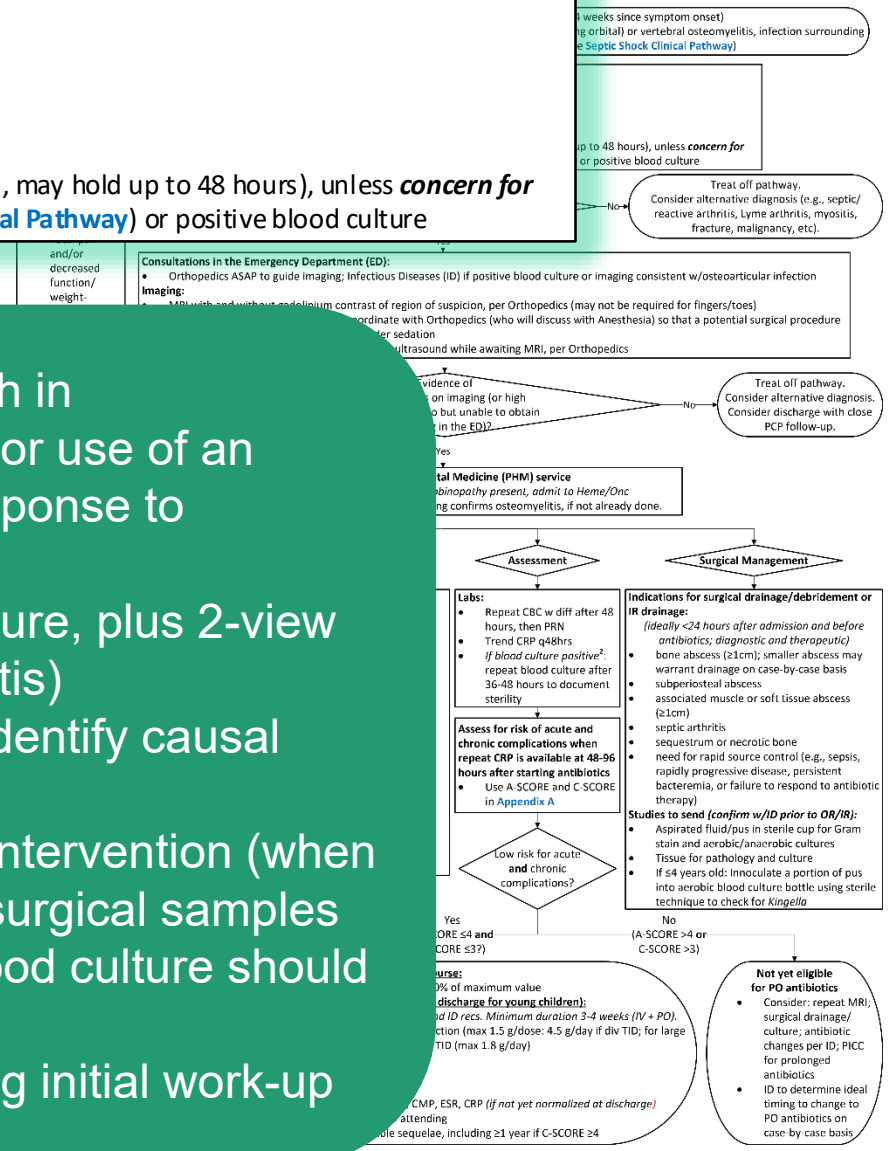
## Initial Evaluation

- **History & physical exam:** consistent with acute osteoarticular infection[1]
- **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 ***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 (the latter, 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





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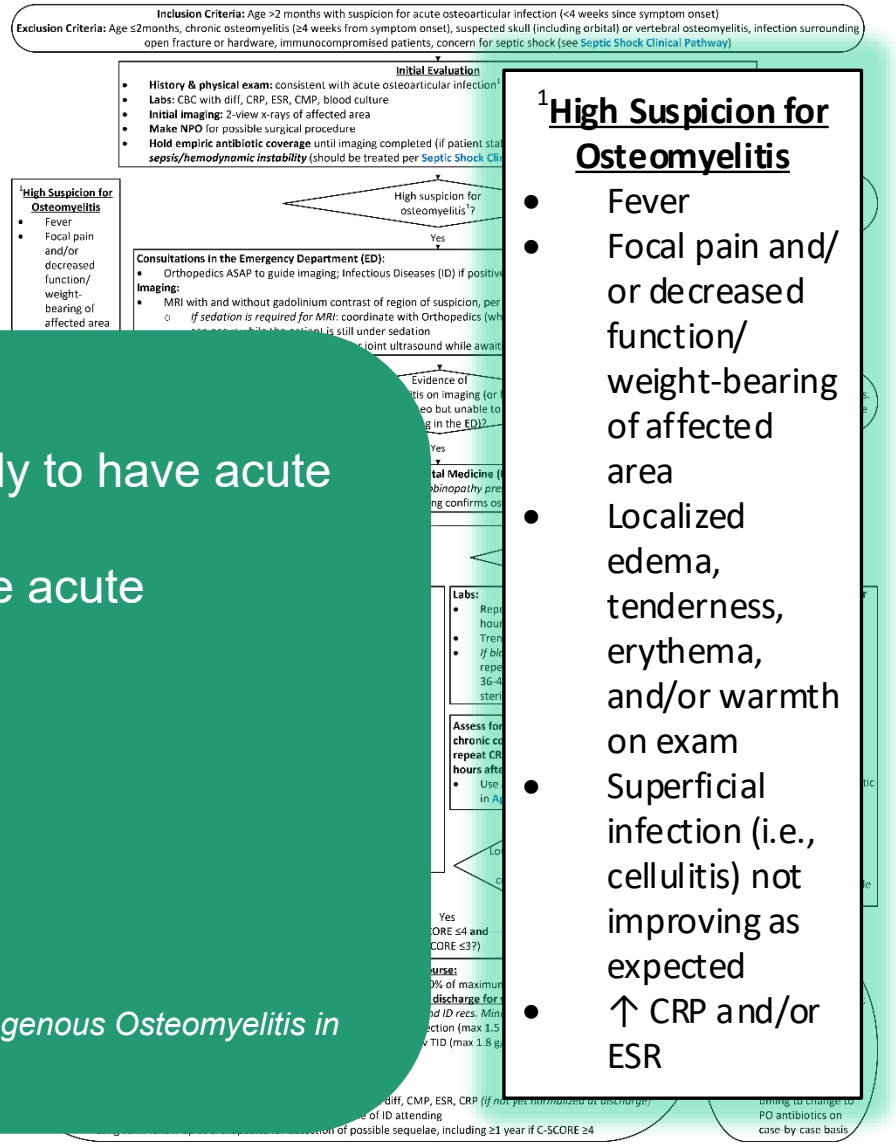
## High Suspicion for Osteomyelitis

- Children with at least 3 of the following 4 characteristics are likely to have acute hematogenous osteomyelitis (sensitivity 78%, specificity 84%)
- Children without any of these characteristics are unlikely to have acute hematogenous osteomyelitis (sensitivity 99%)

1. Duration of illness > 3 days
2. History of fever or highest ED temperature ≥ 38°C
3. CRP > 2.0 mg/dL
4. ESR > 25 mm/hr

*Stephan AM, Platt S, Levine DA, et al. A Novel Risk Score to Guide the Evaluation of Acute Hematogenous Osteomyelitis in Children. Pediatrics 2024; 153(2): e2023063153.*

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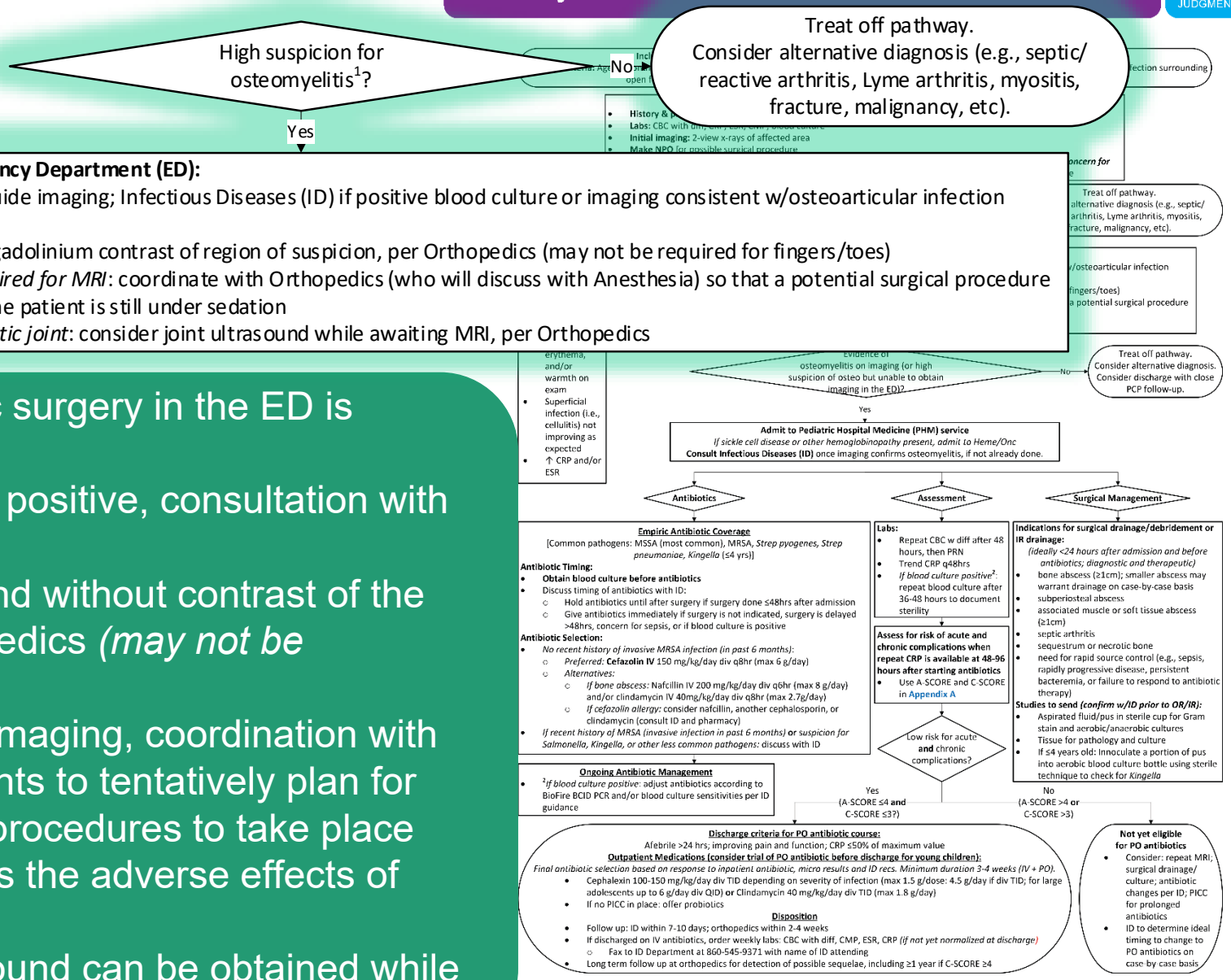


- Timely communication with orthopedic surgery in the ED is essential to help guide imaging
- If blood culture is already known to be positive, consultation with ID in the ED is essential
- Imaging should include an MRI with and without contrast of the affected region, with input from orthopedics *(may not be necessary for fingers/toes)*
- 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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Evidence of osteomyelitis on imaging (or high suspicion of osteo but unable to obtain imaging in the ED)?

No → Treat off pathway. Consider alternative diagnosis. Consider discharge with close PCP follow-up.

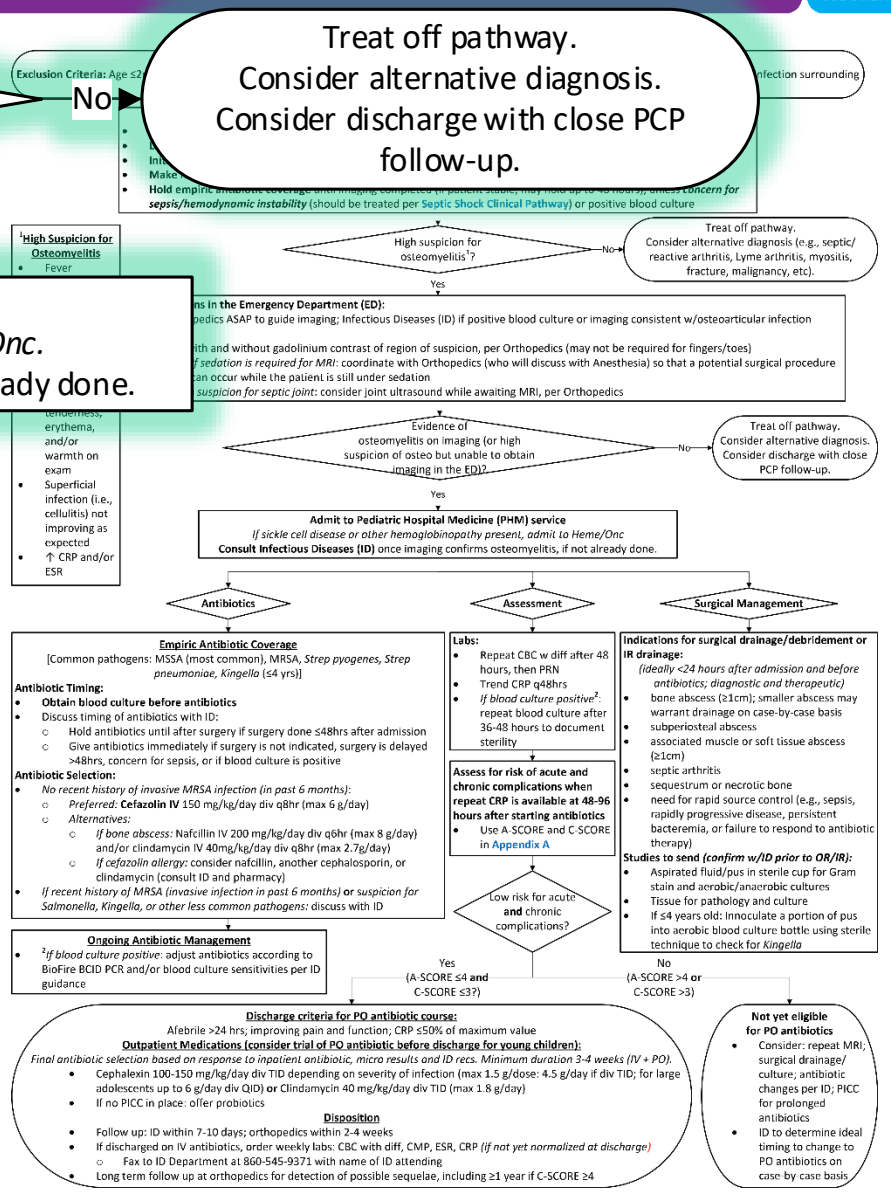
Yes

**Admit to Pediatric Hospital Medicine (PHM) service**

*If sickle cell disease or other hemoglobinopathy present, admit to Heme/Onc.*

**Consult Infectious Diseases (ID)** once imaging confirms osteomyelitis, if not already done.

- If osteomyelitis is confirmed on MRI, patient to 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





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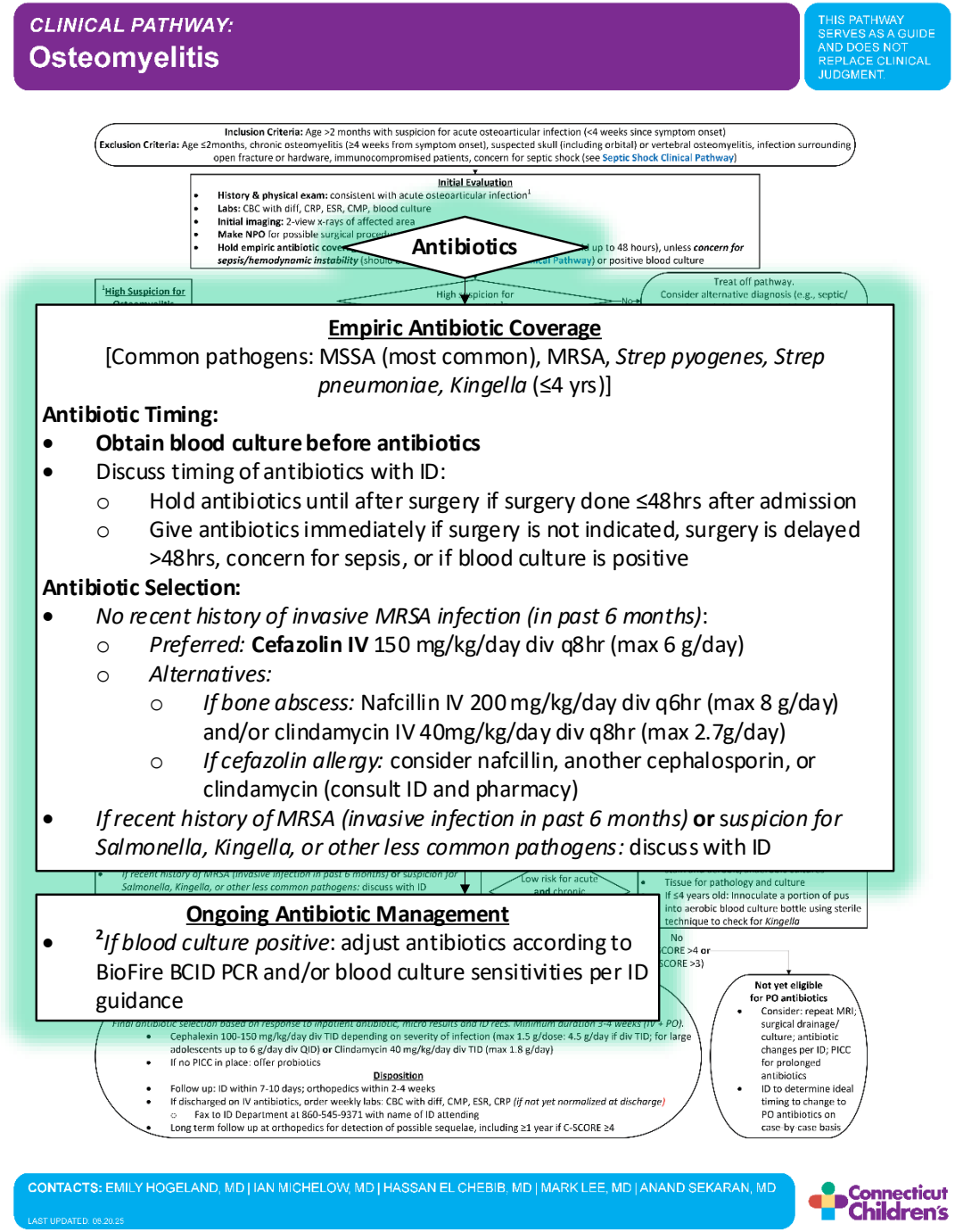
- Successful management of osteomyelitis requires antibiotic therapy +/- surgical intervention

- 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., invasive MRSA infection in past 6 months, 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



- 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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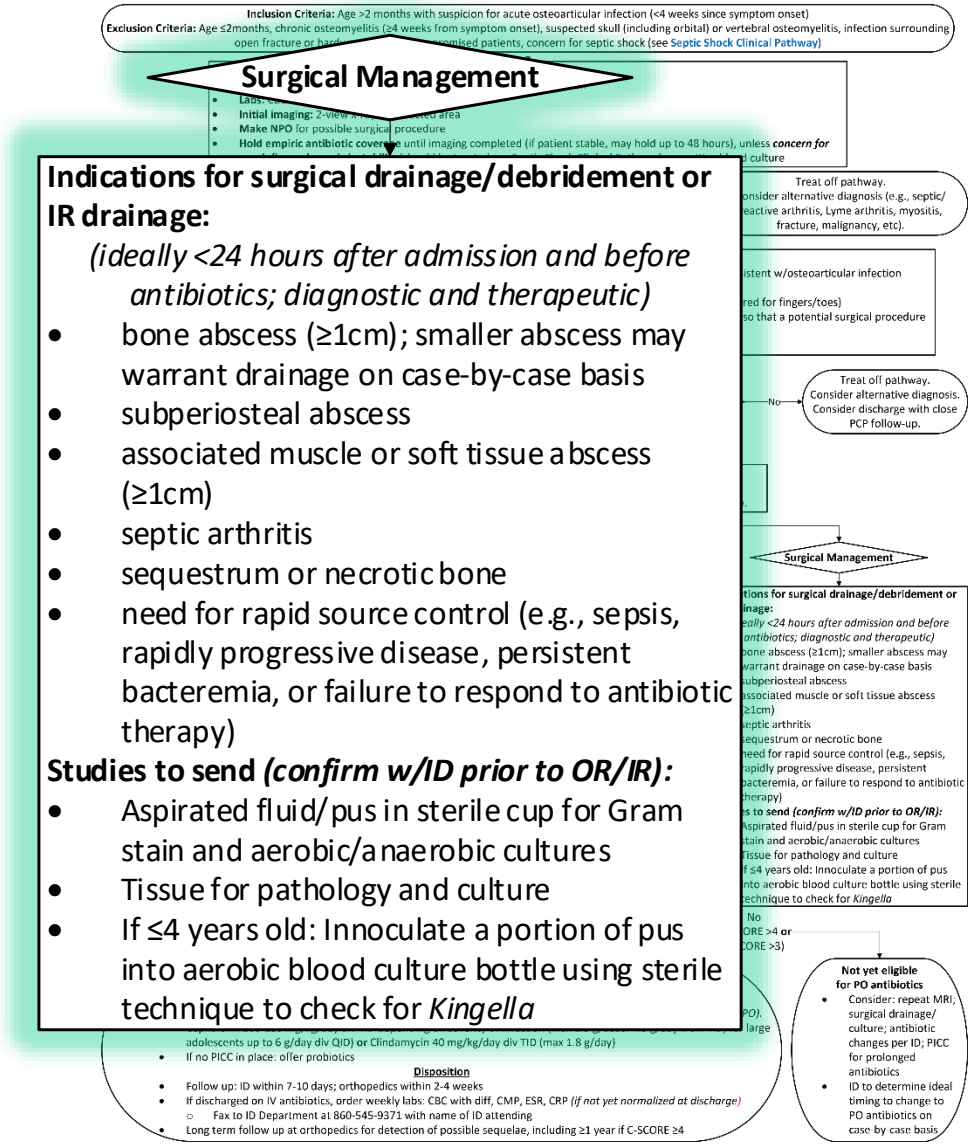



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- Ongoing assessment includes clinical response to therapy and trending CBC and CRP to gauge response to therapy
- Risks for acute and chronic complications can be assessed with A-SCORE and C-SCORE and be done within 48-96 hours of starting antibiotics.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

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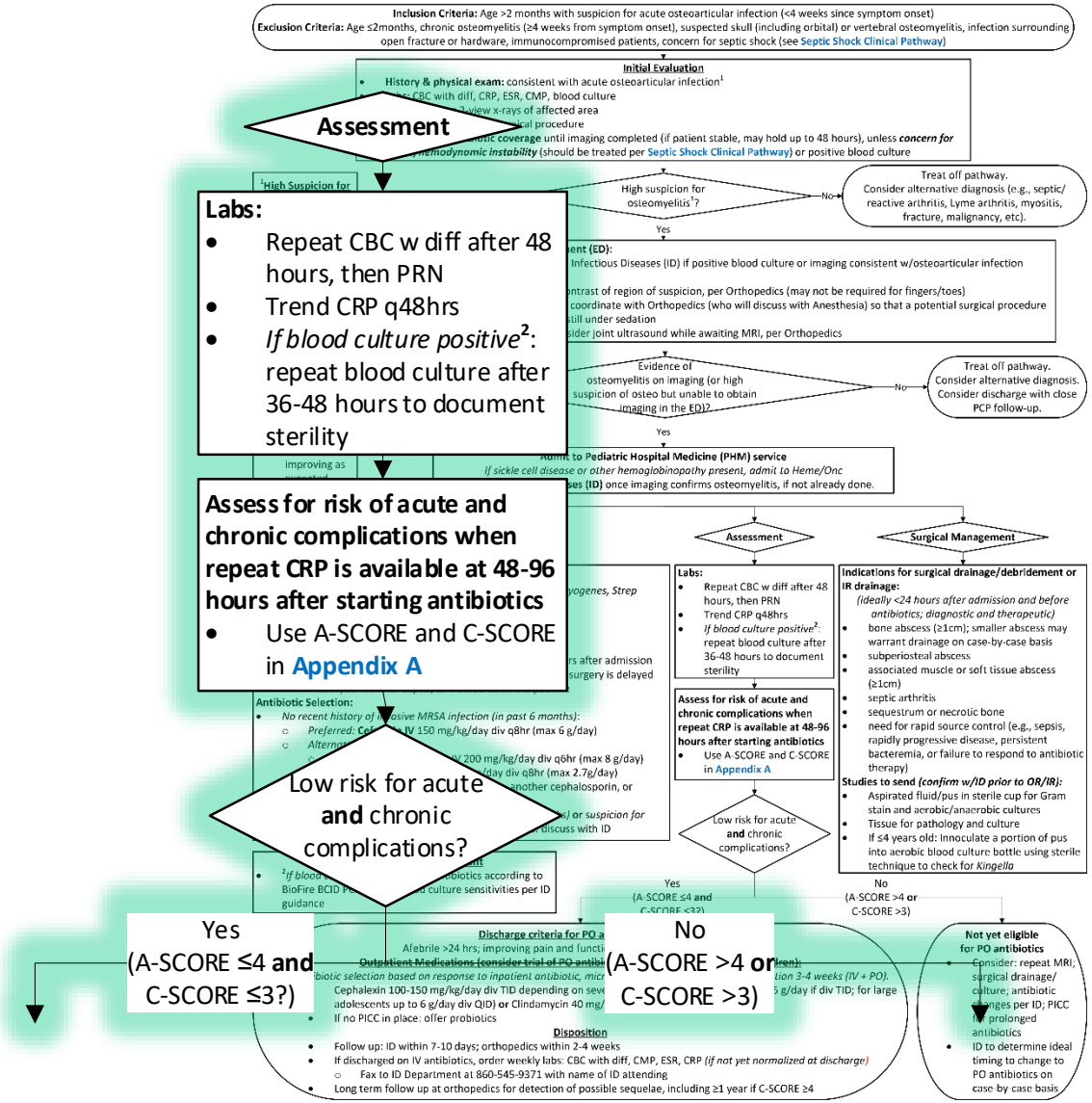



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- 2 clinical scores (A-SCORE and C-SCORE) have been clinically shown to be superior to existing markers to predict complications of acute hematogenous osteomyelitis (Alhinai et al, 2020)
- Both scores have high negative predictive values and can help 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

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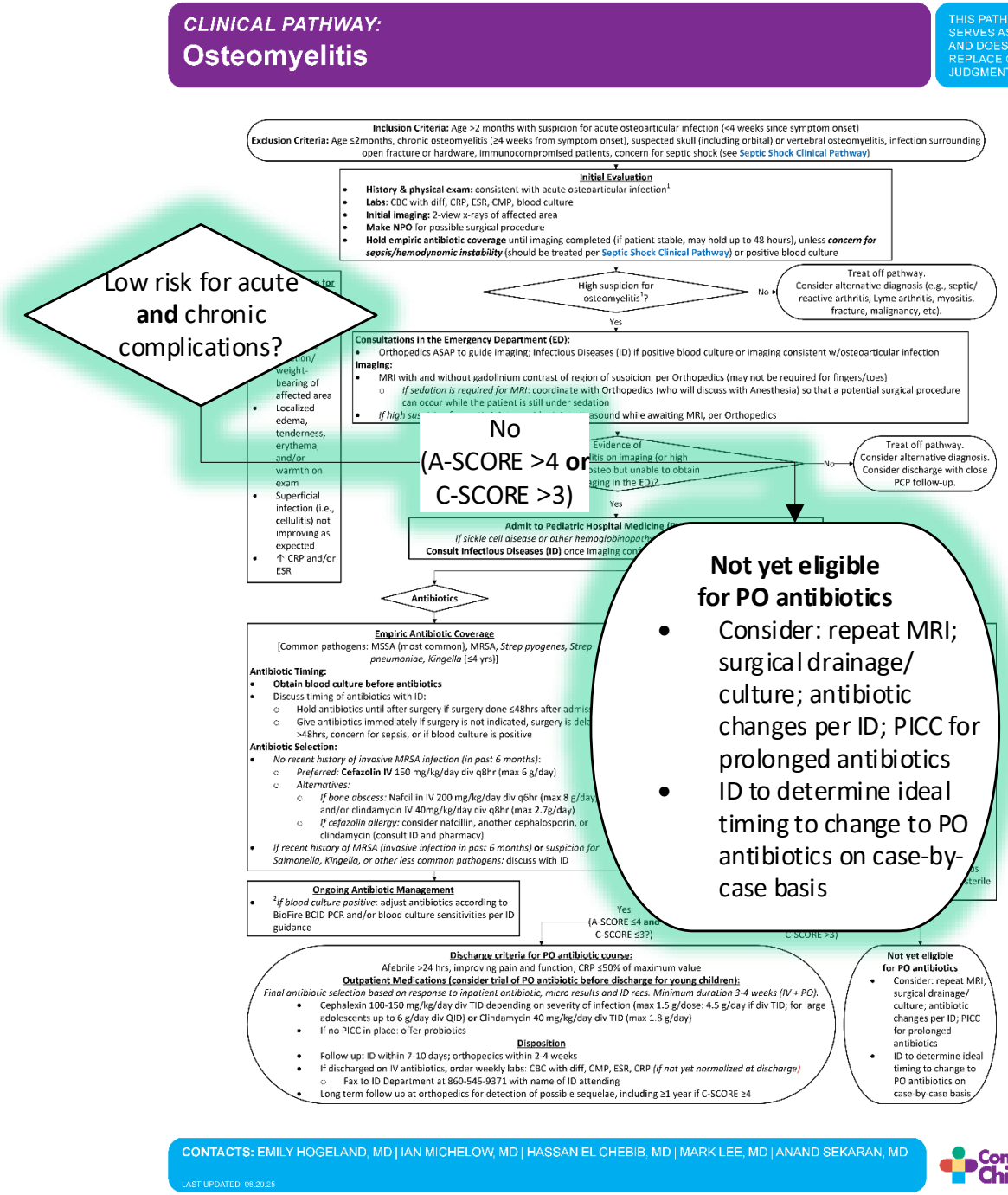
- Children with a high A-SCORE (>4) OR C-SCORE (>3) are generally not eligible for transition to PO antibiotics, and may need further imaging or surgical intervention
- ID will guide transition to PO antibiotics on case-by-case basis, but PICC line may be necessary for long-term IV antibiotics



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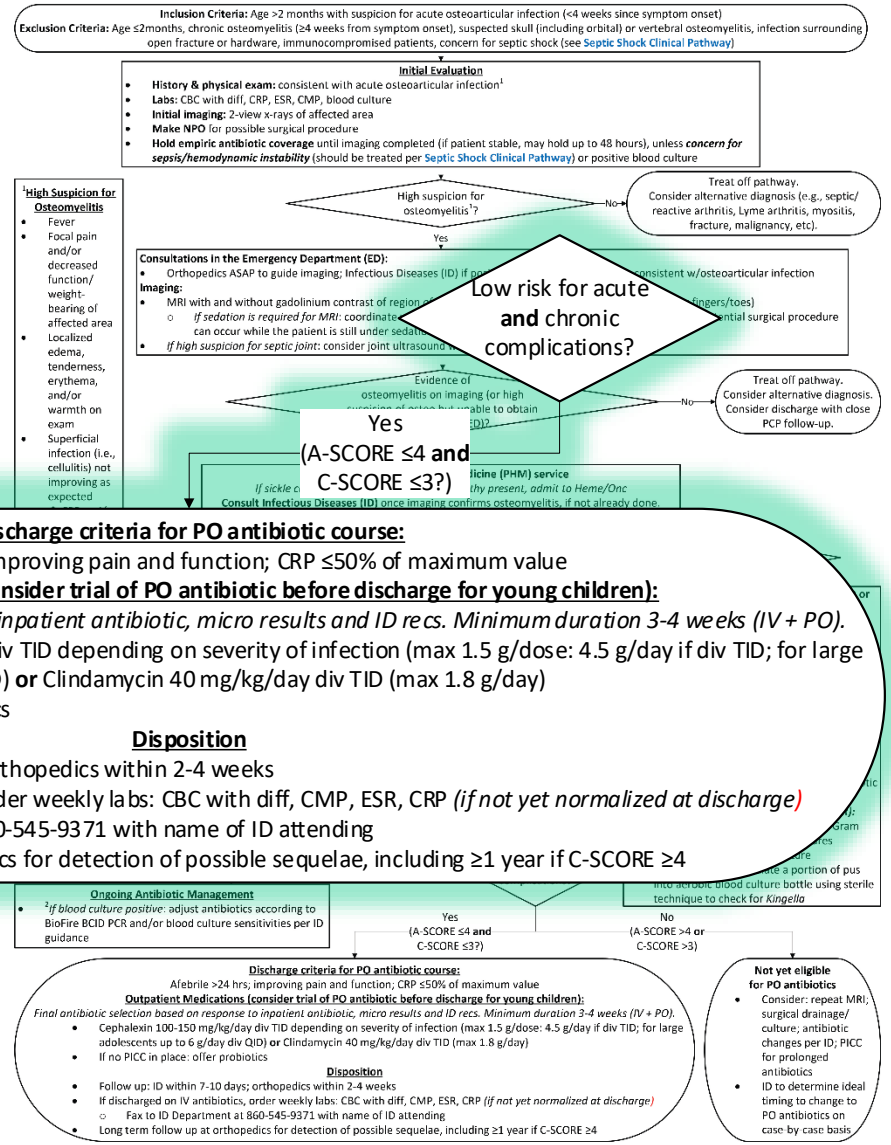
- Children with low risks of both acute and chronic complications, and clinical improvement (based on fever curve, clinical exam, and CRP trend), are often eligible for PO antibiotics
- Antibiotic duration is generally 3-4 weeks **(total IV + PO)**, and antibiotic choice depends on response to therapy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

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# 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

# Quality Metrics

- 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. Alhinai Z, Elahi M, Park S, et al. Prediction of Adverse Outcomes in Pediatric Acute Hematogenous Osteomyelitis. *Clin Infect Dis*. 2020 Dec 3;71(9):e454-e464.

2. Shapiro K, Carrillo-Marquez MA, Arnold SR. Diagnosis and Management of Acute Osteoarticular Infections: Summary of New Guidelines. *Pediatr Rev*. 2025 May 1;46(5):258-266.

3. Stephan AM, Platt S, Levine DA, et al. A Novel Risk Score to Guide the Evaluation of Acute Hematogenous Osteomyelitis in Children. *Pediatrics*. 2024 Jan 1;153(2):e2023063153.

4. 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 Sep 23;10(8):801-844.

# 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.