Musculoskeletal (MSK) Infection

Algorithm 1. Orthopedic Follow-up for MSK Infection

**Inclusion Criteria:**
- Patients 6 months to 18 years
- Patients with suspicion of acute (less than 2 weeks) deep musculoskeletal infection, osteomyelitis, septic arthritis, pyomyositis

**Exclusion Criteria:**
- Infants (less than 6 months)
- Post-op infection or foreign bodies
- Infections from penetrating trauma
- Chronic infection
- Medically complex children

**MSK Infection**

- **Osteomyelitis**
  - Non-operative: Return in 2 weeks for wound check
  - 1st visit: 2 weeks wound check
  - 2nd visit: 3 months x-rays
  - 3rd visit: 6 months x-rays
  - If infection is adjacent to physes: 4th visit: 1 year x-rays (bilateral hips to ankles standing AP)

- **Septic joint**
  - Operative: Return in 2 weeks for wound check
  - 1st visit: 2 weeks wound check
  - 2nd visit: 3 months x-rays
  - 3rd visit: 1 year x-rays
  - If septic hip: 4th visit: 2 years x-rays (AP pelvis, frog, lateral)
Algorithm 2. Musculoskeletal Infection Diagnostic

Patient arrives with pain in bone, joint or muscle, and/or refusal to walk, weight bear, or use limb

Evaluation by ED Attending (See Clinical Assessment section)

History and Clinical Evaluation considered High Risk for MSK Infection

Order appropriate 2-view plain films of area, CBC, ESR, CRP and blood culture

Usual ED care

Suspected septic knee:
- ED aspiration, interpretation and disposition.
- If suspected bacterial (>50K cell count, + Gram stain, clinically consistent), proceed as in non-knee MSK infection.
- If epidemiology supports, consider Lyme disease (send serology) and consider ortho/rheum/ID consults as appropriate

Does patient have decreased use/pain of extremity or spine and or inability to bear weight AND at least one of the following:
1. Positive blood culture
2. And/or abnormal plain films
3. And/or abnormal labs
   a. Abnormal white blood cell count (>12K)
   b. Abnormal ESR (>40)
   c. CRP (>2 mg/dL)
4. And/or fever >38.5°C

- Emergent orthopedic evaluation
- Consider ID consult either in ED or on Ward

- Consider further imaging as in imaging studies section.
- Orthopedics to order MRIs from ED, advise on order for ward.
- Biopsy/aspiration to establish microbial etiology (unless blood culture positive for likely pathogen), for therapeutics (to prevent rupture into contiguous joint, for example) and abscess discovery.
- Send source culture (NO SWABS), Gram stain and pathology on all cases (exception for patients with positive blood culture for likely pathogen). For joints, send cell count, glucose, protein, synovial pathology and fluid to save from suspected source.
- If orthopedics cannot access, discuss with interventional radiology.

Surgical intervention indicated if:
- Microbial etiology unknown (i.e. blood cultures negative)
- Infection of a joint suspected
- Drainable abscess or fluid collection found on clinical exam or imaging, especially if patient has signs of toxic shock syndrome (i.e., hypotension, "sunburn" rash, peeling skin, etc.)

Proceed to inpatient algorithm for inpatient management and ED management while awaiting admission/ OR

- Admit
- Consult Orthopedics
- Consider ID consult
- Withhold antibiotics until seen by Orthopedics/ID

Discharge to home with PCP follow-up or an orthopedic consult in the morning

Inclusion Criteria:
- Patients 6 months to 18 years
- Patients with suspicion of acute (less than 2 weeks) deep musculoskeletal infection, osteomyelitis, septic arthritis, pyomyositis

Exclusion Criteria:
- Infants (less than 6 months)
- Post-op infection or foreign bodies
- Infections from penetrating trauma
- Chronic infection
- Medically complex children

Orthopedics to order MRIs from ED, advise on order for ward.

Can patient be safely discharged to home?

Can patient take oral fluids and pain meds?

Can patient reliable follow-up?
Algorithm 3. Musculoskeletal Infection Inpatient

**CLINICAL PATHWAY**

Does patient have adequate source culture/patient pending?
- **No**
  - Have all possibilities for obtaining a source culture been exhausted? Obtaining source culture as evidence clearly indicates better outcome in terms of antibiotic side effects, and length/complications of PICC line use. **If deemed clinically safe (see text), withhold antibiotics until source culture obtained.**
  - If patient condition allows and not contraindicated by bacterial differential based on exposures or history, cover 
    - Narrowly with IV agent that has oral alternative and assess clinical response. If no source culture can be obtained, assure two blood cultures taken.
    - Greater than or equal to 4 years = cefazolin and/or clindamycin (cover K. kingae)
    - 6 months to 4 years = clindamycin and/or cefazolin
    - Consider both clindamycin and cefazolin for increased S. aureus coverage, particularly if bacteremic (see text for CHCO susceptibility data).
    - Consider adding vancomycin if hip joint involved (potential increased morbidity) for expanded MRSA coverage. **Narrow based on culture and susceptibility results**

- **Yes**
  - Repeat 3-10cc blood culture (consider anaerobic culture) and cover broadly:
    - Vancomycin and cefazolin (broad and effective MRSA/MSSA)
    - Ceftriaxone (Gram negative)
    - Clindamycin (optimal penetration, anaerobic coverage, and toxin inhibition)
    - Other coverage or therapies may be indicated depending on clinical scenario or exposures, for example Lemierre syndrome, toxic shock, adolescent staphylococcal sepsis syndrome.
  - **#Narrow based on culture and susceptibility results**

Is patient critically ill?
- **Yes**
  - Pursue culture of source as soon as possible, for diagnostic and therapeutic purposes; particularly important for toxic shock
  - If does not improve, consider:
    - Repeat laboratory assessment
    - Repeat drainage
    - Repeat imaging
    - Repeat cultures
    - Expand/change antibiotics
    - Alternate diagnoses

- **No**
  - If improves, treat intravenously until:
    - Clinically substantially improved (weight bearing if allowed, well appearing)
    - Tolerating orals
    - Afebrile x 24 hours
    - Known susceptibilities
    - Falling CRP (please check daily while on IV therapy)
  - If blood cultures positive, repeat daily until negative x 48 hrs. If ongoing bacteremia, consider evaluation for intravascular infection and/or other foci, and longer course of intravenous antibiotics.
  - Also consider longer course of intravenous treatment if adequate drainage not achieved, unusual organism(s), hip joint involvement, multifocal disease, unusually severe disease.

**DISCHARGE WITH PLAN FOR OUTPATIENT MANAGEMENT, INCLUDING:**
- Arrange home IV therapy if indicated, and assure family understands importance of compliance, can purchase medication, and understands possible side effects of antibiotics (see Table 1) and PICC line use if applicable.
- Follow weekly for:
  - Continued clinical improvement
  - Antibiotic tolerance/compliance
  - Improving ESR/CRP
  - Laboratory indications of antibiotic side effects (obtain baseline and follow up labs per table 1)
- Treat until:
  - Patient has reached expected clinical improvement for condition
  - ESR/CRP normal
  - Minimum total time on antibiotics:
    - Septic joint: 3-6 weeks; if less than 18 months, consider all septic joints contiguous osteomyelitis
    - Osteomyelitis: 4-6 weeks.
    - Range depends on severity, and some severe infections will require longer therapy.
  - Obtain baseline plain radiograph at 3 months after diagnosis/surgical procedure
  - Note children with MRSA osteomyelitis are high risk for pathologic fracture

**# See antibiotic choices, dosing and side effects in Table 1.**
SUMMARY

DIAGNOSIS

- **Clinical Assessment**
  - Vital signs on admission
  - Observation and/or history for limited use or immobility of extremity/spine, gait disturbance/limp, inability to bear weight, pain, travel history/exposures, fever greater than or equal to 38.5°C
  - Physical examination for the presence of limited range of motion, tenderness, swelling, warmth at site, erythema, psoas sign, fever

- **Initial Evaluation and Labs**
  - Complete blood count (CBC) with differential, C-reactive protein (CRP), Erythrocyte sedimentation rate (ESR), Blood culture x 2 (per Children’s Hospital Colorado protocol)
  - If knee/elbow: Arthrocentesis, interpretation and disposition in ED. Arthrocentesis performed by ED or Orthopedics (if ED physician, consider Ortho consult prior to arthrocentesis).
    - If suspected bacterial (greater than or equal to 50,000 cell count, organisms seen on Gram stain, or if presentation is clinically consistent), proceed with MSK CCG
    - If travel/cell count supports, consider Lyme disease (send serology) and consider Orthopedics/Rheumatology/Infectious Disease (ID) consults
  - Suspected deep seated bones or joints (e.g. shoulder, hip): Obtain labs/imaging; consult Orthopedics
  - **Source Evaluation**: Send purulent material (aspirate, not a swab) for Gram stain and bacterial culture, and if possible tissue/synovium for pathology. If joint fluid, send for bacterial culture, Gram stain, cell count, differential and fluid to hold. If unusual case or exposures, consult ID for further testing/culturing recommendations.

- **Initial Imaging Studies**
  - Plain radiographs (all patients): Radiographs can be insensitive for the evaluation of acute soft tissue and osseous infection, but if diagnostic may avoid further imaging; soft tissue swelling, though nonspecific, may be an early finding of MSK infection.
  - Ultrasound: Hip ultrasound may be helpful in the setting of equivocal physical exam findings for hip effusion. Consider ordering if a negative hip ultrasound would avoid further imaging and/or aspiration.
  - Additional Imaging (e.g. MRI or CT) as directed by ORTHOPEDIC CONSULTANT AND RADIOLOGY

TREATMENT

- **Surgical intervention indicated if**:
  - Microbial etiology unknown (i.e. blood cultures negative)
  - Infection of a joint suspected
  - Drainable abscess or fluid collection found on clinical exam or imaging, especially if patient has signs of toxic shock syndrome (i.e., hypotension, “sunburn” rash, peeling skin, etc.)

- **Antibiotic Therapy (Table 1)**
  - Withhold antimicrobial therapy until source cultures obtained unless patient unstable

ALGORITHM 1. Orthopedic Follow up for MSK Infection
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ALGORITHM 3. Musculoskeletal Infection Inpatient Algorithm
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TARGET POPULATION

Inclusion Criteria
- 6 months to 18 years
- With suspicion of acute (less than 2 weeks) deep musculoskeletal infection; osteomyelitis, septic arthritis, pyomyositis

Exclusion Criteria
- Postoperative infection or foreign bodies
- Infections from penetrating trauma
- Chronic infection
- Infants (less than 6 months), as they may have: 1) other pathogens, 2) multifocal disease, and 3) poor oral antibiotic absorption
- Medically complex children

KEY TREATMENT PRINCIPLES

Indicated:
- Laboratory workup including complete blood count (CBC) with differential, C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and blood cultures¹
• Radiographic imaging
• Source culture prior to antibiotics in non-critical patients
• Avoidance of PICC line placement in most patients

Not routinely indicated:
• Antibiotics prior to source culture for well-appearing children
• MRI (unless orthopedic consult deems necessary)
• PICC/central line placement

CLINICAL ASSESSMENT

1. Vital signs on admission
2. Observation and/or history for:
   o Limited used or immobility of extremity or spine
   o Gait disturbance/Limp
   o Inability to bear weight
   o Pain
   o Fever greater than 38.5°C
   o Travel and exposures
3. Physical examination for the presence of:
   o Limited range of motion
   o Tenderness
   o Swelling
   o Warmth at site
   o Erythema
   o Psoas sign
   o Fever

INITIAL EVALUATION AND LABS

1. Complete blood count (CBC) with differential
2. C-reactive protein (CRP)
3. Erythrocyte sedimentation rate (ESR)
4. Blood culture x 2 (per Children’s Hospital Colorado protocol)
5. If knee/elbow: Arthrocentesis, interpretation and disposition in ED. Arthrocentesis performed by ED or Orthopedics (if ED physician, consider Ortho consult prior to arthrocentesis).
   o If suspected bacterial (greater than or equal to ≥50,000 cell count, + Gram stain, or presentation clinically consistent), proceed with MSK CCG.
   o If travel/cell count supports, consider Lyme disease (send serology) and consider Orthopedics/Rheumatology /Infectious Disease consults.
6. Suspected deep seated bone or joints (e.g. shoulder, hip): Obtain labs/imaging; consult Orthopedics

**INITIAL IMAGING STUDIES**

- **Plain radiographs (all patients):** Radiographs can be insensitive for the evaluation of acute soft tissue and osseous infection, but if diagnostic may avoid further imaging; soft tissue swelling, though nonspecific, may be an early finding of MSK infection.

- **Ultrasound:** Hip ultrasound may be helpful in the setting of equivocal physical exam findings for hip effusion. Consider ordering if a negative hip ultrasound would avoid further imaging and/or aspiration.

**Additional Imaging as directed by ORTHOPEDIC CONSULTANT AND RADIOLOGY**

- **MRI:** The orthopedic team is to place all MRI orders in EPIC from the ED. MRI should not be ordered until Orthopedics has evaluated patient. This is to assure the correct exam is ordered in the appropriate time frame.

**MRI ordering process:**

**Critically ill patients needing EMERGENT exam:**

- 7am-10pm: Call radiologist to approve a sedated or non-sedated emergent exam. Please contact MSK radiologist through lead tech (7-5993) from 7am-4pm. Please contact evening radiologist through the lead tech (7-5993) from 4pm-10pm.

- 10pm-7am: if an MRI should not wait for earliest sedated or non-sedated slot please have Orthopedic attending call the CT tech (7-8645), who will call in an MRI tech to perform an emergent exam.

**Weekdays (7am-10pm), patients needing URGENT (not critical/emergent) exam:**

- 7 a.m. to 4 p.m.: Call radiologist to schedule exam, goal is to perform within 10 hours.

- 4 p.m. to 10 p.m.: Call evening radiologist through lead tech (7-5993) to schedule exam, goal is to perform during evening shift if slot available, otherwise in following AM as below after 10pm.

- After 10 p.m. NON-SEDATED patient: Please have Orthopedic resident, fellow, PA or attending call the overnight CT Tech (7-8645), who will schedule and place patient in a 6:30am slot.

- After 10 p.m. SEDATED patient: Please have Orthopedic resident, fellow, PA, or attending call overnight CT tech (7-8645), who will schedule and place patient in a 7:30am sedated slot. Anesthesiology will accommodate sedated MRI add-on by sending swing shift anesthesiologist if necessary.

**Weekends and holidays, patients needing URGENT (not critical/emergent) exam**

- 7am-10pm: Call on-call radiologist through lead tech (7-5993) to schedule exam. Goal is to perform the MRI within 10 hours.

- After 10pm NON-SEDATED patient: Please have Orthopedic resident call the overnight CT tech (7-8645), who will schedule and place patient in a 7:30 am slot.

- After 10 p.m. SEDATED patient: Please have Orthopedic resident call overnight CT tech (7-8645), who will schedule and place patient in the earliest sedated slot. If sedated MRI slot is outside the 10 hour goal, Orthopedic attending should call anesthesia to find first available anesthesiologist.

**PROCEDURES | INTERVENTIONS (Emergency Department/Operating Room/Interventional Radiology)**

Biopsy/aspiration to establish microbial etiology, for therapeutics (to prevent rupture into contiguous joint, for example) and abscess discovery. Evidence clearly indicates better outcome in terms of antibiotic side effects, and length/complications of PICC line use. Send pus (not a swab) for Gram stain and bacterial culture, and if possible tissue/synovium for pathology. If joint fluid, send for bacterial culture, Gram stain, cell count, differential and fluid to hold. If unusual case or exposures, consult Infectious Disease for further testing/culturing recommendations.
CONSULTATIONS TO CONSIDER

Seek primary attending’s approval prior to consulting specialist, primary team to coordinate consult communication.

Orthopedics
Orthopedics prefers to be consulted on all confirmed and probable musculoskeletal infections as soon as suspected, and prior to advanced imaging, as orthopedics can facilitate and will order timely MRI.

Infectious Disease
Infectious Diseases prefers to be consulted on all confirmed and probable musculoskeletal infections, particularly if ID to follow as an outpatient or upon unit transfer. Consultation should occur per inpatient teams, unless early contact preferred by ED team.

Rheumatology
- Polyarthritis
- Suspicion or history of JRA, SLE, rheumatic fever, post-strep arthritis or psoriasis
- Chronic joint effusion

INITIAL THERAPIES | EMERGENCY DEPARTMENT AND INPATIENT UNIT

1. Pain control administered per Emergency Department/primary team
2. All patients are to be treated intravenously initially
3. Source culture should be obtained prior to starting antibiotics, unless blood culture positive or patient’s clinical status too unwell. Goal is source culture by end of day after admission, in orthopedic trauma room if needed. If time slots are an issue, call orthopedic trauma to help facilitate.
4. If blood culture positive, cover according to suspected organism (Table 1)
5. If patient condition allows and not contraindicated by bacterial differential based on exposures or history, cover narrowly with IV agent with oral alternative and follow cultures and assess clinical response.
   - Greater than or equal to 4 years = clindamycin and/or cefazolin
   - 6 months to 4 years = cefazolin (cover *K. kingae*)
   - Consider both clindamycin and cefazolin for increased *S. aureus* coverage, particularly if bacteremic. Per internal data from 2009-2014 isolates, if culture positive (80%), 81% of isolates are *S. aureus*; of those, 93% were susceptible to clindamycin, 88% were susceptible to cefazolin, 100% susceptible to combination.
   - Consider adding vancomycin if hip joint involved (potential increased morbidity) for expanded MRSA coverage.
6. If critically ill, repeat appropriate volume blood culture (consider anaerobic blood culture for Lemierre syndrome) and cover broadly; multiple antibiotics may be indicated:
   - Vancomycin and cefazolin (broad and effective MRSA/MSSA)
   - Ceftriaxone (Gram negative)
   - Clindamycin (optimal penetration, anaerobic coverage, and toxin inhibition)
7. Other coverage or therapies may be indicated depending on clinical scenario or exposures, for example Lemierre syndrome, toxic shock, adolescent staphylococcal sepsis syndrome
8. Narrow based on culture and susceptibility results
ADMISSION CRITERIA

- Admit all patients with suspected and confirmed acute musculoskeletal infections unless indicated otherwise by Pediatric Orthopedics or ID.
- Prior to admission at South Campus, consult orthopedic surgery to discuss best admission location for patient’s needs. If the patient requires transfer to Anschutz Medical Campus for expedited care, efforts should be made to obtain the MRI at South Campus prior to transfer if this can be obtained without a delay in care.

CHANGE TO ORAL ANTIBIOTICS | DISCHARGE CRITERIA

- If improves, treat intravenously and inpatient until5,8,15,24-30:
  - Clinically substantially improved (weight bearing if allowed, improved motion of infected joint, well appearing)
  - Tolerating orals
  - Afebrile x 24 hours
  - Known susceptibilities indicating there is an appropriate oral alternative to intravenous therapy
  - Falling CRP
- If blood cultures positive, repeat daily post initiation of antibiotics until negative x 48 hours; if ongoing bacteremia, consider evaluation for intravascular infection and/or other foci, and longer course of intravenous antibiotics17.
- Also consider longer course of intravenous treatment if: adequate drainage not achieved, unusual organism(s), hip joint involvement, multifocal disease, unusually severe disease, doubt about oral absorption or compliance.

If condition does not improve, consider:

- Repeat laboratory assessment
- Repeat imaging31
- Repeat drainage
- Repeat cultures
- Expand/change antibiotics
- Alternate diagnoses

DISCHARGE PLANNING AND FOLLOW-UP

1. Arrange home IV therapy if indicated, and assure family: 1. understands importance of compliance, 2. is able to purchase medication, and 3. understands possible side effects of antibiotics (Table 1) and PICC line use if applicable.

2. Treat until:
   - Patient has reached expected clinical improvement for condition
   - ESR/CRP normal
   - Minimum total time on antibiotics26,28,29,36:
     - Septic joint: 3 to 6 weeks; if less than 18 months, consider all septic joints contiguous osteomyelitis
     - Osteomyelitis: 4 to 6 weeks
     - Range depends on severity, and some severe infections will require longer therapy

3. Infectious diseases or primary care follow up
   - Follow each 1-2 weeks for 35:
     - Continued clinical improvement
CLINICAL PATHWAY

1. Antibiotic tolerance/compliance
2. Improving ESR/CRP
3. Laboratory indications of antibiotic side effects (obtain baseline and follow up labs per Table 1)

4. Orthopedic follow up (Algorithm 1.)
   - Surgical patients should follow up at two weeks post operatively
   - Obtain baseline plain radiograph at three months
   - Remaining follow up after three months will be determined at discretion of orthopedics
   - Note children with MRSA osteomyelitis are high risk for pathologic fracture37, children with hip infection at risk if avascular necrosis

PARENT | CAREGIVER EDUCATION

It is suggested that parent/caregiver education contain the following information:

- Education on obtaining and taking antibiotics
- Pain control measures
- Return precautions and contact information for orthopedics and infectious diseases
- Education regarding antibiotic side effects
- PICC line training and education (including risk of infection) if applicable
# TABLE 1. Antibiotics and Monitoring for Patients with Musculoskeletal Infections

(Other antibiotics may be indicated based on culture results) Antimicrobial Stewardship at Children’s Hospital Colorado, Sarah Parker and Jason Child 2014

<table>
<thead>
<tr>
<th>Daily amount (in mg/kg/day)</th>
<th>Cefazolin (IV)</th>
<th>Cephalexin (PO)</th>
<th>Ceftazadime (IV)</th>
<th>Ceftriaxone (IV)</th>
<th>Vancomycin (IV)</th>
<th>Clindamycin (IV or PO)</th>
<th>Ampicillin (IV)</th>
<th>Amoxicillin (PO)</th>
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<tbody>
<tr>
<td>100-150 mg/kg/day divided Q6-8H</td>
<td>100-150 mg/kg/day divided QID</td>
<td>150-200 mg/kg/day divided Q6-8H</td>
<td>100 mg/kg/day divided Q12-24H</td>
<td>60-80 mg/kg/day divided Q6H</td>
<td>40 mg/kg/day IV, divided Q6-8H PO, divided TID</td>
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<tr>
<td>100-150 mg/kg/day divided Q12-24H</td>
<td>200 mg/kg/day divided Q12-24H</td>
<td>6000 mg divided Q8H (adjust dose with levels, can use continuous, consult ID)</td>
<td>2700 mg IV (IV, divided Q8H)</td>
<td>8000mg IV divided Q6H</td>
<td>2000-4000 mg PO divided TID</td>
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<tr>
<th>Single daily amount maximum for MSK infection</th>
<th>Cefazolin (IV)</th>
<th>Cephalexin (PO)</th>
<th>Ceftazadime (IV)</th>
<th>Ceftriaxone (IV)</th>
<th>Vancomycin (IV)</th>
<th>Clindamycin (IV or PO)</th>
<th>Ampicillin (IV)</th>
<th>Amoxicillin (PO)</th>
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<tr>
<td>8000 mg divided Q6H</td>
<td>4000 mg divided QID</td>
<td>8000 mg divided Q6H</td>
<td>2000 mg divided Q12-24H</td>
<td>6000 mg divided Q8H (adjust dose with levels, can use continuous, consult ID)</td>
<td>2700 mg IV (IV, divided Q8H)</td>
<td>8000mg IV divided Q6H</td>
<td>2000-4000 mg PO divided TID</td>
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<th>S. pyogenes</th>
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<tr>
<th>Side Effects&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Diarrhea, including &lt;i&gt;C. difficile&lt;/i&gt; colitis</th>
<th>Bone marrow suppression</th>
<th>Rash</th>
<th>Stevens Johnson Syndrome</th>
<th>Drug fever</th>
<th>Nephrotoxicity, Intersitial nephritis</th>
<th>Nephrotoxicity, other</th>
<th>Elevated transaminases</th>
<th>Labs to monitor for infection resolution and side effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea, including &lt;i&gt;C. difficile&lt;/i&gt; colitis</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<td>+</td>
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<td>CBC, CRP or ESR, BUN, Cr</td>
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<td>Bone marrow suppression</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<td>Rash</td>
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<td>Stevens Johnson Syndrome</td>
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<td>+</td>
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<tr>
<td>Drug fever</td>
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<td></td>
<td>CBC, CRP or ESR, BUN, Cr</td>
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</tbody>
</table>

<sup>1</sup> 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 <i>Clostridium difficile</i> 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.
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.

The use of clindamycin for MRSA depends on local susceptibility patterns and, if available, susceptibility testing. It is important that the microbiology lab perform a “D-test” or equivalent for inducible clindamycin resistance. At Children’s Hospital Colorado, D test is routinely performed and our MSSA and MRSA isolates are 86% susceptible. We feel it is reasonable to use as first line in non-critically ill patients greater than 4 years of age (below 4 years, include K. kingae coverage).

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

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; 1% is in children < 6 months, and 4% in children ≥ 4 years. It predominantly causes septic arthritis, but can also cause isolated osteomyelitis and tenosynovitis; it generally has a milder presentation than S. aureus.
REFERENCES

Clinical pathways are intended for informational purposes only. They are current at the date of publication and are reviewed on a regular basis to align with the best available evidence. Some information and links may not be available to external viewers. External viewers are encouraged to consult other available sources if needed to confirm and supplement the content presented in the clinical pathways. Clinical pathways are not intended to take the place of a physician’s or other health care provider’s advice, and is not intended to diagnose, treat, cure or prevent any disease or other medical condition. The information should not be used in place of a visit, call, consultation or advice of a physician or other health care provider. Furthermore, the information is provided for use solely at your own risk. CHCO accepts no liability for the content, or for the consequences of any actions taken on the basis of the information provided. The information provided to you and the actions taken thereof are provided on an “as is” basis without any warranty of any kind, express or implied, from CHCO. CHCO declares no affiliation, sponsorship, nor any partnerships with any listed organization, or its respective directors, officers, employees, agents, contractors, affiliates, and representatives.

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Sarah Nickels, PhD | Clinical Effectiveness

APPROVED BY
Clinical Pathways and Measures Committee – April 18, 2016

<table>
<thead>
<tr>
<th>MANUAL/DEPARTMENT</th>
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<td>ORIGINATION DATE</td>
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APPROVED BY

Lalit Bajaj, MD, MPH
Medical Director, Clinical Effectiveness

REVIEW | REVISION SCHEDULE
Scheduled for full review on April 18, 2020
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