Clinical Utility of Repeat Magnetic Resonance Imaging Studies Among Children with Acute Hematogenous Osteomyelitis

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Introduction

- Acute hematogenous osteomyelitis (AHO) is a common and significant cause of hospitalization in children
- Magnetic resonance imaging (MRI) is the modality of choice for AHO
- Limited guidance for whether repeat MRIs are worthwhile when children do not improve as expected

Study Objectives

- Determine whether repeat MRIs change clinical management among children with AHO
- Identify clinical markers to predict which patients are most likely to have meaningful findings on repeat MRI

Methods

- Retrospective chart review
- Children 6 months to 18 years with discharge diagnosis of AHO
- All MRI reports reviewed from 3 weeks prior to admission through 24 months post discharge
- Multiple MRI studies performed during the same radiology visit were considered a single MRI study
- An MRI was "clinically impactful" if:
  - A new infectious process was identified (e.g., new abscess not previously seen)
  - Surgical intervention occurred within 24 hours of MRI completion
- Bivariable comparisons of clinical and demographic variables were performed
- Multivariable logistic regression performed to identify clinical factors associated with impactful repeat MRIs

Tables & Figures

Table 1: Demographics and Clinical Characteristics Based on Number of Magnetic Resonance Imaging Studies Performed

Characteristics	Total Patients (n=239) n (%)	No Repeat MRI (n=198) n (%)	Repeat MRI (n=41) n (%)	P-value
Age, years, median (IQR)	9.6 (5.4,12.3)	9.4 (5.2, 12.3)	10 (5.9, 12.4)	0.29
Male Sex	154 (64)	133 (67)	21 (51)	0.05
Payor Status				0.16
Commercial	151 (63)	120 (61)	31 (76)	
Government Assisted	84 (35)	74 (37)	10 (24)	
Uninsured/Self Pay	4 (2)	4 (2)	0 (0)	
Infection Location				0.02
Lower Extremity	93 (39)	81 (41)	12 (29)	
Upper Extremity	21 (9)	21 (11)	0 (0)	
Hip and Pelvis	56 (23)	43 (22)	13 (32)	
Hands/Feet/Wrists/Ankles	41 (17)	33 (17)	8 (20)	
Central/Axial Skeleton	14 (6)	12 (6)	2 (5)	
Vertebrae	8 (3)	5 (3)	3 (7)	
Multifocal	6 (3)	3 (2)	3 (7)	
Septic Arthritis	48 (20)	36 (18)	12 (29)	0.13
Length of Stay, days, median (IQR)	5 (4,6)	5 (3,6)	7 (6, 11)	<0.01
Length of intravenous antimicrobials, days, median (IQR)	3.9 (2.6,6.8)	3.3 (2.4,5.3)	8.4 (4.9, 17.9)	<0.01
Length of fever, hours, median (IQR)	42 (17,81)	36 (15,73)	82 (40,183)	<0.01
Peak C-reactive protein >20 mg/dL	36 (15)	19 (10)	17 (41)	<0.01
Prolonged bacteremia	28 (12)	16 (8)	12 (29)	<0.01
Admitted to Intensive Care Unit	17 (7)	12 (6)	5 (12)	0.18
Related Readmission	27 (11)	15 (8)	12 (29)	<0.01
Perceived Therapeutic Failure	11 (5)	4 (2)	7 (17)	<0.01
Microbiology				0.42
Culture Negative	41 (17)	36 (18)	5 (12)	
Methicillin-susceptible S. aureus (MSSA)	147 (62)	123 (63)	24 (59)	
Methicillin-resistant S. aureus (MRSA)	23 (10)	16 (8)	7 (17)	
S. pyogenes	15 (6)	12 (6)	3 (7)	
S. pneumoniae	3 (1)	3 (2)	0 (0)	
Polymicrobial/Other	7 (3)	5 (3)	2 (5)	

Table 2: Clinical Characteristics Associated with Impactful Repeat MRI

Outcomes	Total (n=239) n (%)	No Impactful Repeat MRI (n=217) n (%)	Impactful Repeat MRI (n=22) n (%)	P-value
Age, years, median (IQR)	9.6 (5.4,12.3)	9.5 (5.4,12.3)	9.7 (5.9, 13.3)	0.59
Male Sex	154 (64)	144 (66)	10 (45)	0.05
Infection Location, n (%)				0.06
Lower Extremity	93 (39)	88 (41)	5 (23)	
Upper Extremity	21 (9)	21 (10)	0 (0)	
Hip and Pelvis	56 (23)	48 (22)	8 (36)	
Hands/Feet/Wrists/Ankles	41 (17)	35 (16)	6 (27)	
Central/Axial Skeleton	14 (6)	13 (6)	1 (5)	
Vertebrae	8 (3)	8 (4)	0 (0)	
Multifocal	6 (3)	4 (2)	2 (9)	
Septic Arthritis	48 (20)	39 (18)	9 (41)	0.02
Length of Stay, days, median (IQR)	5 (4,6)	5 (4,6)	7 (6,11)	<0.01
Peak C-reactive protein >20mg/dL	36 (15)	26 (12)	10 (45)	<0.01
Bacteremia Present	128 (54)	111 (51)	17 (77)	0.02
Prolonged bacteremia	28 (12)	21 (10)	7 (32)	<0.01
Admitted to Intensive Care Unit	17 (7)	13 (6)	4 (18)	0.06
Venous Thromboembolism	6 (3)	5 (2)	1 (5)	0.52
Microbiology, n (%)				0.61
Culture Negative	41 (17)	39 (18)	2 (9)	
Methicillin-susceptible S. aureus (MSSA)	147 (62)	134 (63)	13 (59)	
Methicillin-resistant S. aureus (MRSA)	23 (10)	19 (9)	4 (18)	
S. pyogenes	15 (6)	13 (6)	2 (9)	
S. pneumoniae	3 (1)	3 (1)	0 (0)	
Polymicrobial/Other	7 (3)	6 (3)	1 (5)	

Figure 1: Clinical Impact of Repeat MRIs in Both Inpatient and Outpatient Setting

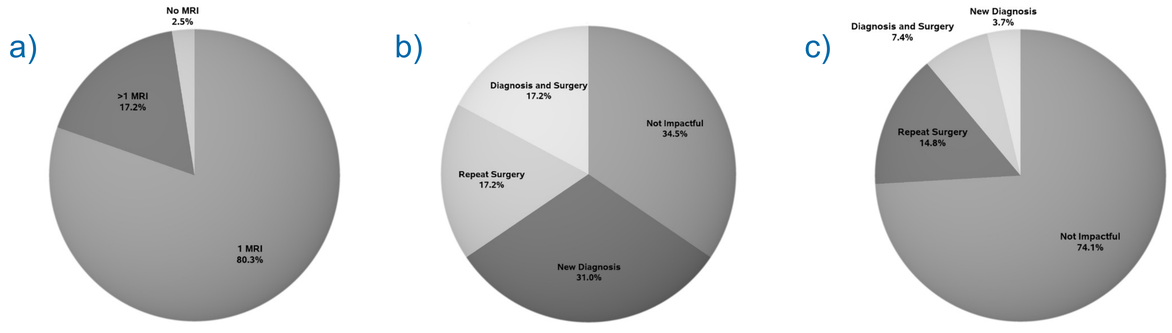

Figure Legend: (A) Proportion of included patients undergoing no MRIs, 1 MRI, and more than 1 MRI during clinical care (including both inpatient and outpatient studies from 3 weeks prior to admission until 24 months after discharge); Clinical impact of repeat MRIs performed while inpatient during course of initial hospitalization (B) or outpatient after hospital discharge (C) including no impact to care, identification of a new diagnosis, repeat surgical procedure within 24 hours of MRI, or both new diagnosis and repeat surgery.

Results

Clinical Characteristics based on Number of MRIs Performed

239 patients met inclusion criteria
- Causative pathogen identified in 198 (83%) patients
  - 71% *Staphylococcus aureus*
  - Among *S aureus* isolates, 12% MRSA
- No difference in: median age, sex, insurance status, presence of concurrent septic arthritis, or identification of MRSA

288 total MRIs performed
- 80% of patients had a single MRI performed
- 248 at our institution
  - 98% with contrast
  - 39% with sedation

Clinical Characteristics Associated with Impactful Repeat MRI

Of 41 patients who underwent repeat MRI, 54% had a repeat MRI that was clinically impactful

Patients who had a clinically impactful repeat MRI were more likely to have:
- Longer hospitalization (7 days vs 5 days, p<0.01)
- Prolonged bacteremia (32% vs 10%, p<0.01)
- Therapeutic failure (27% vs 2%, p<0.01)
- Peak CRP levels >20mg/dL (45% vs 12%, p<0.01)
- Concurrent septic arthritis (41% vs 18%, p=0.02)

Clinical Characteristics Associated with Impactful Repeat MRI

Multivariable logistic regression found:
- Peak CRP >20mg/dL (OR 3.9, CI 1.4,10.7)
- Prolonged bacteremia (OR 3.4, CI 1.1,10.2)

There was no difference in:
- Infection location
- Presence of multifocal infection
- Rate of ICU admission
- Presence of venous thromboembolism
- Causative pathogen identified

Discussion

- 1 in 5 children with AHO had multiple MRIs performed through their treatment course
- Repeat MRIs obtained during initial admission were impactful 66% of the time
- Repeat MRIs obtained after discharge were impactful 25% of the time
- Peak CRP > 20mg/dL and persistent bacteremia were both associated with having an impactful repeat MRI
- Critical illness, location of infection, causative pathogen, and development of a venous thrombosis (VTE) were not predictive of having an impactful repeat MRI

Conclusions

- Repeat MRI can be clinically impactful for pediatric AHO when used judiciously among ill pediatric patients
- Future prospective studies are needed to better define which children with AHO will benefit from repeat MRI