Musculoskeletal Infections: Diagnosis and Management – Pediatric – Inpatient/Emergency Department Clinical Practice Guideline

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**Introduction**

Musculoskeletal infections such as osteomyelitis (OM) and septic arthritis (SA) can have long term, devastating consequences for children and adolescents if they are not diagnosed and promptly treated.\(^1\)\(^2\) The classic presentation for these infections is a child with a fever and difficulty bearing weight or refusal to walk (“limping”).\(^3\) The clinical challenge then begins in determining what particular type of infection the child has (e.g., septic arthritis versus osteomyelitis versus Lyme arthritis).\(^2\) To further complicate matters, the evaluation and management of the patient involves a number of hospital services including laboratory, orthopedics, radiology and anesthesiology, which can present a separate systems challenge for the clinicians involved.\(^4\)

**Scope**

**Intended Users:** Physicians, Advanced Practice Providers, Nurses, Pharmacists

**Objective(s):** To provide an evidence-based guideline to assist in the assessment and management of pediatric patients who present with a possible septic arthritis or osteomyelitis infection.

**Target Population:** Pediatric patients age 17 years or younger who present to the emergency department with suspected osteomyelitis or septic arthritis infection and who do not have one or more of the following criteria/conditions: immunocompromised, known rheumatologic disease, prosthesis, age less than 56 days old, recent orthopedic procedure involving affected joint, penetrating injury, Sickle cell disease, Thrombocytopenia or coagulopathy, and/or clinically unstable.

**Clinical Questions Considered:**
- When should a quick MRI be obtained instead of a full MRI?
- When should a transition from IV antibiotics to oral antibiotics be considered?

**Recommendations**

**Triage**

1. A child who presents with a clinical impression of infection (e.g., swollen red joint, limited use of joint, refusal to bear weight with fever, toxic appearance) is suspect for a musculoskeletal infection.

2. A child who presents with limited use of a limb (e.g., joint swelling, localized bony tenderness, overlying warmth or redness, refusal to bear weight or walk, painful and limited range of motion in all directions,) and a fever > 101.3°F (38.5 °C) should be screened for bony abnormalities and/or fracture with x-ray imaging.\(^5\) *(UW Health Moderate quality of evidence, S recommendation)*
   a. X-ray imaging should be done prior to collecting labs related to musculoskeletal suspicion.
   b. In a limping child with localized pathology on clinical presentation, anteroposterior and lateral radiography of affected areas should be performed, especially frog-leg lateral radiographs when evaluating the hip.\(^3\)\(^6\) *(UW Health Moderate quality of evidence, S recommendation)*
Differential Diagnosis

1. If no significant bony abnormalities or fractures are noted on x-ray, obtain the following labs: erythrocyte sedimentation rate (ESR), serum C-reactive protein (CRP), complete blood count (CBC) with differential, as well as blood culture(s) prior to starting antibiotics.5 (UW Health Moderate quality of evidence, S recommendation.) Antibiotics can be withheld until specimens are obtained except for toxic/unstable and ill appearing children where clinical judgement suggests immediate antibiotics are indicated. Refer to UW Health Clinical Policy 2.5.8- Blood Cultures for Pediatric Patients for additional guidance on blood culture collection.

2. A Lyme Antibody, IgG w/Reflex to Immunoblot should be ordered if the knee joint is involved.7,8 (UW Health Moderate quality of evidence, S recommendation)

Assessment of Joint

1. If the hip joint or pelvis is the infected area in question, quick MRI is the preferred imaging modality. (UW Health Moderate quality of evidence, C recommendation)
   a. Quick MRI is preferred over ultrasound in patients with a suspected hip infection because it yields more diagnostic information and can rule out infection of muscle or adjacent bone (such as pyomyositis which can present with similar symptoms as a septic hip.) Quick MRI is advised before a full MRI since it requires no sedation (although an anxiolytic such as midazolam may be given, if needed), may be done on the same day as ED presentation, and allows for better resource planning (e.g., scheduling surgery, PICC line placement, and sedation if full MRI is needed.)9-12 (UW Health Very low quality of evidence, C recommendation)
   b. Ultrasound or a full MRI may be considered as warranted.9-12 (UW Health Moderate quality of evidence, C recommendation)

   If hip/pelvis is involved with infected area in question and full MRI is being considered instead of quick MRI, an attending discussion including Pediatric Radiologist should occur.

2. If quick MRI (or other imaging) findings of hip/pelvis concerning for infection, consult the Orthopedic and Pediatric Infectious Disease services to determine clinical course (surgery, possible admission, etc.)

3. Joints that appear swollen and erythematous by physical exam may be aspirated without Pediatric Orthopedic or Radiology consultation and intervention, if the physician is capable and comfortable in doing so.13 (UW Health Low quality of evidence, C recommendation)

4. If effusion is detected on imaging of a difficult joint (e.g., shoulder), consult Pediatric Orthopedics and/or Pediatric Radiology for aspiration with or without ultrasound guidance.7,14 It is preferred to have aspiration conducted in the Emergency Department if clinically indicated and feasible.

Quick MRI is only indicated for suspicion of infection in hip/pelvis. Attending physician required for quick MRI of other joints. If full MRI is being considered for diagnostic purposes, an attending discussion including Pediatric Radiologist should occur.
Analysis and Interpretation of Joint Aspirate

1. Joint aspirate specimens should be sent to the lab for synovial fluid cell count and body fluid culture aerobic/anaerobic with gram stain. If a small volume of fluid is obtained, prioritize cell count on sample. (UW Health Moderate quality of evidence, C recommendation)

   If the child is less than 5 years and Kingella kingae is possible or if the patient has been previously treated with antibiotics, the lab should be requested to keep the cultures active for at least 10 days and 16s ribosomal PCR testing should be ordered to be done as soon as the laboratory runs them. (UW Health Moderate quality of evidence, C recommendation)

2. If synovial fluid interpretation yields white blood cell (WBC) count < 50 K/µL, consult Pediatric Orthopedics and/or Pediatric Infectious Disease Services and plan for possible admission to Pediatric Hospital Medicine Service.

3. If synovial fluid interpretation yields WBC count ≥ 50 K/µL, an interdisciplinary discussion (Pediatric Orthopedics, Pediatric Anesthesia, Pediatric Radiology, Pediatric Hospital Medicine and/or Pediatric Infectious Disease) should occur to determine how to best proceed with treatment (e.g., debridement surgery, MRI, or whether empiric antibiotic is needed.)

Pediatric patients with a musculoskeletal infection (e.g., osteomyelitis, septic arthritis) that require hospital admission should be admitted to the Pediatric Hospital Medicine Service.

Sedation/Anesthesia for Procedures and MRI

1. It is recommended to assess if anesthesia will be required for the patient to undergo a full MRI evaluation, given some older patients do not require it. (UW Health Very low quality of evidence, C recommendation)

2. It is recommended that providers try to minimize the number of instances the pediatric patient is sedated or undergoes general anesthesia during the encounter or admission. For example, if the patient is undergoing sedation for a full MRI and is determined that a PICC line will be needed, consider PICC line placement while patient is sedated from MRI. (UW Health Moderate quality of evidence, C recommendation)

   If sedation is needed for a full MRI, contact the Pediatric Anesthesia service versus the Pediatric Sedation Clinic for timelier evaluation of infection.

Diagnosis of Infection

1. Septic arthritis of the hip should be suspected over transient synovitis if 3 or more of the following Kocher criteria are met: inability to bear weight, oral temperature > 101.3°F (38.5°C), ESR > 40 mm/hr, white blood cell count > 12 K/µL or CRP > 2 mg/dL. These criteria are not applicable to any other joint or osteomyelitis. (UW Health Moderate quality of evidence, C recommendation)

2. A WBC > 50 K/µL from synovial fluid interpretation strongly suggests a bacterial infection and surgical debridement and antibiotic therapy should be considered. (UW Health Moderate quality of evidence, S recommendation)

Antimicrobial Therapy Management

1. Placement of a peripherally inserted central catheter (PICC) line should be considered once the patient is diagnosed with a musculoskeletal infection, given that the recommended antibiotic duration for septic arthritis can be 3-4 weeks and 4-5 weeks for...
osteomyelitis. Antibiotic therapy is also initially given by intravenous (IV) route. \(^{19,20}\) (UW Health Moderate quality of evidence, C recommendation)

2. Antibiotics with activity against *Staph aureus* and *Group A streptococci* should be selected for empiric therapy because these pathogens are typically the primary causes of osteomyelitis and septic arthritis.\(^8\) (UW Health High quality of evidence, S recommendation)

3. It is recommended to initiate empiric antibiotic therapy as follows\(^21\) in any patient who meets the following criteria: (UW Health Moderate quality of evidence, C recommendation):
   a. Non-toxic, clinically stable – initiate oxacillin 50mg/kg every 6 hours.
   b. Non-toxic, clinically stable with concern for MRSA (e.g. history of MRSA) – initiate vancomycin 15 mg/kg every 6 hours.
   c. Toxic, ill-appearing – initiate oxacillin + vancomycin.
   d. If there is concern for *Kingella Kingae* (age 3 months-3 years), *Strep Pneumoniae*, *Haemophilus Influenzae* (i.e. non-immunized) or *Neiserria gonorrhoeae* (i.e., sexually active adolescent) – add ceftriaxone 37.5 mg/kg twice a day.

4. It is recommended to obtain a baseline creatinine level before initiating vancomycin, and to discontinue any non-steroidal anti-inflammatory drugs (NSAIDs) once a patient is started on vancomycin.\(^{22,23}\) (UW Health Low quality of evidence, C recommendation)

5. Consider CRP every 2-3 days and obtaining ESR measurement once a week to monitor patient response to antibiotic treatment, along with clinical assessment.\(^{24,25}\) (UW Health Low quality of evidence, C recommendation)

6. If the patient is afebrile, pain decreased, and CRP \(\leq\) 2 mg/dL or has decreased by 50%, consider switching antibiotic administration from intravenous to oral route for continued antibiotic therapy.\(^1,4,26,27\) (UW Health Low quality of evidence, C recommendation)

**Disclaimer**
Clinical practice guidelines assist clinicians by providing a framework for the evaluation and treatment of patients. This guideline outlines the preferred approach for most patients. It is not intended to replace a clinician’s judgment or to establish a protocol for all patients. It is understood that some patients will not fit the clinical condition contemplated by a guideline and that a guideline will rarely establish the only appropriate approach to a problem.
Methodology

Development Process
Each guideline is reviewed and updated a minimum of every 3 years. All guidelines are developed using the guiding principles, standard processes, and styling outlined in the UW Health Clinical Practice Guideline Resource Guide. This includes expectations for workgroup composition and recruitment strategies, disclosure and management of conflict of interest for participating workgroup members, literature review techniques, evidence grading resources, required approval bodies, and suggestions for communication and implementation.

Methods Used to Collect the Evidence:
The following criteria were used by the guideline author(s) and workgroup members to conduct electronic database searches in the collection of evidence for review.

Literature Sources:
- Electronic database search (e.g., PubMed)
- Databases of systematic reviews (e.g., Cochrane Library)
- Hand-searching journals, external guidelines, and conference publications

Time Period: June 2018 to October 2018

The following is a list of various search terms that were used individually or in combination with each other for literature searches on PubMed: septic arthritis, osteomyelitis, musculoskeletal, pediatric, MRI, imaging.

Methods to Select the Evidence:
Literary sources were selected with the following criteria in thought: English language, subject age (i.e., pediatric), publication in a MEDLINE core clinical journal and strength of expert opinion (e.g., professional organization or society).

Methods Used to Formulate the Recommendations:
The workgroup members agreed to adopt recommendations developed by external organizations and/or created recommendations internally via a consensus process using discussion of the literature and expert experience/opinion. If issues or controversies arose where consensus could not be reached, the topic was escalated appropriately per the guiding principles outlined in the UW Health Clinical Practice Guideline Resource Guide.

Methods Used to Assess the Quality of the Evidence/Strength of the Recommendations:
Recommendations developed by external organizations maintained the evidence grade assigned within the original source document and were adopted for use at UW Health.

Internally developed recommendations, or those adopted from external sources without an assigned evidence grade, were evaluated by the guideline workgroup using an algorithm adapted from the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology (see Figure 1).
Figure 1. GRADE Methodology adapted by UW Health

Rating Scheme for the Strength of the Evidence/Recommendations:

<table>
<thead>
<tr>
<th>GRADE Ranking of Evidence</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>We are confident that the effect in the study reflects the actual effect.</td>
</tr>
<tr>
<td>Moderate</td>
<td>We are quite confident that the effect in the study is close to the true effect, but it is also possible it is substantially different.</td>
</tr>
<tr>
<td>Low</td>
<td>The true effect may differ significantly from the estimate.</td>
</tr>
<tr>
<td>Very Low</td>
<td>The true effect is likely to be substantially different from the estimated effect.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GRADE Ratings for Recommendations For or Against Practice</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong (S)</td>
<td>Generally should be performed (i.e., the net benefit of the treatment is clear, patient values and circumstances are unlikely to affect the decision.)</td>
</tr>
<tr>
<td>Conditional (C)</td>
<td>May be reasonable to perform (i.e., may be conditional upon patient values and preferences, the resources available, or the setting in which the intervention will be implemented.)</td>
</tr>
</tbody>
</table>

Recognition of Potential Health Care Disparities: Acute osteoarticular infections such as osteomyelitis and septic arthritis are relatively rare in high-income settings compared to developing countries. The annual incidence in a high-income country like the United States varies between 10 and 25 per 100000 population.28
Collateral Tools & Resources

The following collateral tools and resources support staff execution and performance of the evidence-based guideline recommendations in everyday clinical practice.

Metrics

- # of patients with X-ray
- # of patients with ultrasound
- # of patients with quick MRI, full MRI
- Average amount of time from when patient presented to ED to when quick MRI is done
- Average number of days patient is on IV antibiotic

Guideline Metrics

1. # of patients with X-ray
2. # of patients with ultrasound
3. # of patients with quick MRI, full MRI
4. Average amount of time from when patient presented to ED to when quick MRI is done
5. Average number of days patient is on IV antibiotic

Guidelines

1. Surgical and Interventional Radiology Antimicrobial Prophylaxis- Adult/Pediatric-Inpatient/Ambulatory
2. Antimicrobial Use Therapeutic Pearls- Adult/Pediatric-Inpatient/Ambulatory
3. Sedation - Nursing Practice Guideline

Order Sets & Smart Sets

IP- Venous Access Team- PICC Placement Request- Pediatric-Supplemental [1429]
IP- Orthopedics- General – Pediatric- Admission [5589]
IP- Pediatric- General Care- Admission [1325]

Patient Resources

1. Health Facts for You #7595- Caring for your Child's PICC
2. Health Facts for You #5093- Understanding your Peripherally Inserted Central Catheter
3. Kids Health- A to Z: Septic Arthritis (Pyogenic Arthritis)
4. Kids Health- Osteomyelitis
5. Kids Health- Blood Culture
6. Kids Health- Blood Test: C-Reactive Protein (CRP)
7. Kids Health- Blood Test: Erythrocyte Sedimentation Rate (ESR)
8. Kids Health- Blood Test: Complete Blood Count
9. Kids Health- Joint Aspiration (Arthrocentesis)
10. Kids Health- Magnetic Resonance Imaging (MRI)
11. Kids Health- Anesthesia- What to Expect
12. Kids Health- Anesthesia Basics
13. Kids Health- Preparing Your Child for Anesthesia

Policies

1. UWHC Clinical Laboratory Policy 1507.P014- Blood Culture Collection
2. UWHC Clinical Policy 8.56 Pediatric Sedation Policy
3. UWHC 2.3.5-Magnetic Resonance Imaging (MRI) Safety and Screening
## Appendix A. Pediatric Musculoskeletal Infection Algorithm (Hip joint focused)

**Exclusion Criteria**
- Immunocompromised
- Known rheumatologic disease
- Prosthesis
- Age < 56 days
- Recent orthopedic procedure involving affected joint
- Penetrating injury
- Sickle cell disease
- Thrombocytopenia, coagulopathy
- Clinically unstable

**A. Clinical impression of infection examples (including but not limited to)**
- Swollen red joint
- Limited use of joint
- Refusal to bear weight with fever, toxic appearance

**B. Labs**
If no significant bony abnormalities or fractures are noted on x-ray, obtain the following labs: erythrocyte sedimentation rate (ESR), serum C-reactive protein (CRP), complete blood count (CBC) with differential, as well as blood culture(s) prior to starting antibiotics.

If knee involved obtain Lynex IgG Lab.

**C. Imaging**
Quick MRI is only indicated for suspicion of infection in hip/pelvis. Attending physician required for quick MRI of any other joints.

Quick MRI should be done with no sedation however patient may receive anxiolytic [i.e., midazolam]

Attending discussion including Pediatric Radiologist should occur if full MRI considered.

**D. Empiric antibiotic suggestions**
- Non-toxic appearing: IV Oxacillin 50mg/kg every 6 hours
- Non-toxic appearing w/ risk for MRSA (incl. hx of MRSA): IV Vancomycin 15 mg/kg every 6 hours
- Toxic appearing or known (+) blood cultures:
  - IV Vancomycin + Oxacillin
- *Obtain baseline Creatinine if starting vancomycin and stop NSAIDS*
- *If Penicillin allergy, consult Feds ID for antibiotic therapy recommendations.*

Add Ceftriaxone 37.5 mg/kg twice a day IV:
- suspect Kingella kingae [i.e., pt is 3 months-3 yrs]
- suspect Strep. pneu or Haemophilus influenzae (i.e., non-immunized pt.)
- suspect Neisseria gonorrhoea (i.e., sexually active teen)

**E. PICC line**
If PICC line indicated, age ≤ 12 yrs. and resources available, consider placing PICC while patient is sedated for procedure (e.g. full MRI) or in OR during surgery.

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**Consult Orthopedic and Pediatric Infectious Disease for consideration of the following:**
- Surgery/debridement/sample
- MRSA swab (2 sites)
- Start IV antibiotic
- PICC line (+/-)
- Possible admission (Patients should be admitted to Pediatric Hospital Medicine Service)

If sample is needed and non-operative osteomyelitis or aspiration needed for septic arthritis in hip, consider Pediatric Radiology consult.
Appendix B. Pediatric Musculoskeletal Infection Assessment (Non-hip joint focused)

[Flowchart image with decision points and treatment options]

F. Aspiration of joint
- For difficult to aspirate joints, consult Orthopedics or Pediatric Radiology. If possible, aspirate in ED versus admitting patient to floor.
- Daytime: Peds Radiology 263-0671 or 263-0670. After hours: Page Radiology Resident on call.
- If aspiration by radiology, contact Peds Anesthesia for procedural sedation if needed.
- Labs for fluid analysis: synovial fluid cell count, and body fluid aerobic/anaerobic culture with gram stain.
- If small volume of fluid obtained and antibiotics given, prioritize conducting cell count on sample.
- If pt <5 yrs and Kingella possible, request lab to keep culture active for at least 10 days and do 16s ribosomal PCR as soon as lab runs.

G. Empiric antibiotic suggestions
- Non-toxic appearing:
  - IV Oxacillin 50mg/kg every 6 hours
  - Non toxemic appearing w/risk for MRSA (incl. hx of MRSA):
    - IV Vancomycin 15 mg/kg every 6 hours
  - Toxic appearing or known (+) blood culture:
    - IV Vancomycin + Oxacillin
      - Obtain baseline Creatinine if starting vancomycin and stop NSAIDs
      - If Penicillin allergy, consult Peds ID for antibiotic therapy recommendations.
    - Add Ceftriaxone 37.5 mg/kg twice a day if:
      - Suspect Kingella kingae (i.e., pt is 3 months-3 yrs)
      - Suspect Strep. pneumonia or Hemophilus influenzae (i.e., non-immunized pt.)
      - Suspect Neisseria gonorrhoea (i.e., sexually active teen)

H. PICC line
- If PICC line indicated, age ≤ 12 yrs and resources available, consider placing PICC while patient is sedated for procedure (e.g., full MRI) or in OR during surgery.

I. Quick MRI
- Quick MRI is often obtained in patients suspected with infection in hip/pelvis prior to surgery.
- May be used to identify location of infection in extremity not otherwise obvious. HOWEVER, attending physician discussion (ED/Pediatric Radiology/Orthopedic) is required for this use.
- Full MRI is recommended in musculoskeletal patients who have had surgical debridement performed if there is question regarding clinical improvement.
References