Osteomyelitis: "Bad to the Bone"

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Incidence

- 5/10,000
- 1% Pediatric Hospitalizations
- More common in young children (50% in preschool-aged children)
- Mostly long bones (femur, tibia, humerus)
Two different causes:

1) Hematogenous seeding secondary to bacteremia
2) Contiguous spread of soft-tissue infection
Acute Hematogenous Osteomyelitis

- Sinuses
- Reactive bone (involucrum)
- Trapped necrotic bone (sequestrum)
- Periosteum

Healthy Bone
- Cortical bone
- Bone marrow (in medullary cavity)

Osteomyelitis
- Pus
- New, brittle bone
- Decreased medullary cavity
- Dying bone marrow

X-ray
Etiology (AHO)

- Staph aureus - most common pathogen
- MRSA – increasing in prevalence
- Group A Strep
- Strep pneumonia
- Gm neg bacteria and Group B Strep seen in newborns
Other Bacterial Causes

- Pseudomonas associated with puncture through tennis shoe
- Salmonella occurs in patients with sickle cell disease
- Kingella kingae – fastidious gm neg rod, increasingly recognized in first 2 years of life
Complications of MRSA osteomyelitis

- Greater local and systemic inflammation (PVL)
- pyomyositis
- deep venous thrombosis
- multifocal infection
DCMC Epidemiology

**Bacteria rate in children treated for osteomyelitis with a positive culture at Dell Children’s Medical Center (2009 - 2014)**

- H.Flu: 0.03%
- Salmonella: 0.83%
- E. Coli: 0.03%
- Pneumococcus: 1.67%
- Enterobacter: 2.50%
- Psuedomonas aeruginosa: 2.50%
- Other Staph: 3.33%
- Kingella Kingae: 3.33%
- Other Gram Negative: 3.33%
- GBS: 4.17%
- GAS: 6.67%
- Other Gram Positive: 9.17%
- MRSA: 10.00%
- Other Bacteria: 34.17%
- MSSA: 56.83%
Clinical Features

- Fever
- Limping
- Localized pain
- Swelling
Differential Diagnosis

- Occult fracture
- Cellulitis
- Toxic synovitis
- JRA
- Malignancy
Diagnostic Studies

- WBC – only elevated in \( \frac{1}{2} \) of patients
- CRP – elevated in over 90% of patients, usually peaks at 48 hours
- ESR – almost always elevated, can be normal early on, peaks at 1 -2 weeks
Imaging

- Plain x-ray- initial films often normal, lytic areas and periosteal reaction seen at 10-15 days
- Bone Scan – sensitive but not specific, often used if no focal symptoms

Figure 2. Bone scan demonstrating right proximal tibial osteomyelitis.
MRI Imaging “Gold Standard”
Culture/PCR

- Bone Aspiration – Usually performed after positive MRI finding
- Blood Culture – Often positive due to concomitant bacteremia
- PCR Testing – Increased yield on bone aspirate, can often detect Kingella and low virulence Staph species
Treatment

- Surgical Drainage of Abscess – subperiosteal abscess drained if significant in size. Bone abscesses drained through bone window
- IV Antibiotics – Initial treatment for all osteo, with Staph and Gm neg coverage (Ancef and Rocephin)
- PO Antibiotics – Can switch to oral if simple osteo, based on clinical response and decrease in CRP.
DCMC Osteo Protocol

- Ortho and ID Consults on admission
- Set MRI slot at 6AM every day
- Bone aspiration for cultures and PCR testing
- Early transition to PO therapy
ACUTE HEMATOGENOUS OSTEOMYELITIS PATHWAY
EVIDENCE-BASED OUTCOME CENTER

INCLUSION CRITERIA
- Physical exam and/or history suggestive of acute hematogenous osteomyelitis or septic joint
- Less than 18 days of signs and symptoms
- Previously healthy children ages 6 months to 18 years of age

RECOMMENDED INITIAL DIAGNOSTIC EVALUATION
- Order CBC with differential x 5, CMP x 1, ESR x 1, CRP every 48 hours
- Order blood culture (minimum 1 set)
- Order plain film of affected region
- Early Orthopedic consultation preferred to evaluate need for additional imaging and aspiration

EXCLUSION CRITERIA
- Evidence of renal or hematologic instability
- Continuous osteomyelitis, penetrating trauma or fracture
- Complicated or difficult to treat osteomyelitis
- Multifocal
- Head, face, or orbital involvement
- Presence of orthopedic device or prosthesis
- Postoperative wound
- History of the following disease states:
  - Bone or cartilage disorder
  - Congenital or acquired bone disorder
  - Immunocompromised
  - Type 1 diabetes
  - Malnutrition
  - Chronic disease
  - Sacroiliac
  - Familial
  - Intravenous
  - Antiphospholipid

START EMPIRIC ANTIBIOTIC THERAPY (See Addendum 1 for antibiotic dosing)
- Age < 3 years
  - Clindamycin and Ceftriaxone
- Age ≥ 3 years
  - Clindamycin

FOCUSED ANTIBIOTIC THERAPY based on cultures and susceptibilities (See addendum for antibiotic dosing)
- MSSA
  - Ceftriaxone
- MRSA
  - Ceftriaxone
- Other organisms
  - Culture positive for MRSA

Meet criteria for oral step-down therapy in <5 days
- MSSA
  - Cefalexin
- K. Kingae
  - Amoxicillin/Clearubact

Criteria for oral step down therapy
- Confirmed diagnosis of uncomplicated osteomyelitis
- Clinical improvement of signs and symptoms
- Afebrile for at least 48 hrs
- CRP decreased 50% from initial CRP
- Received at least 72 hrs of IV antibiotics

DISCHARGE CRITERIA
- Patient is afebrile for 24 hours with clinical improvement in symptoms and physical exam
- Patient has tolerated one dose of oral antibiotics identical to the planned home regimen in the hospital
- Scheduled follow-up with the primary pediatrician, infectious disease, and orthopedics is arranged
- Antibiotic prescription is filled and delivered prior to discharge or easily accessible by parents immediately after discharge to avoid missed dose

Dell Children’s
medical center of central texas
A member of the Seton Family of Hospitals
INCLUSION CRITERIA
- Physical exam and/or history suggestive of acute hematogenous osteomyelitis or septic joint
- Less than 14 days of signs and symptoms
- Previously healthy children ages 6 months to 18 years of age

EXCLUSION CRITERIA
- Evidence of sepsis or hemodynamic instability
- Contiguous osteomyelitis: penetrating trauma or fracture
- Complicated or difficult to treat osteomyelitis
  - Multifocal
  - Chronic
  - Head, face, or orbital involvement
  - Presence of orthopedic device or prosthesis
  - Post-operative wound
- History of the following disease states:
  - Bone or cartilage disorder
  - Congenital or acquired bone disease
  - Congenital or acquired immunodeficiency
  - Type I or II diabetes
  - Sickle cell disease
  - Chronic sinusitis
  - Sacroiliitis
  - Fasciitis
  - Synovitis
  - Arthropathy
DISCHARGE CRITERIA

- Patient is afebrile for 24 hours with clinical improvement in symptoms and physical exam.
- Patient has tolerated one dose of oral antibiotics identical to the planned home regimen in the hospital.
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Focused Antibiotic Therapy

- MSSA: IV Oxacillin, PO Cephalexin
- Strep, Kingella: IV Ceftriaxone, PO Augmentin
- MRSA: IV Vancomycin (manage off pathway)
Results of DCMC Osteo Protocol

- Increased Bone Aspirations performed
- Increased Yield of Bone cultures
- Decreased days of IV abx
- Decreased Use of PICC lines
- Decreased Hospital days
- Increased use of oral abx
Impact of a Pediatric Evidence-Based Acute Hematogenous Osteomyelitis Diagnostic and Treatment Algorithm

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Abstract
Background: Recent data guiding treatment of acute hematogenous osteomyelitis (AO) suggest successful use of evidence-based guidelines (EBG). The goal of this study was to evaluate the impact of a recently implemented guideline at our institution which recommends early transition (≤5 days) from IV to oral antimicrobial therapy for AO.

Methods: This was a single-center, retrospective study of previously healthy patients ≥6 months to 18 years, diagnosed by bone biopsy, presenting with fewer than 30 days of symptoms. Baseline demographic and variable collection were included for the study evaluation. The following variables were collected: total length of stay, duration of oral antibiotics, reason for non-compliance, total number of days of oral antibiotics, and length of stay. Data were analyzed using Fisher's exact test and Chi-squared tests.

Results: A total of 107 patients ≥6 months to 18 years were treated with a total number of 67 cases. After the algorithm implementation, there was a significant decrease in the median length of IV antibiotics from 24.5 to 10 days (p<0.001) and an increase in the length of oral antibiotics treatment from 14 to 22 days (p<0.001). Additionally, there was a significant increase in PICC line utilization in 2013 (464 cases). Reduction of IV antibiotic duration correlated with a significant decrease in median length of stay from 24.5 to 10 days. There was no change in length of stay for 38-day readmission from prior algorithm implementation.

Conclusions: Our results support a significant impact of transitioning directly from the use of IV antibiotics to oral antibiotics at our institution. There is a change in length of stay of 14 vs 38-day readmission from prior algorithm implementation. These findings highlight the value of standardization of care across disciplines through the use of evidence-based guidelines in the pediatric population.

Introduction

Our institution created a multidisciplinary algorithm to guide diagnosis and treatment of acute hematogenous osteomyelitis in pediatrics. The algorithm suggests early transition to oral antibiotics:

- Selection of antibiotics
  - Decrease the duration of ITN antimicrobial therapy
  - Decrease the need for PICC line utilization in children with acute osteomyelitis
  - Make changes to treatment position without any negative effect on the clinical course

Objectives: The impact of creating and implementing an evidence-based algorithm on the length of hospital stay and oral antibiotics in children with acute hematogenous osteomyelitis

Results

Table 1. Study Population

<table>
<thead>
<tr>
<th>Variable (n=107)</th>
<th>Total population (107)</th>
<th>Pre-Algorithm (n=76)</th>
<th>Post-Algorithm (n=31)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years (mean)</td>
<td>7</td>
<td>6.7</td>
<td>7.2</td>
<td></td>
</tr>
<tr>
<td>Sex, male</td>
<td>54%</td>
<td>65%</td>
<td>61%</td>
<td></td>
</tr>
<tr>
<td>Hospital Length of stay (median)</td>
<td>5</td>
<td>4.5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Readmission Rate</td>
<td>3%</td>
<td>9.2%</td>
<td>6.5%</td>
<td></td>
</tr>
<tr>
<td>Length of IV antibiotics (median days)</td>
<td>14</td>
<td>14</td>
<td>22</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Length of oral antibiotics (median days)</td>
<td>22</td>
<td>24.5</td>
<td>10</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PICC utilization rate</td>
<td>77%</td>
<td>86%</td>
<td>55%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Use of recommended lab tests: CBC, CRP, ESR</td>
<td>94%</td>
<td>95%</td>
<td>94%</td>
<td></td>
</tr>
<tr>
<td>Use of PCR testing for Staphylococcus aureus</td>
<td>14%</td>
<td>8%</td>
<td>32%</td>
<td></td>
</tr>
</tbody>
</table>

Summary and Conclusion:

• Our institution decreased the duration of IV antibiotics and PICC line utilization in the management of pediatric acute osteomyelitis.

• Limitations:
  - Retrospective design
  - Limited study period after implementation of the algorithm
  - Variability among providers in the use and application of the algorithm

References:
DCMC Results

Figure 1. Median Length of Antibiotic Treatment for Uncomplicated Osteomyelitis

- Median Number of IV Antibiotics days
- Median Number of PO Antibiotics days
DCMC Results

Figure 2. PICC line Utilization in Uncomplicated Osteomyelitis

Year

Osteomyelitis Guideline Implemented

2009 2010 2011 2012 2013 2014

PICC line Utilization

0% 20% 40% 60% 80% 100%
Thank you