**Inclusion Criteria**
- Suspected septic arthritis and/or osteomyelitis in children > 3 months old

**Exclusion Criteria**
- Permanent implanted orthopedic hardware
- Symptoms at site contiguous with pressure ulcer/chronic wound
- Suspected necrotizing soft tissue infection
- Suspected axial skeletal involvement (e.g. skull, spine, ribs, sternum)
- Chronic recurrent multifocal osteomyelitis
- Immunocompromised patient (e.g. BMT, oncology, transplant)

**Kocher Criteria**
- Predictors for SA of the hip:
  - Non-weight-bearing
  - Temp > 38.5°C
  - ESR ≥ 40 mm/hr
  - WBC > 12,000 cells/mm³

*Caird et al.* introduced a fifth predictor for SA of the hip:
- CRP > 2.0 mg/dL

**ED Team Assessment**
Evaluate for signs/symptoms suggestive of a primary MSK infection

**Initial Workup**
- Labs: Order CBC with diff, CRP, ESR
- Microbiology: Consider aerobic + anaerobic blood cultures
- Imaging: Order x-ray of the involved bone/joint

**Low Clinical Suspicion for SA and/or OM:**
- Consider hip US if hip SA remains on the differential
- Consider alternative diagnoses (e.g. transient synovitis)
- If patient is clinically stable for discharge, consider PCP follow-up in 1-3 days

**Moderate/High Clinical Suspicion for SA and/or OM:**
- Consult Orthopedics
- Order hip US if hip SA is suspected
- Consider MRI of the suspected involved extremity w/Ortho input (see MRI Logistics)
- Coordinate procedural sedation/analgesia if joint aspiration appropriate in the ED

**Initial Antibiotics**
- Draw aerobic + anaerobic blood cultures prior to initiating antibiotics
- Empiric IV Antibiotics
- Discuss timing of first antibiotic dose with Orthopedics -- may hold if patient is clinically stable, diagnosis is not yet confirmed, and/or patient is awaiting further diagnostics/surgical intervention

**ED Decision to Admit**
- Orthopedics: All patients >1 year old with confirmed SA and/or OM OR with high suspicion for SA and/or OM awaiting further diagnostics or surgical intervention
- General Medicine: Consider for patients <1 year old or patients with other active complex medical conditions

*Team 7 Patients -- discuss with Team 7 attending if admission to Orthopedics would be preferred to facilitate acute surgical decision-making
There is considerable overlap in the clinical presentation of septic arthritis (SA) and osteomyelitis (OM). The rate of concurrent infection in children with both septic arthritis and osteomyelitis may be ~15-40%.

Systemic symptoms may include:
- Fever
- Infants: irritability, vomiting, poor feeding

Local symptoms may include:
- Limp, refusal to bear weight, pseudoparalysis
- SA: hot swollen immobile peripheral joint, pain on passive range of motion
- OM: focal tenderness

Pain/tenderness and joint involvement may be easier to localize in older children compared with infants and young children.

[LOE: Guideline (Saavedra-Lozano, 2017)]
Kocher Criteria

Original Derivation Study, 1999:
Retrospective chart review of 282 patients evaluated between 1979 and 1996 at a major tertiary-care children’s hospital presenting with an acutely irritable hip.

Final diagnoses included confirmed septic arthritis, presumed septic arthritis, and transient synovitis, on the basis of joint fluid aspirate results, cultures from joint fluid and blood, and the patients’ clinical course.

Four independent multivariate clinical predictors were identified to differentiate between septic arthritis and transient synovitis: fever (T > 38.5°C), non-weight bearing status, elevated ESR (≥40 mm/hr), and elevated WBC (>12,000 cells/mm³).

Probability for septic arthritis of the hip based on number of predictors present:
- 0 predictors: <0.2% risk
- 1 predictor: 3.0% risk
- 2 predictors: 40.0% risk
- 3 predictors: 93.1% risk
- 4 predictors: 99.6% risk

[LOE: Expert Opinion (Kocher, 1999)]

Prospective Validation Study, 2004:
Kocher Criteria were prospectively applied to 213 consecutive patients between 1997 and 2002 at a major tertiary-care children’s hospital presenting with an acutely irritable hip.

51 children were diagnosed with septic arthritis; 103 children were diagnosed with transient synovitis.

Probability for septic arthritis of the hip based on number of predictors present:
- 0 predictors: 2.0% risk
- 1 predictor: 9.5% risk
- 2 predictors: 35.0% risk
- 3 predictors: 72.8% risk
- 4 predictors: 93.0% risk

[LOE: Expert Opinion (Kocher, 2004)]
Caird et al, 2006:
Prospective cohort study of 48 patients evaluated between 2000 and 2003 at a major tertiary-care children’s hospital presenting with an acutely irritable hip who underwent hip aspiration.

34 children were diagnosed with septic arthritis; 14 children were diagnosed with transient synovitis.

Researchers performed a multivariate analysis comparing these two groups on the basis of the four Kocher Criteria plus CRP. They found that only ESR and CRP were independently associated with septic arthritis, with CRP being the strongest predictor:

- CRP > 2.0 mg/dL → OR = 14.5 (95% CI: 3.2-64.9)
- ESR ≥ 40 mm/hr → OR = 7.0 (95% CI: 1.5-51.8)

Probability for septic arthritis of the hip based on number of predictors present:

- 0 predictors: 16.9% risk
- 1 predictor: 36.7% risk
- 2 predictors: 62.4% risk
- 3 predictors: 82.6% risk
- 4 predictors: 93.1% risk
- 5 predictor: 97.5% risk

[LOE: Expert Opinion (Caird, 2006)]
Option #1: MRI w/ and w/o contrast

- After placing order, coordinate timing with Radiology
- For children requiring sedation, coordinate with Anesthesia

Contact Info:
MRI: x7-4458
Anesthesia Board Runner: x7-2433

Option #2: FAST OSTEO MRI

- Seattle Children’s FAST OSTEO MRI protocol is currently being evaluated by Radiology for efficacy and cost-efficiency
- Only available to:
  - Patients with high suspicion for OM
  - Patients ≥ 24 months of age
  - Patients who have received formal consultation and approval for this imaging protocol by Orthopedics
- Orthopedics Team will place order, with name of supervising Orthopedics Attending specified in “Special Instructions”
- If between 0700-2300: contact Radiology to expedite non-sedated limited MRI for osteomyelitis evaluation
- If between 2300-0700: contact Radiology to coordinate for first study in the morning*

*First study in the morning only available at 0700, Mon-Fri. Patient should be waiting NPO in MRI holding with MRI screening sheet completed by nursing
# Empiric IV Antibiotics

## Empiric First Dose Antibiotics Table - Septic Arthritis / Osteomyelitis

<table>
<thead>
<tr>
<th>Clinical Scenario</th>
<th>Recommended Therapy</th>
</tr>
</thead>
</table>
| Non-toxic; low risk for MRSA | IV Cefazolin 50mg/kg x1  
Max dose: 2000mg |
| Non-toxic; cefazolin allergy* or MRSA risk | IV Clindamycin 13.3mg/kg x1  
Max dose: 600mg |
| Systemically/critically ill and MRSA not yet ruled out by culture | IV Vancomycin 15mg/kg x1  
Max dose: 2000mg |

*Cefazolin does not share a side-chain with other cephalosporins. Patients with a documented allergy to other cephalosporins are at low-risk for reacting to cefazolin administration and should preferentially receive this therapy as opposed to clindamycin, unless there are other clinical concerns for MRSA infection.

For patients at risk for other special non-staph/strep pathogens (e.g. sickle cell disease -- *Salmonella*), consider ID Consult to assist with antibiotic selection.

[LOE: Guideline (Saavedra-Lozano, 2017)]

**MRSA Risk Factors:** known MRSA carrier, recurrent skin abscesses in patient or family member, recently or frequently hospitalized.
Musculoskeletal Infections Approval & Citation

Approved by the CSW MSK Infections team for October 1, 2019 go-live

CSW MSK Infections Team:

<table>
<thead>
<tr>
<th>Role</th>
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<tbody>
<tr>
<td>ED &amp; Co-Owner</td>
<td>Alex Stephan, Fellow-MD</td>
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<td>ED &amp; Co-Owner</td>
<td>Derya Caglar, MD</td>
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<tr>
<td>ED Clinical Nurse Specialist</td>
<td>Sara Fenstermacher, MSN, RN, CPN</td>
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<td>Orthopedics</td>
<td>Todd Blumberg, MD</td>
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<tr>
<td>Pharmacy</td>
<td>Adam Brothers, PharmD</td>
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<tr>
<td>Infectious Disease</td>
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<tr>
<td>Radiology</td>
<td>Sarah Menashe, MD</td>
</tr>
<tr>
<td>Lab</td>
<td>Xuan Qin, PhD</td>
</tr>
<tr>
<td>Hospitalist</td>
<td>Jason Rubin, MD</td>
</tr>
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</table>

Clinical Effectiveness Team:

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant:</td>
<td>Lisa Abrams, ARNP</td>
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<td>Project Manager:</td>
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<tr>
<td>Librarian:</td>
<td>Jackie Morton, MLS</td>
</tr>
<tr>
<td>Program Coordinator:</td>
<td>Kristyn Simmons</td>
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Clinical Effectiveness Leadership:

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</tr>
</thead>
<tbody>
<tr>
<td>Medical Director:</td>
<td>Darren Migita, MD</td>
</tr>
<tr>
<td>Operations Director:</td>
<td>Karen Rancich Demmert, BS, MA</td>
</tr>
</tbody>
</table>


Please cite as:
This pathway was developed through local consensus based on published evidence and expert opinion as part of Clinical Standard Work at Seattle Children’s. Pathway teams include representatives from Medical, Subspecialty, and/or Surgical Services, Nursing, Pharmacy, Clinical Effectiveness, and other services as appropriate.

When possible, we used the GRADE method of rating evidence quality. Evidence is first assessed as to whether it is from randomized trial or cohort studies. The rating is then adjusted in the following manner (from: Guyatt G et al. J Clin Epidemiol. 2011;4:383-94, Hultcrantz M et al. J Clin Epidemiol. 2017;87:4-13.):

Quality ratings are downgraded if studies:
- Have serious limitations
- Have inconsistent results
- If evidence does not directly address clinical questions
- If estimates are imprecise OR
- If it is felt that there is substantial publication bias

Quality ratings are upgraded if it is felt that:
- The effect size is large
- If studies are designed in a way that confounding would likely underreport the magnitude of the effect OR
- If a dose-response gradient is evident

Certainty of Evidence:
- 💪💪💪💪 High: The authors have a lot of confidence that the true effect is similar to the estimated effect
- 💪💪💪 Moderate: The authors believe that the true effect is probably close to the estimated effect
- 💪💪💪💪 Low: The true effect might be markedly different from the estimated effect
- 💪💪💪💪💪 Very low: The true effect is probably markedly different from the estimated effect

Guideline: Recommendation is from a published guideline that used methodology deemed acceptable by the team

Expert Opinion: Based on available evidence that does not meet GRADE criteria (for example, case-control studies).

The empiric antibiotic recommendations in this pathway are based on an internal work group’s development of consensus-based guidelines of care for children with bone or joint infections, updated 12/2018.
Summary of Version Changes

- **Version 1.0 (10/1/2019):** Go live
Medical Disclaimer

Medicine is an ever-changing science. As new research and clinical experience broaden our knowledge, changes in treatment and drug therapy are required.

The authors have checked with sources believed to be reliable in their efforts to provide information that is complete and generally in accord with the standards accepted at the time of publication.

However, in view of the possibility of human error or changes in medical sciences, neither the authors nor SCHS nor any other party who has been involved in the preparation or publication of this work warrants that the information contained herein is in every respect accurate or complete, and they are not responsible for any errors or omissions or for the results obtained from the use of such information.

Readers should confirm the information contained herein with other sources and are encouraged to consult with their health care provider before making any health care decision.
**Methods**
The literature search was conducted in February of 2019. The search targeted synthesized literature on osteomyelitis, septic arthritis and infectious arthritis and was limited to English and humans and 2009-current. The search was executed in Ovid Medline, Embase, Cochrane Database of Systematic Review (CDSR), and Turning Research into Practice database (TRIP).

Two reviewers independently screened abstracts, included guidelines and systematic reviews that addressed optimal diagnosis, treatment, and prognosis of patients who meet pathway inclusion/exclusion criteria. One reviewer extracted data and a second reviewer quality checked the results. Differences were resolved by consensus. Additional references from internal Seattle Children’s Hospital guidelines were added as supplemental resources.

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**Identification**
- Records identified through database searching (n=498)
- Additional records identified through other sources (n=0)

**Screening**
- Records after duplicates removed (n=486)

**Eligibility**
- Records screened (n=486)
- Records excluded (n=420)
- Articles excluded (n=60)
  - Did not answer clinical question (n=15)
  - Did not meet quality threshold (n=21)
  - Outdated relative to other included study (n=22)
  - Not in English (n=2)
- Records assessed for eligibility (n=66)

**Included**
- Studies included in pathway (n=6)

Flow diagram adapted from Moher D et al. BMJ 2009;339:bmj.b2535
Included Studies


Additional References

