MUSCULOSKELETAL INFECTION CLINICAL PATHWAY

EXECUTIVE SUMMARY

Physician Owner(s): Stephen Dolter, MD

Primary Objective

Maintain a pathway for treating musculoskeletal infections in the Emergency Department and the Medical-Surgical Unit.

Recommendations

1. Recommended patient population:
   a. Age 6 months to 18 years
   b. Suspicion of acute (less than 2 weeks) deep musculoskeletal infection such as septic arthritis, osteomyelitis, and/or pyomyositis
   c. Not intended for patients:
      i. Who exhibit signs of sepsis and/or shock or who are otherwise critically ill
      ii. With postoperative infection
      iii. With infections from penetrating trauma
      iv. With chronic infection (symptoms for greater than 2 weeks)
      v. Less than 6 months of age, as they may have: other pathogens, multifocal disease, and/or poor oral antibiotic absorption
      vi. Who are medically complex

2. Emergency Department evaluation
   a. Obtain vital signs
   b. Observation and/or history for[1]
      i. Pain and/or irritability
      ii. Fever greater than 38.5C
      iii. Limited used or immobility of extremity or spine
      iv. Gait disturbance, limp, or inability to bear weight on lower extremity
      v. Non-infectious causes of pain and decreased mobility
   c. Physical examination for the presence of:
      i. Fever
      ii. Limited range of motion
      iii. Tenderness
      iv. Swelling
      v. Warmth at site
      vi. Erythema
   d. Initial laboratory studies[3-4,24]
      i. CBC
      ii. CRP
      iii. ESR
      iv. Blood cultures
   e. Initial imaging studies
      i. Plain radiographs[5]
         1. Not sensitive for evaluating acute soft tissue and osseous infection
         2. If diagnostic, may avoid further imaging
      ii. Ultrasound

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1. Should be utilized if symptoms can be localized to the hip(s) or knee(s)
2. Not necessary if a clinically identifiable joint effusion is present

f. Synovial fluid aspiration and analysis
   i. If physical examination and/or imaging is consistent with a joint effusion, synovial fluid should be aspirated
   ii. Fluid should be sent for cell count, culture, and Gram stain[2]
   iii. Fluid should be sent for *Kingella* PCR in patients whose age is between 6 months and 5 years
   iv. Extra fluid should be saved in the lab
g. MRI following discussion with Orthopedics and OR scheduling to assure the correct exam is ordered in the appropriate time frame and that space is reserved for a potential I&D following the MRI if indicated
   i. If symptoms can be localized to the knee(s) or hip(s), ultrasound of the affected joint(s) should be performed prior to MRI
   ii. If septic arthritis is suspected or confirmed[6] (synovial WBC greater than 25K), MRI should be performed urgently
   iii. If symptoms cannot be localized to a joint or if septic arthritis is not suspected, it is acceptable to postpone imaging until morning if patient presents at night

3. Emergency Department treatment
   a. Pain control
   b. NPO and place PIV

4. Consults
   a. Orthopedics: discuss all confirmed and probable MSK infections prior to advanced imaging
   b. Infectious Diseases: consult on all confirmed and probable MSK infections within 24 hours of admission
   c. Pediatric Hospital Medicine: primary admitting service for all patients with MSK infections

5. Operating room evaluation and treatment
   a. Surgical drainage and/or irrigation indicated if:
      i. Infection of a joint is suspected (or confirmed based upon synovial fluid analysis)
      ii. Abscess appreciated on physical examination or imaging
   b. Best method of obtaining a source culture to be discussed with Orthopedic Surgery
   c. Laboratory testing on source tissue/fluid:
      i. Culture (NO SWABS), Gram stain, and pathology on all cases
      ii. For patients 6 months to 5 years of age, add *Kingella kingae* PCR[14-15]

6. Inpatient care
   a. Admit all patients with suspected or confirmed MSK infections to the Pediatric Hospital Medicine service unless directed otherwise by the Orthopedic Surgery or Infectious Diseases services
   b. Coordinate imaging (ultrasound, MRI) and surgical intervention with Orthopedic Surgery if not previously performed

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c. Consult Infectious Diseases within 24 hours
d. Antibiotic therapy
    i. Blood cultures (and source cultures if reasonable) should be obtained prior to beginning antibiotic therapy
    ii. All patients should receive IV antibiotics initially
    iii. If MRSA is not suspected, recommended empiric therapy is with cefazolin[48]
    iv. Consider adding vancomycin if patient has a history of MRSA or has MRSA risk factors
    v. If blood culture and/or Biofire BCID identifies an organism, modify antimicrobial therapy according to the Children's antibiogram
e. Adjust therapy based on clinical course, culture and susceptibility results, and clinical improvement
f. Consider evaluation for intravascular infection or distant foci of infection if patient:
    i. Remains bacteremic for greater than 3 days
    ii. Has Staphylococcus aureus bacteremia
    iii. Has multifocal disease
    iv. Has unusually severe disease
g. Anticipate a longer course of IV antibiotics and plan for PICC if[51]:
    i. Patient has hip joint involvement
    ii. Patient remains bacteremic for greater than 3 days
    iii. Patient has multifocal or unusually severe disease
    iv. Cultures grow an unusual organism
    v. Adequate surgical drainage of the affected area cannot be performed
h. If patient does not improve as expected, consider
    i. Repeat lab assessment
    ii. Repeat imaging[43]
    iii. Repeat surgical intervention
    iv. Repeat cultures
    v. Expansion of antibiotic coverage
    vi. An alternative diagnosis
i. If therapy results in clinical improvement, treat with intravenous antibiotics until [25,30,36-39]:
    i. Patient appears well
    ii. Weight bearing, range of motion, and use of affected anatomy is improved
    iii. Patient can tolerate oral medication
    iv. Patient has been afebrile for at least 24 hours
    v. CRP is decreasing
    vi. Bacteremia (if initially present) has cleared

7. Discharge planning
    a. Arrange home antibiotics
    b. Ensure adequate supply of oral antibiotics is available, that a prescription has been sent to the preferred pharmacy, and that family can obtain medications without any barriers

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c. If IV antibiotic therapy is indicated, arrange home health teaching, order necessary supplies, order appropriate monitoring labs (CBC, CRP, ESR, serum chemistries), and develop a clear communication plan
d. Ensure family understands importance of medication adherence and understands possible side effects of antibiotics (Refer to Table 1)

8. Follow-up
   a. Infectious Diseases
   b. Orthopedic Surgery

Rationale

Safety:	Will be maintained by close communication between ED, Orthopedic Surgery, Infectious Diseases, and Hospital Medicine providers.
Quality & Delivery:	Will be improved by reducing unnecessary variation related to diagnostic testing, antimicrobial utilization, and specialist involvement.
Cost:	Will be reduced by reducing variation in treatment which leads to potential delays, adverse events, and readmissions.
Engagement:	Is created and supported by involvement of providers across the continuum of care that evaluate and treat musculoskeletal patients.
Patient/Family Satisfaction:	Shall be improved by providing timely, high-quality care based on established guidelines and the latest evidence available in the literature.

Metrics

1. Increase MSI order set utilization to >50% by December 2023 and 60% by December 2024. (Process Metric)
2. Increase proportion of US completed for MSI concern to 25% by April 2023. (Outcome Metric)
3. Reduce the proportion of MRIs performed between the hours of 2200-0500 to <5% by October 2023. (Outcome Metric)
4. Increase ID consults within 24 hours to 80% by December 2023 (Outcome/Process Metric)
5. Monitor Readmissions within 30 days (Balancing Metric)

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Team Members

Champion: Dr. Stephen Dolter, MD Hospital Medicine
Emergency Department: Jennifer Wang, MD
Orthopedic Surgery: Matthew Halanski, MD; Brian Hasley, MD; Ryan Koehler, MD
Infectious Diseases: Gwen Skar, MD
Radiology: Travis Kruse, MD
Pharmacy: Jennifer Zwiener, PharmD
Clinical Effectiveness: Kelsey Spackler, DNP APRN-NP; Abby Vipond, MSN, APRN
Care Transformation Business Intelligence Data Scientist: Ellen Kerns, PhD

Evidence

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Children's HOSPITAL & MEDICAL CENTER

Table 1. **Antibiotics and Monitoring for Patients with Musculoskeletal Infections (Other antibiotics may be indicated based on culture results)**
Developed by Antimicrobial Stewardship at Children's Hospital Colorado, Sarah Parker & Jason Child 2014

	Cefazolin (IV)	Cephalexin (PO)	Ceftriaxone (IV)	Vancomycin (IV)	Clindamycin (IV or PO)	Ampicillin (IV)	Amoxicillin (PO)
Dosing (mg/kg/dose)	33.3 mg/kg (septic joint) Q8H 50 mg/kg (osteo) Q8H	33.3 - 50 mg/kg TID	75 mg/kg Q24H	15-20 mg/kg Q6H	10-13.33 mg/kg Q8H	50 mg/kg Q6H	30 mg/kg TID
Daily Maximum for MSK Infection	2,000 mg/dose Q8H *For severe cases: 2,000 mg/dose Q6H*	1,333 mg/dose TID	2,000 mg/dose Q24H	2,000 mg/dose Q8H *For severe cases: 2,000 mg/dose Q6H*	900 mg/dose Q8H	2,000 mg/dose Q6H	1,000 mg/dose TID
Organism							
MSSA[2]	++	+	-	+	+/-		
MRSA				+	+/-[3]		
S. pyogenes (Group A strep)	+	+	+	+	+	+	+
S. pneumoniae	+	+	+	+		+	+
Kingella kingae[5]	++	+	+		+/-	+/-	+/-
Side Effects							
Diarrhea, including *C. difficile* colitis	+	+	+	+	+	+	+
Bone marrow suppression	+	+	+	+	+	+	+
Rash	+	+	+	+	+	+	+
Stevens Johnson Syndrome	+	+	+	+	+	+	+
Drug fever	+	+	+	+	+	+	+
Nephrotoxicity, Interstitial nephritis	+	+	+			+	+
Nephrotoxicity, other				+			
Elevated transaminases			+		+		
Labs to monitor for infection	[1]CBC, CRP or ESR,	[1]CBC, CRP or ESR, BUN,	[1]CBC, CRP or ESR,	[1]CBC, CRP or ESR, BUN, Cr,	[1]CBC, CRP or ESR, BUN, Cr,	[1]CBC, CRP or ESR, BUN, Cr	[1]CBC, CRP or ESR, BUN, Cr

[1] All patients on antibiotics for MSK infection should be followed with a weekly CBC, ESR or CRP. There are additional labs specific to the antibiotic, for example: urinalysis and BUN/creatinine screen for renal function and interstitial nephritis, CBC for neutropenia. Clinically patients should be followed for signs of allergy including rash, for diarrhea (any antibiotic can cause *Clostridium difficile* colitis), for fevers (for severe allergy and line infection, recurrent infection), for compliance and other complaints. All antibiotics can cause anaphylaxis. Side effects listed are most common, but do not represent all side effects.

[2] Although cefotaxime and ceftriaxone are often listed as having activity against MSSA, in general, antistaphylococcal penicillins (such as nafcillin) or first generation cephalosporins (such as cefazolin) are the preferred therapy.

[3] The use of clindamycin for MRSA depends on local susceptibility patterns and, if available, susceptibility testing.

[4] Nafcillin, vancomycin and penicillin can be given by continuous infusion; discuss with ID/pharmacy.

[5] *Kingella kingae* is a predominant cause of bone and joint infection in the 6 month to less than 4 year age group, but is difficult to culture. Unless microbial cause is known, it should be empirically covered. 92% of *K. kingae* disease is in children aged 6 to 29 months. It predominantly causes septic arthritis, but can also cause isolated osteomyelitis and tenosynovitis; it generally has a milder presentation than *S. aureus*.

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Table 2. Brief Differential for the Acute Limping Child

Infectious etiologies	Septic arthritis
	Osteomyelitis
	Discitis
	Pyomyositis
	Psoas abscess
	Cellulitis
Other Orthopedic Conditions	SCFE
	Perthes
	Fracture, acute or stress
	Foreign body
Inflammatory Conditions	Transient synovitis
	JRA
	Reactive arthritis (Strep, etc)
	Rheumatic fever
Other Systemic Conditions	Leukemia
	Spine or other solid tumors
	Sickle cell disease

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Appendix A.

Stat Joint/Synovial Aspirates (Orthopedic Surgery)

1. Nurse will obtain joint aspirate kit (will be kept in OR – in the core, in cabinet by ice machine, ED and lab)
2. Notify Pathology (X5519) that a "STAT JOINT/SYNOVIAL ASPIRATE" will be obtained in OR or ED. (These exact words are critical for communication).
3. Surgeon will perform joint aspiration - using the kit to obtain the specimen.
    a. > 1.0 cc obtained: 1.0 cc or more in EDTA (purple top tube) [for cell count & differential]
    b. < 1.0 cc obtained: 0.5 cc or more in sterile syringe with cap [for culture (includes gram stain)]
        i. culture (syringe) ONLY [will not be enough for cell count & differential]
4. GREEN JOINT SPECIMEN STAT RUN PAPER completed
    a. Patient sticker with identification
    b. Specimen source
    c. Surgeon
    d. Results call to phone number
    e. Tests to be performed (check box)
        i. Cell count & differential
        ii. Gram stain & culture
5. Specimen sent to Pathology (tube station # 410)
    a. Tube the biohazard specimen bag which should contain the following:
        i. Labeled Specimen(s) – include phone # for lab to call and report results.
        ii. GREEN JOINT SPECIMEN STAT RUN PAPER – this paper has to be sent with the specimen to alert lab of STAT RUN.
    b. Call Pathology AGAIN to notify them that specimen has been sent (X5519) – confirm that lab understands it is a "STAT JOINT/SYNOVIAL ASPIRATE" that will need to be immediately delivered to Hematology and Microbiology.
        i. Document the specimen and "mark as sent" – you do not need to create orders or print anything.
6. Pathology technician IMMEDIATELY delivers specimens to Hematology & Microbiology
7. Pathology technician enters orders into EPIC (to be signed by MD).
8. Hematology performs cell count & differential
    a. Call results once cell count completed
    b. Call results once differential completed
9. Microbiology performs gram stain & sets up culture
    a. Call gram stain result
10. OR or ED nurse ensures that a replacement kit is obtained from lab and restocked

JOINT ASPIRATE KIT (available in OR, ED & lab)

- Two 10 cc syringes
- 18 gauge spinal needle
- 18 gauge delivery needle
- EDTA (purple) tube
- Laboratory GREEN SURGERY SPECIMEN RUN STAT paper
- Instructions/procedure

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