Acute Hematogenous Osteomyelitis

Inpatient

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Center for Clinical Excellence

Verify that patient is appropriate for this pathway

Baseline Studies
- CBC with diff
- CRP, ESR
- Blood Culture
- X-rays of affected bone

Signs and Symptoms
- Bone pain/tenderness/warmth/swelling
- Limp or refusal to bear weight/limited mobility of affected limb/extremity
- Constitutional symptoms
- Fever (not universally present)

Empiric Antibiotics

Specimen Request /Orders

Patient ill-appearing or with rapidly progressive infection?
- Yes → Hemodynamic instability?
  - Yes → **Off Pathway** Start Empiric Antibiotics Transfer to PICU
  - No → Delay antibiotics until specimen obtained (unless clinically worsening)
- No → Delay antibiotics until specimen obtained (unless clinically worsening)

Contact radiologist to confirm appropriate MRI study (limited vs. standard) based on presenting symptoms and exam. Discuss need for sedation.

Obtain MRI w/wo contrast ASAP*

MRI consistent with osteomyelitis?
- No → **Off Pathway**
- Yes → Findings requiring surgical intervention? (consult w/Ortho)
  - Yes
    - Make NPO and start MIVF
    - Place specimen request
    - **OR for I&D**
  - No → Blood culture with growth of common pathogen?
    - Yes → If not yet administered, start Empiric Antibiotics. Base antibiotics upon culture results and susceptibilities.
    - No → Lesion amenable to IR aspiration or biopsy? (consult w/IR)
      - Yes → Place orders w/phase of care "Intra-procedure (IR)" → **IR for procedure** → If not yet administered, start Empiric Antibiotics. Base antibiotics upon culture results and susceptibilities.
      - No → If not yet administered, start Empiric Antibiotics. Base antibiotics upon culture results and susceptibilities.
    - May still consider → Lesion amenable to IR aspiration or biopsy? (consult w/IR)

** At least 2 negative cultures if cultures with *S. aureus*

If not yet administered, start Empiric Antibiotics. Base antibiotics upon culture results and susceptibilities.

Clinically improving?
- Afebrile
- Decreased pain/swelling
- Improved use of limb
- Decreasing CRP

Oral antibiotic choice available and tolerating PO?
- Yes
  - Switch to oral antibiotics when:
    - Afebrile >24 hrs
    - CRP < 50% of peak or < 3 mg/dl
    - Blood cxs negative >48 hrs**
    - Bearing weight or using affected limb
  - PICC placement for outpatient parenteral antibiotics. Arrange Homecare (medications and labs)
- No → PICC placement for outpatient parenteral antibiotics. Arrange Homecare (medications and labs)

No → 48-72 hours without improvement?
- Yes → **Off Pathway**
- No
  - Repeat CBC,CRP
  - Consider repeat I&D
  - If chest pain/cough: Consider DVT/PE - CXR. Possible CT Angio and LE Doppler U/S

Discharge Home
- Obtain ESR/CRP prior to discharge
- Discharge on antibiotics (discuss duration with ID)
- Follow up with PCP, ID and Ortho, if needed
- Discuss need for f/u labs and imaging

Discharge Criteria and Orders

Pre-Pathway Validation

Is this Acute Hematogenous Osteomyelitis (OM) ?

Acute osteomyelitis is defined as the diagnosis of bone infection within 4 weeks after the onset of clinical manifestations (symptoms or signs) in a previously uninfected bone. Hematogenous osteomyelitis is more common in children compared to adults and is caused by microorganisms that enter the bone from the blood. Non-hematogenous osteomyelitis may occur from direct inoculation of the bone (i.e. trauma, surgery) or from extension of a contiguous infection (i.e. cellulitis).

Typical presentation:
The initial phase of hematogenous osteomyelitis may be associated with malaise and low grade fever. Many symptoms of OM are related to the age of the child and causative microorganism. Acute OM may present gradually with onset over a few days but usually manifests within two weeks. Patients may have local symptoms such as erythema, swelling, and warmth at the site of infection. There may be a dull pain with or without motion. In subacute presentations, some patients may have generalized malaise, mild pain over several weeks with minimal fever, or other constitutional symptoms. Acute OM may also present as septic arthritis, especially if the metaphysis of the bone is within the infected joint capsule (e.g. hip, shoulder).

Diagnostic Criteria for Acute Hematogenous Osteomyelitis for patients beyond 1 month of age.

- Significant bone pain and/or tenderness with or without warmth and swelling
- Limp or refusal to bear weight/limited mobility of affected limb/extremity
- Constitutional symptoms (irritability, decreased activity and/or appetite)
- Fever (absence of fever does not rule out osteomyelitis)

Consider other alternate clinical problem and diagnosis when:

- None of the diagnostic criteria are met.

Consider a diagnostic timeout ("What else could this be?") or using a diagnostic checklist.

Pathway Inclusion Criteria

- Signs, symptoms, laboratory and imaging concerning for acute hematogenous osteomyelitis

Pathway Exclusion Criteria

- Patients ≤ 1 month of age or < 44 weeks corrected gestational age
- Chronic osteomyelitis
- Chronic multifocal osteomyelitis

Special Patient Populations

Pathway can be used in the following populations with special consideration in terms of diagnosis, microbiology, antimicrobials, and treatment duration.

- Presence of implanted surgical material
- Penetrating injury/recent orthopedic procedure of the involved bone
- Immunocompromised host
- Involvement of cranial bones, vertebral bones, ribs and sternum
- Septic arthritis
- Sickle cell disease
- ICU patients

Diagnostic Timeout

Red Flags

- Physical examination and radiologic tests including MRI of the involved bone are not consistent with osteomyelitis
- Lytic bone lesions and/or lesions consistent with chronic osteomyelitis

Admission Criteria

- All patients with concerns of acute osteomyelitis should be admitted unless outpatient follow up is discussed and scheduled with infectious disease service.

Diagnostic Timeout Differential Diagnosis

Infectious Diagnoses

- Septicemia
- Cellulitis
- Discitis
- Pyogenic bursitis or arthritis
- Myositis/Pyomyositis
- Necrotizing fasciitis

Non-infectious- Diagnoses

- Fractures
- Thrombophlebitis
- Scurvy
- Rheumatic fever
- Toxic synovitis
- Post-infectious arthralgias/arthritis
- Chronic recurrent multifocal osteomyelitis

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Signs & Symptoms

- Significant bone pain and/or tenderness with or without warmth and swelling
- Limp or refusal to bear weight/limited mobility of affected limb/extremity
- Constitutional symptoms (irritability, decreased activity and/or appetite)
- Fever (absence of fever does not rule out osteomyelitis)

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Severity Assessment

	Uncomplicated	Complicated
Sites of infection	Single bone	2 or more bones involved Additional soft tissue sites of infection beyond the bone (e.g., muscle [myositis or pyomyositis], pneumonia, and liver abscess)
Clinical response to medical and surgical treatment	Rapid (within 3-5 d), including signs of sepsis or septic shock	Slow, prolonged response, or lack of clinical response Need for more than 1 surgery for source control
Course of bacteremia when present	Rapid resolution of bacteremia (serial blood cultures become negative when obtained within 1-2 d after the initiation of therapy and source control)	Prolonged bacteremia (3 or more days), suggestive of uncontrolled infection/distant site(s) of infection
Acute sequelae of infection	None	Venous thrombosis or septic thrombophlebitis
Late sequelae of infection	No findings that suggest risk of physis injury or other short- or long-term osteoarticular sequelae of infection	Findings concerning for physeal injury with potential impacts on bone growth with long-term sequelae Presence of or concern for pathologic fracture

Feigin and Cherry's Textbook of Pediatric Infectious Diseases: 2-Volume Set 8th Edition by James Cherry MD (Author), Gail J. Demmler-Harrison MD (Author), Sheldon L. Kaplan MD (Author), William J. Steinbach MD (Author), Peter J Hotez MD PhD (Author) 8th Edition - December 29, 2017 Chapter 55.

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Empiric Antibiotics Choice

Age 1 month to < 5 years	Stable Vitals	Clindamycin + Cefazolin
	Hemodynamic Instability	Vancomycin + Cefazolin
Age ≥ 5 years	Stable Vitals	Clindamycin
	Hemodynamic Instability	Vancomycin

*For patients with history of prior MRSA infections or colonization, review previous cultures to identify potential resistance to empiric therapy.

*For patients with special consideration (e.g. Sickle cell disease, hardware or device related infection, critically ill, etc.), consultation with Infectious Disease is recommended for antimicrobial selection.

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Hemodynamic Instability/Concern for Sepsis

The systemic inflammatory response system (SIRS) is a widespread inflammatory response. When the etiology of SIRS is infection, it is called sepsis.

The presence of 2 or more of the following criteria defines SIRS:

- Core temperature (measured by rectal, bladder, oral or central-probe) of > 38.5 °C or < 36°C.
- Tachycardia:
  - Mean heart rate > 2 standard deviations above normal for age
  - For children < 1 year of age: bradycardia defined as mean heart rate < 10th% per age
- Mean respiratory rate > 2 standard deviations above normal for age or mechanical ventilation for an acute pulmonary process
- Leukocyte count elevated or depressed for age, or > 10% immature neutrophils

Pediatric Systemic Inflammatory Response Syndrome
Vital Signs and Lab Values by Age

Age group	Heart Rate (beats per min.)		Respiratory Rate (breaths per min.)	Leukocytes (x 10^3/mm)	Systolic BP (mmHg)
	Tachycardia	Bradycardia			
0-7 Days	➢ 180	< 100	➢ 50	➢ 34	< 65
1-4 Weeks	➢ 180	< 100	➢ 40	➢ 19.5 or < 5	< 75
1-12 Months	➢ 180	< 90	➢ 34	➢ 17.5 or < 5	< 100
2-5 Years	➢ 140	NA	➢ 22	➢ 15.5 or < 5	< 94
6-12 Years	➢ 130	NA	➢ 18	➢ 13.5 or < 4. 5	< 105
13 to < 18 years	➢ 110	NA	➢ 14	➢ 11 or < 4.5	< 117

Goldstein et al. International pediatric sepsis consensus conference: definitions for sepsis and organ dysfunction in pediatrics. Pediatr Crit Care Med. 2005.

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Specimen Request/Orders

- Culture – aerobic (discuss anaerobic, fungal and AFB cultures with ID fellow/ attending)
- *Staphylococcus aureus* PCR
- *Group A streptococcus* PCR
- *Kingella kingae* PCR (<5yrs)
- *Streptococcus pneumoniae* PCR (<5yrs)
- Bartonella PCR (if indicated based on epidemiologic history)
- Pathology
- Discuss additional testing with ID fellow or attending, including *universal PCR and Karius Test.*

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Discharge Criteria & Orders

Discharge Criteria

- Afebrile ≥24 hours
- Blood cultures negative > 48 hours*
- CRP <3 mg/dL or decreased by >50% from peak
- Bearing weight or using affected limb
- Antibiotics and follow-up in place

* At least 2 negative cultures if cultures with *S. aureus*

Discharge Orders

- Obtain CRP/ESR prior to discharge
- Primary Care communication and follow up in one week
- ID follow-up in 1-4 weeks
- Monitoring Labs (CBC, ESR, CRP)
  - Response to/end of therapy
  - Discuss potential drug adverse effects
- Repeat or end of therapy imaging
- Duration of therapy

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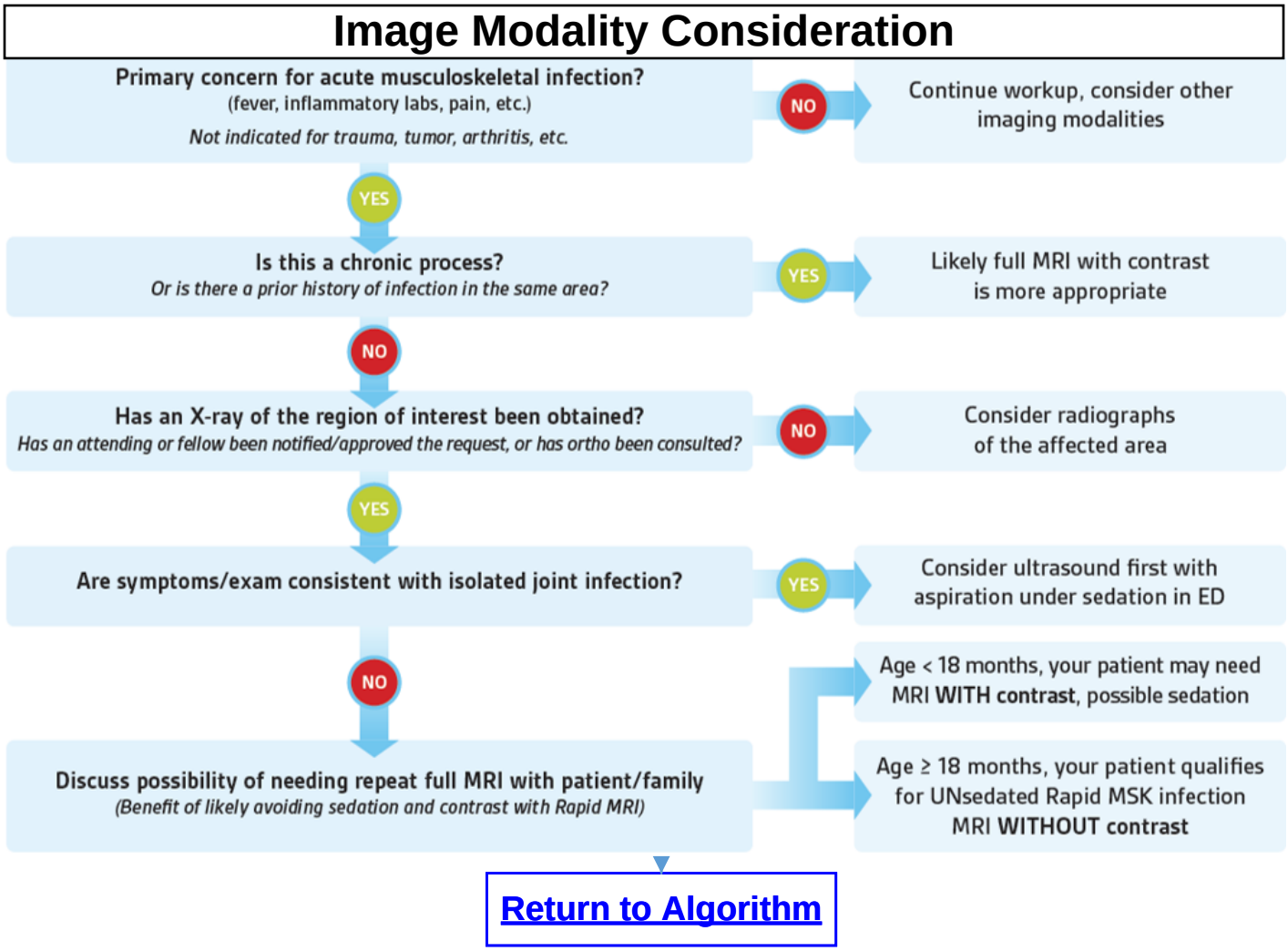
Diagnostic Testing

- Laboratory data are usually nonspecific for osteomyelitis. There may or may not be leukocytosis, and there is usually elevation of **ESR, and C-reactive protein**. The CRP level correlates with clinical response to therapy and may be used to monitor treatment. ESR can be used to monitor and decide on the duration of treatment upon discharge. **Blood cultures** may be positive and helpful in timely identification of the microbial pathogen.
- Plain **radiographs** could be used to rule out other potential causes of symptoms such as metastasis or fractures. Typically seen are soft tissue swelling, osteopenia, osteolysis, bony destruction, and nonspecific periosteal reaction. Rarely, Brodie's abscess, which is a well-circumscribed lytic lesion, may be seen.
- MRI has the highest sensitivity and specificity to detect early bone infection within 3-5 days of onset. A negative MRI result is sufficient for the exclusion of disease if symptoms have been present for at least one week. The use of IV contrast does not improve the detection of disease but helps provide the distinction between a phlegmon, necrotic tissue, and abscess. A CT scan is more used to determine the extent of bony destruction (especially in the spine) to guide biopsies or in patients with contraindications to MRI.
- Biopsy may be necessary to isolate and identify the offending microorganism. Cessation of antibiotics 48 to 72 hours before **bone biopsy** may increase microbiological yield but is not routinely necessary as bone cultures are often positive regardless of prior antibiotic therapy because these infections occur in areas of infection-induced infarction or necrosis.

Please refer to specimen collection for orders to be obtained with biopsy.



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References & Metrics

References

This pathway is based on the evidence based recommendations in the following national published guideline:

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(8):801-844. doi:10.1093/jpids/piab027

2. Cherry J, Demmler-Harrison GJ, Kaplan SL, Steinbach WJ, Hotez PJ. *Feigin and Cherry's Textbook of Pediatric Infectious Diseases E-Book*. 8th ed. *Elsevier Health Sciences*; 2017:Chapter 55.

3. Goldstein B, Giroir B, Randolph A; International Consensus Conference on Pediatric Sepsis. International pediatric sepsis consensus conference: definitions for sepsis and organ dysfunction in pediatrics. *Pediatr Crit Care Med*. 2005;6(1):2-8. doi:10.1097/01.PCC.0000149131.72248.E6

Quality Measures

Pathway Goal: Improve efficiency and outcomes for osteomyelitis patients admitted to inpatient service from emergency room.

Outcome Measures

- % of pathway eligible patients with IV ATB <5 days
- LOS (from ED to discharge for hospitalized patients)

Process Measures

- % of pathway eligible patients receiving MRI within 24 hours, including patients in the ED
- Order set utilization

Balancing Measure

- Readmission within 7 days of discharge

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Team & Process

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Clinical Pathway Development

This clinical pathway was developed using the process described in the NCH Clinical Pathway Development Manual Version 6, 2022. Clinical Pathways at Nationwide Children's Hospital (NCH) are standards which provide general guidance to clinicians. Patient choice, clinician judgment, and other relevant factors in diagnosing and treating patients remain central to the selection of diagnostic tests and therapy. The ordering provider assumes all risks associates with care decisions. NCH assumes no responsibility for any adverse consequences, errors, or omissions that may arise from the use or reliance on these guidelines. NCH's clinical pathways are reviewed periodically for consistency with new evidence; however, new developments may not be represented, and NCH makes no guarantees, representations, or warranties with respect to the information provided in this clinical pathway.

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