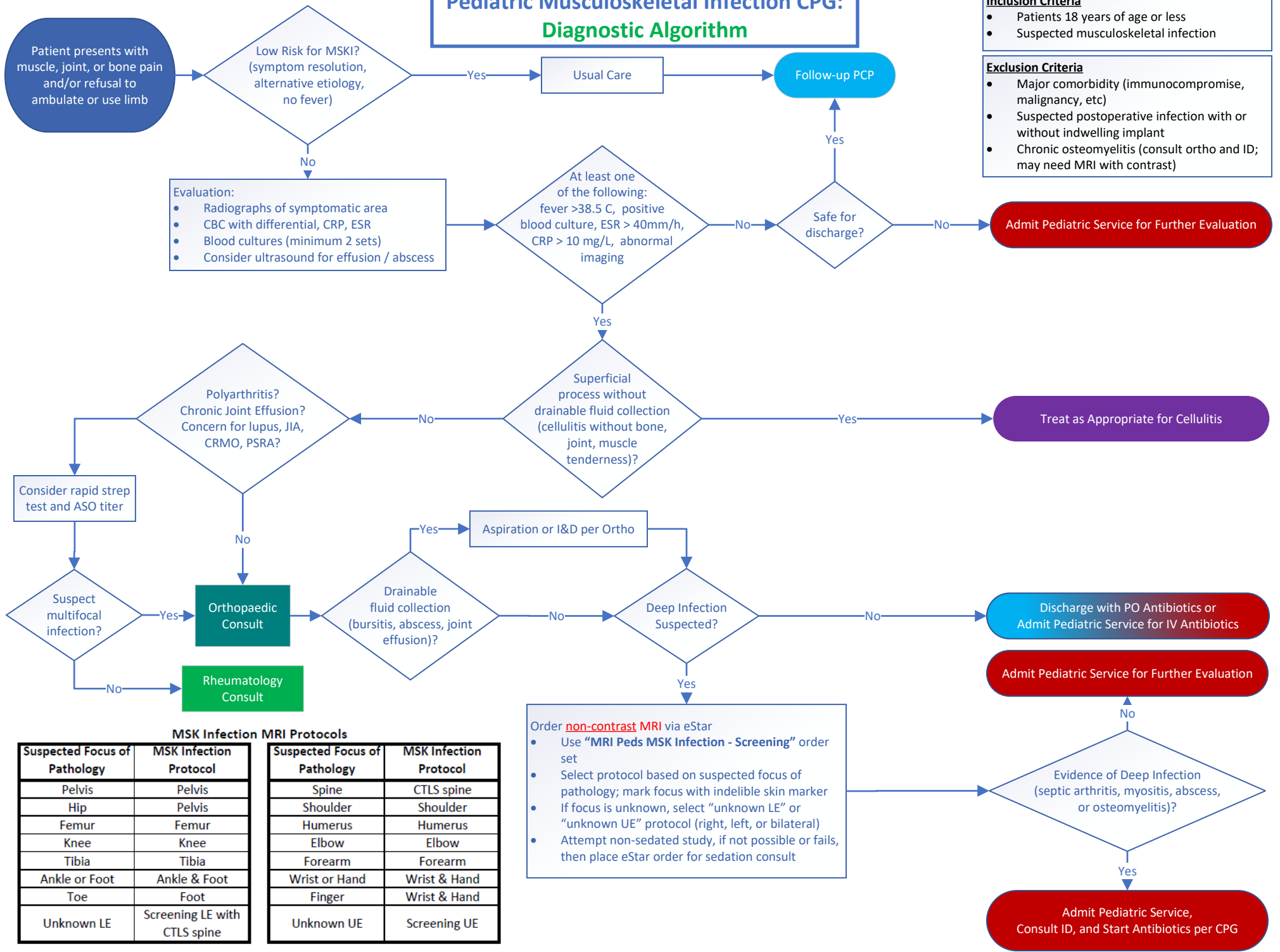


Pediatric Musculoskeletal Infection CPG: Diagnostic Algorithm



- Inclusion Criteria**
- Patients 18 years of age or less
 - Suspected musculoskeletal infection
- Exclusion Criteria**
- Major comorbidity (immunocompromise, malignancy, etc)
 - Suspected postoperative infection with or without indwelling implant
 - Chronic osteomyelitis (consult ortho and ID; may need MRI with contrast)

- Evaluation:**
- Radiographs of symptomatic area
 - CBC with differential, CRP, ESR
 - Blood cultures (minimum 2 sets)
 - Consider ultrasound for effusion / abscess

Polyarthritis?
Chronic Joint Effusion?
Concern for Lupus, JIA,
CRMO, PSRA?

Consider rapid strep
test and ASO titer

Suspect
multifocal
infection?

Orthopaedic
Consult

Rheumatology
Consult

Drainable
fluid collection
(bursitis, abscess, joint
effusion)?

Aspiration or I&D per Ortho

Deep Infection
Suspected?

Discharge with PO Antibiotics or
Admit Pediatric Service for IV Antibiotics

Admit Pediatric Service for Further Evaluation

- Order **non-contrast MRI** via eStar
- Use "MRI Peds MSK Infection - Screening" order set
 - Select protocol based on suspected focus of pathology; mark focus with indelible skin marker
 - If focus is unknown, select "unknown LE" or "unknown UE" protocol (right, left, or bilateral)
 - Attempt non-sedated study, if not possible or fails, then place eStar order for sedation consult

Evidence of Deep Infection
(septic arthritis, myositis, abscess,
or osteomyelitis)?

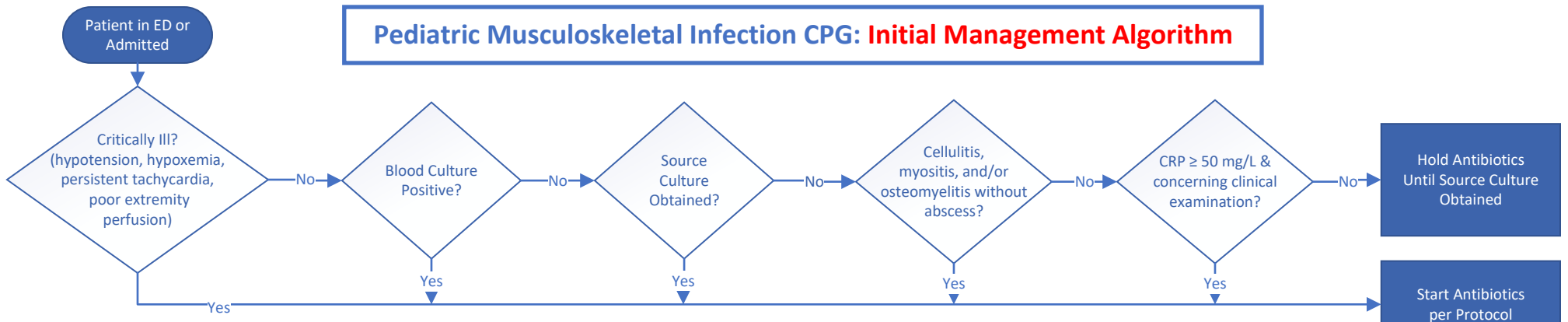
Admit Pediatric Service,
Consult ID, and Start Antibiotics per CPG

MSK Infection MRI Protocols

Suspected Focus of Pathology	MSK Infection Protocol
Pelvis	Pelvis
Hip	Pelvis
Femur	Femur
Knee	Knee
Tibia	Tibia
Ankle or Foot	Ankle & Foot
Toe	Foot
Unknown LE	Screening LE with CTLS spine

Suspected Focus of Pathology	MSK Infection Protocol
Spine	CTLS spine
Shoulder	Shoulder
Humerus	Humerus
Elbow	Elbow
Forearm	Forearm
Wrist or Hand	Wrist & Hand
Finger	Wrist & Hand
Unknown UE	Screening UE

Pediatric Musculoskeletal Infection CPG: Initial Management Algorithm



Initial Antibiotic Therapy Protocol

	Drug	Dose	Route	Frequency	Considerations
Critically Ill Patient					
(Vanco or Dapto) AND (Cefazolin or Nafcillin)	vancomycin	60 mg/kg/day	IV	divided Q6H	goal trough 15-20mg/L, 30 minutes prior to 4th dose
	or				
	daptomycin	10 mg/kg/dose	IV	Q24H	until susceptibilities available
	AND				
	cefazolin	150 mg/kg/day	IV	divided Q8H	
or					
nafcillin	200mg/kg/day	IV	divided Q6H		
If immunocompromised or concern for necrotizing infection, consult ID					
Medically Stable Patient					
Children < 5 years	cefazolin	150 mg/kg/day	IV	divided Q8H	If well-appearing child with preceding URI symptoms, history of daycare attendance, and/or normal or minimally elevated CRP , consider cefazolin monotherapy to cover for <i>Kingella</i> .
	AND				
	clindamycin	40 mg/kg/day	IV	divided Q8H	
Children ≥ 5 years	clindamycin	40 mg/kg/day	IV	divided Q8H	
Children with allergy to clindamycin or high suspicion for clindamycin resistant <i>S. aureus</i>	vancomycin	60mg/kg/day	IV	divided Q6H	goal trough 15-20mg/L, 30 minutes prior to 4th dose
	may also consider				
	linezolid	<12 years: 30 mg/kg/day ≥12 years: 20 mg/kg/day	PO	<12 years: TID ≥12 years: BID	Max 1200 mg/day

Consider evaluation for

- Sepsis (Rapid Response)
- Pneumonia / pleural effusion (CXR)
- DVT (extremity u/s)
- PE (chest CT w/contrast)

Consider escalation of care

- Continuous pulse oximetry
- Monitored bed
- ICU admission

When to Consult ID Service?

- Critically ill patients and/or suspicion of necrotizing infection
- Cellulitis, septic bursitis, or superficial abscess if not improving with initial antibiotic therapy
- Diagnosis of septic arthritis, myositis, or osteomyelitis

Source Culture and Control Protocol

Use algorithm above to determine the timing of antibiotic initiation. Antibiotics should be started prior to source culture if the patient is critically ill, has positive blood cultures, or has a CRP ≥ 50 mg/L with a concerning clinical examination. Source culturing is **not** indicated for

- Cellulitis or myositis
- Discitis (unless failing to improve with empiric treatment)
- Osteomyelitis without abscess (unless failing to improve with empiric treatment)

Ortho will consider **source culture and operative debridement** for

- Abscess (drainable fluid collection per ortho)
- Joint effusion with suspected septic arthritis
- Osteomyelitis with abscess (drainable fluid collection per ortho)

Interventional Radiology consult to be recommended by Ortho team for sites more amenable to IR biopsy and /or drain placement

Source Culture Technique

Body and synovial *fluid and tissue* cultures should be sent in a specimen cup for

- Bacteria cultures
- *Kingella* PCR if age < 5 years (also inoculate extra fluid into blood culture bottle as described below)

NO SWABS should be used for cultures due to low yield. Extra fluid may be sent in a blood culture bottle:

- If fluid volume (1-3ml), use Pediatric BacTec (Peds Plus/F) - **pink**
- If larger fluid volume (8-10ml), use Adult BacTec (Plus Aerobic/F) - **gray**

Fungal and AFB cultures should only be sent for patients with chronic infection, immunocompromise, penetrating inoculation, or failed primary treatment.

Synovial fluid is ideally sent for "Synovial Fluid Exam" in a **lavender** top tube (EDTA K2), but may be sent in a **red** top tube or a sterile cup

Pediatric Musculoskeletal Infection CPG: Ongoing Inpatient and Outpatient Management

Inpatient Lab Monitoring

- Daily CRPs are used by the ortho team for surgical decision making. Following operative intervention, CRP should be checked again on POD#2, then Q24H until no further operative intervention is planned. Once the decision for nonoperative management has been made, CRP should be checked Q48h.

All patients need the following labs near the time of discharge:

- CBC with differential, Cr, AST/ALT, ESR

Additional labs near the time of discharge if home antibiotic plan includes

- vancomycin: vanco trough
- daptomycin: creatine kinase (CK)

Additional Inpatient or Outpatient Imaging

If patient fails to improve:

- Persistent symptoms
- Rising or sustained elevated CRP
- Fever despite appropriate therapy

Then consider imaging (MRI or bone scan) to ensure no other focus of infection – please check with Ortho and ID teams prior to ordering additional imaging

Discharge Readiness

Transition to oral antibiotics when patient is showing signs of clinical improvement by:

- Resolution of fever
- Improving physical exam (decreased pain, improved weight bearing)
- Evidence of decreasing inflammation
- Tolerating oral intake

Outpatient Management

ID Clinic follow up visits

- Patients on oral therapy - appointment at 1-2 weeks
- Patients on IV therapy - appointment at 10-14 days
- Attempt to coordinate follow up with Ortho visit

Minimum Antibiotic Duration – Per ID Service

- **Septic arthritis** - 2 weeks
- **Myositis** - 3 weeks
- **Osteomyelitis** – 3-4 weeks if uncomplicated

At completion of therapy

- Consider stopping therapy if physical exam has returned to normal, CRP is normal, and no clinical concerns
- If any previous criteria not met, continue for additional two weeks and reassess

Culture Directed Therapy: Use Susceptibility Data to Guide Therapy

Organism	IV Antibiotic	PO Antibiotic
MSSA	naftillin or cefazolin	cephalexin or cefadroxil
MRSA	vancomycin, daptomycin, or clindamycin	clindamycin, linezolid, TMP/SMX, or doxycycline
Kingella kingae	cefazolin	cephalexin or cefadroxil
Group A Strep	penicillin or ampicillin	penicillin or amoxicillin

Convert From IV to PO When Clinically Improving; PO antibiotics can be used in patients with bacteremia if bacteremia clears within 72h of source control and initiation of effective antibiotic therapy.

Recommended Dosing of Common Oral Antibiotics Used to Treat Osteomyelitis

Antibiotic	Dose	Frequency
Cephalexin	100 mg/kg/day, max 4 g/day	TID or QID
Cefadroxil	30 mg/kg/day, max 2 g/day	BID or TID
Clindamycin	40 mg/kg/day, max 600 mg/dose	TID
Trimethoprim-sulfamethoxazole	12 mg/kg/day (TMP), max 320 mg/dose	BID
Linezolid	<12 years: 30 mg/kg/day, Max 1200 mg/day ≥12 years: 20 mg/kg/day, Max 1200 mg/day	<12 years: TID ≥12 years: BID
Doxycycline	4.4 mg/kg/day, max 100 mg/dose	BID

Outpatient Lab monitoring

Frequency of testing

- **Oral antibiotics** - check labs at follow up visits in outpatient ID
- **IV antibiotics** – weekly labs via home health; fax to Peds ID at 615-343-9723

What labs to monitor

- **All patients** - CBC with differential, Cr
- **Beta-lactams** - AST/ALT
- **Daptomycin** - CK
- **Trimethoprim-sulfamethoxazole** - K
- **Vancomycin** - vanco trough

Pediatric Musculoskeletal Infection CPG: MRI Recommendations

Use the “**Peds MRI MSK Infection Screening**” order panel in eStar – Consider calling the MRI technologist (64933) for assistance in ordering the study

Contraindications to Screening MRI (discuss the appropriate study to order with the radiologist - 5-READ or page via Synergy)

- Bone lesion with concern for malignancy
- Decubitus ulcer
- Chronic osteomyelitis
- Follow-up study for known MSK infection (discuss with radiologist, contrast may be indicated)

Contrast

Screening MSK Infection MRIs are routinely done without contrast. If you think that contrast is required, please discuss with the radiologist (5-READ or page via Synergy)

Sedation

A non-sedated MRI is preferred; the study will be protocolled with limited sequences (“**Fast Osteo Protocol**”) in an attempt to avoid sedation. If this will not be possible or an attempt at a non-sedated study fails, then place eStar order for a sedation consult and make the patient NPO as appropriate.

Order Priority

- Routine – MRI studies are routinely performed 6 am - 10 pm. For patients with suspected MSK infection, an “IP ORTHO” MRI time slot is available Monday – Friday with start times ranging from 9:30 – 10:30 am. This slot may be requested for patients who are evaluated overnight (10 pm – 6 am) and are awaiting MRI. Request the time slot via the MRI technologist (64933).
- STAT – Select if the patient is septic and emergent operative treatment is pending MRI. For STAT exams after hours (10 pm - 6am), call the radiologist on call (5-READ); if the study is approved as emergent by the radiologist, the CT tech (6-4921) will call in the on-call MRI tech.

Protocol

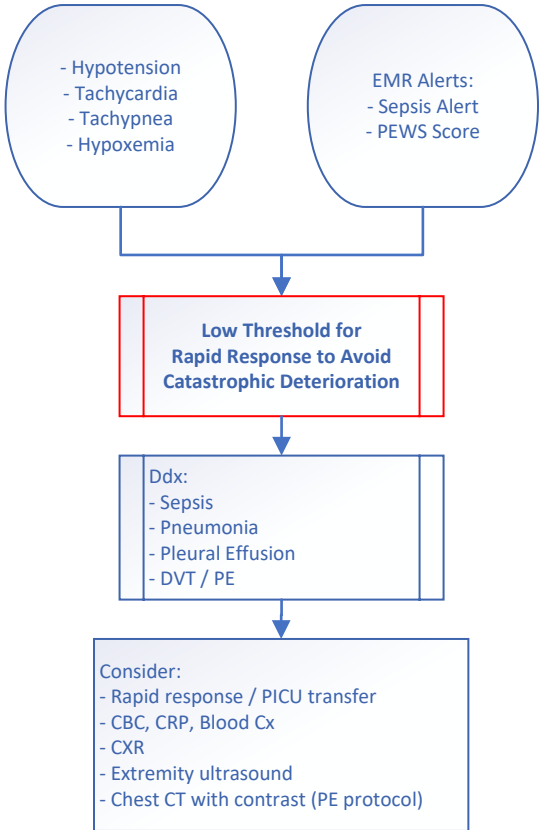
- Select screening protocol based on suspected focus of pathology. If focus is unknown, select “unknown LE” or “unknown UE” protocol (right, left, or bilateral)
- Discuss the protocol requested with the MRI technologist (64933)

Peds MRI MSK Infection Screening Protocols

Suspected Focus of Pathology	MSK Infection Screening Protocol	Initial Field of View	1st sequence	2nd sequence	3rd sequence	4th sequence	Estimated Time (min)	Comments
Pelvis	Pelvis	Iliac crest to mid-femur	Coronal STIR	Coronal T1	Axial T2 fat sat		10-15	
Hip	Pelvis	Iliac crest to mid-femur	Coronal STIR	Coronal T1	Axial T2 fat sat		10-15	
Femur	Femur	Hip joint to knee joint	Coronal STIR	Coronal T1	Axial T2 fat sat		10-15	
Knee	Knee	Mid-femur to mid-tibia	Coronal STIR	Coronal T1	Axial T2 fat sat		10-15	
Tibia	Tibia	Knee joint to Ankle joint	Coronal STIR	Coronal T1	Axial T2 fat sat		10-15	
Ankle or Foot	Ankle & Foot	Mid-tibia to toes / plantar foot	Coronal STIR	Coronal T1	Axial T2 fat sat	Sagittal STIR	12-18	Planes are in reference to the foot
Toe	Foot	Hindfoot to toes / plantar foot	Coronal STIR	Coronal T2	Axial T2 fat sat		10-15	
Unknown LE	Screening LE	Iliac crest to plantar foot	Coronal STIR	Coronal T1	Axial T2 fat sat		10-15	If screening LE study negative, then perform CTLS spine MRI study
	CTLS spine	Occiput to coccyx	Sagittal STIR	Sagittal T1	Axial T2		10-15	
Spine	CTLS spine	Occiput to coccyx	Sagittal STIR	Sagittal T1	Axial T2		10-15	
Shoulder	Shoulder	Shoulder joint to mid-humerus	Coronal STIR	Coronal T1	Axial T2 fat sat		10-15	
Humerus	Humerus	Shoulder joint to elbow joint	Coronal STIR	Coronal T1	Axial T2 fat sat		10-15	
Elbow	Elbow	Mid-humerus to mid-forearm	Coronal STIR	Coronal T1	Axial T2 fat sat	Sagittal STIR	12-18	
Forearm	Forearm	Elbow joint to Wrist joint	Coronal STIR	Coronal T1	Axial T2 fat sat		10-15	
Wrist or Hand	Wrist & Hand	Mid-forearm to fingers	Coronal STIR	Coronal T1	Axial T2 fat sat		10-15	
Finger	Hand	Wrist joint to fingers	Coronal STIR	Coronal T2	Axial T2 fat sat		10-15	
Unknown UE	Screening UE	Shoulder joint to fingers	Coronal STIR	Coronal T1	Axial T2 fat sat		10-15	

Pediatric Musculoskeletal Infection CPG: Clinical Deterioration / Complications

Signs of Clinical Deterioration



Signs of MSKI Complications

