

# Acute Hematogenous Osteomyelitis in Children

## Pathogenesis, Diagnosis, and Treatment



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### KEYWORDS

• Acute hematogenous osteomyelitis • Children • Pathogenesis • Diagnosis • Treatment

### KEY POINTS

- Proper care for children with AHO is inherently a multidisciplinary and collaborative process that should be guideline driven and evidence based.
- AHO is the most difficult condition to understand in the realm of pediatric musculoskeletal infection and continues to present a significant clinical challenge due to the evolving epidemiology and complex pathogenesis.
- A lack of institutional consensus as to the most effective evaluation and management strategies may lead to variation in care, which in turn may have an adverse impact on clinical outcomes. Such variability, which may easily occur in large pediatric medical centers, can make coordination of care extremely difficult.
- Despite these challenges, a guideline-driven, multidisciplinary approach has been introduced and shown to effectively reduce hospital stay, improve the timing and selection of empirical antibiotic administration, reduce delay to initial MRI, reduce the rate of readmission, and shorten antibiotic duration.
- Carefully monitoring regional trends in microbiologic epidemiology and applying a guideline-driven approach for evaluation and treatment will improve care for children with AHO and, inevitably, those with other forms of musculoskeletal infection as well.

### INTRODUCTION

Musculoskeletal infection in children is a broad topic covering an array of conditions that may occur in isolation or in combination, including complex or systemic forms. These conditions include osteomyelitis (acute, subacute, and chronic), discitis, septic arthritis, pyomyositis, abscess (superficial or deep), cellulitis, fasciitis (including necrotizing fasciitis), lymphangitis, and lymphadenitis. Children with musculoskeletal infection may have additional involvement

of other systems, including deep vein thrombosis (DVT), septic pulmonary embolism, pneumonia, empyema, endocarditis, bacteremia, and septic shock. The clinical presentation of children with any of these conditions may have sufficiently similar features to create an initial diagnostic dilemma until thorough history, physical examination, laboratory tests, plain radiographs, and advanced imaging can be performed. A variety of disciplines and hospital services are usually involved in the evaluation process, including emergency medicine,

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pediatrics, infectious disease, orthopedic surgery, intensive care, radiology, anesthesiology, laboratory, nursing, and pharmacy. Because of this, the care of children with musculoskeletal infection inevitably requires an organized, interdisciplinary approach to reach timely, comprehensive, and accurate diagnoses. From that point forward, effective treatment may be carefully planned and enacted with subsequent monitoring of the child until clinical resolution is achieved. Ideally, clinical practice guidelines should be established to help orchestrate the complex array of events that are necessary to reach the point of resolution with the best outcomes. Unfortunately, this is not a simple undertaking. There is a paucity of high-quality evidence to guide care. There are substantial regional variations in the incidence and severity of illness of children with these conditions. There is also moderate disagreement as to the categorical differentiation of the array of conditions that comprise musculoskeletal infection in children, which can confuse recommendations of evaluation and treatment at regional and institutional levels. Of even greater relevance, however, is the wide range of individual practice preferences, knowledge limitations, and institutional workflows that lead to variation in understanding and treating these conditions. To overcome these limitations, it is necessary to focus on foundational disorders and develop sound principles to guide awareness of pathophysiology, diagnosis, and treatment that serve to guide care for the wide array of disorders that comprise pediatric musculoskeletal infection. AHO is the principal disorder that enables establishing this foundation. Developing rational, evidence-based clinical practice guidelines for this one condition will effectively support the evaluation and management of the full spectrum of pediatric musculoskeletal infections because children with AHO represent the entire gamut of illness from mild to severe, simple to complex, and focal to systemic. For these reasons, this review is devoted exclusively to AHO in children, with the intent to provide an update on the current understanding of existing evidence and future directions, which should be explored to improve care for those with any form of musculoskeletal infection.

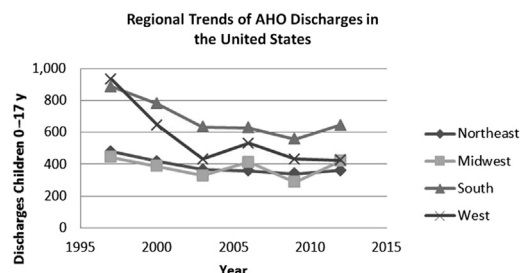
## EPIDEMIOLOGY

The incidence of AHO varies by region and time.<sup>1</sup> The authors reported a 600% increase in pediatric osteomyelitis over a 2-decade period within a community.<sup>1</sup> During that time, the local

population had increased by 220%.<sup>1</sup> The relative virulence of the infections has seemingly increased, a concern attributed to the causative organism. The Agency for Healthcare Research and Quality provides national estimates on hospital discharges for children ages 0 to 17 years from the Healthcare Cost and Utilization Project (HCUP) Kids' Inpatient Database (KID). Trends between 1997 and 2012 suggest that the incidence of AHO has varied regionally, with the highest percentage currently reported the southern region (Fig. 1). Surveillance data from specific communities have reported varying incidence rates over time, with 1 report indicating a 600% increase in the incidence of osteomyelitis when comparison was made to the experience of the same organization 2 decades prior.<sup>1</sup> The incidence of AHO also varies according to the age and gender of the child due to processes of skeletal and vascular development.<sup>2,3</sup> The reported rate of AHO varies between 1:5000 and 1:10,000, with boys having a rate twice that of girls.<sup>4-7</sup>

## PATHOGENESIS

AHO is caused by bacterial seeding that is thought to develop due to transient bacteremia, which can result from otitis media, pharyngitis, and daily activities, such as brushing teeth.<sup>8</sup> A transient bacteremia alone is thought insufficient for the development of AHO due to the lack of available free iron in human blood to sustain the bacteria. Bacterial genetic up-regulation of virulence and iron metabolism genes or regional bone trauma are postulated to predispose to infection.<sup>3</sup> In rabbits, bacterial inoculation associated with bone trauma had a higher rate of osteomyelitis than those without injury.<sup>9,10</sup>



**Fig. 1.** HCUPnet KID data for hospital discharges of children 0 to 17 years by regions of the United States from 1997 to 2012. (Data from HCUP Kids' Inpatient Database (KID). Healthcare cost and utilization project (HCUP). Rockville (MD): Agency for Healthcare Research and Quality; 2015.)

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