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Osteomyelitis and Causing Microbes in Paediatric Patients and Current Recommendations in the Management

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Abstract

The muscles and bone related infections are remains common cause of morbidity. In children, osteomyelitis is primarily hematogenous in origin and acute in nature. Methicillin resistant Staphylococcus aureus is the most common organism, but incidence of methicillin resistant S. aureus in the community is continuously rising. Owing to the emergence of community-associated methicillin-resistant S. aureus the overall management process must have to advance. The functional outcomes may become poor if there is poor quality of management. That is why management includes careful consideration about pathogenesis, microbiology, diagnostic options, surgical and medical treatment of osteomyelitis.
Keywords: Osteimyelitis, Microbes, Infection, Antimicrobial activity, Management.

Introduction

Osteomyelitis is the inflammatory infection of bone that are destroyed and followed by new bone formation [1], the initiation of OM is an acute infection that later develops into chronic conditions [2]. There are many diverse forms of this disease due to which it is considered as complicated. One of these diverse forms focuses on the source of the infection and distinguishes between infections arising from hematogenous seeding from the endosteal blood supply and infections arising as a consequence of an overlying soft tissue infection [1].

The incubation period of the infection is two weeks after the injury, the initial infection is known as the acute infection. When the disease has been present for more than one month it is termed as chronic OM. This chronic disease occurs if there is inadequate treatment of acute infection. In reality, there are no distinct subtypes; instead there is a spectrum of pathologic features that reflect balance between the type and severity of the cause of the inflammation, the immune system and local and systemic predisposing factors [3]. Sign and symptoms of acute and chronic osteomyelitis may vary, depending on the type (Fig 1) [4].

Diagnosis of osteomyelitis can be challenging task. Inflammatory markers such as erythrocyte sedimentation rate and C-reactive protein tend to be elevated during osteomyelitis and decrease with effective therapy, but they are useful only to monitor response to therapy. MRI, CT scan, and 3-phase bone scan are marginally better than plain radiographs for diagnosing OM, but all have poor sensitivity and specificity. Bone biopsy with characteristic pathology and positive culture is the gold standard diagnosis. The presence of infected material immediately adjacent to bone should be treated as OM [5].

OM is a pyogenic bony infection, which means the

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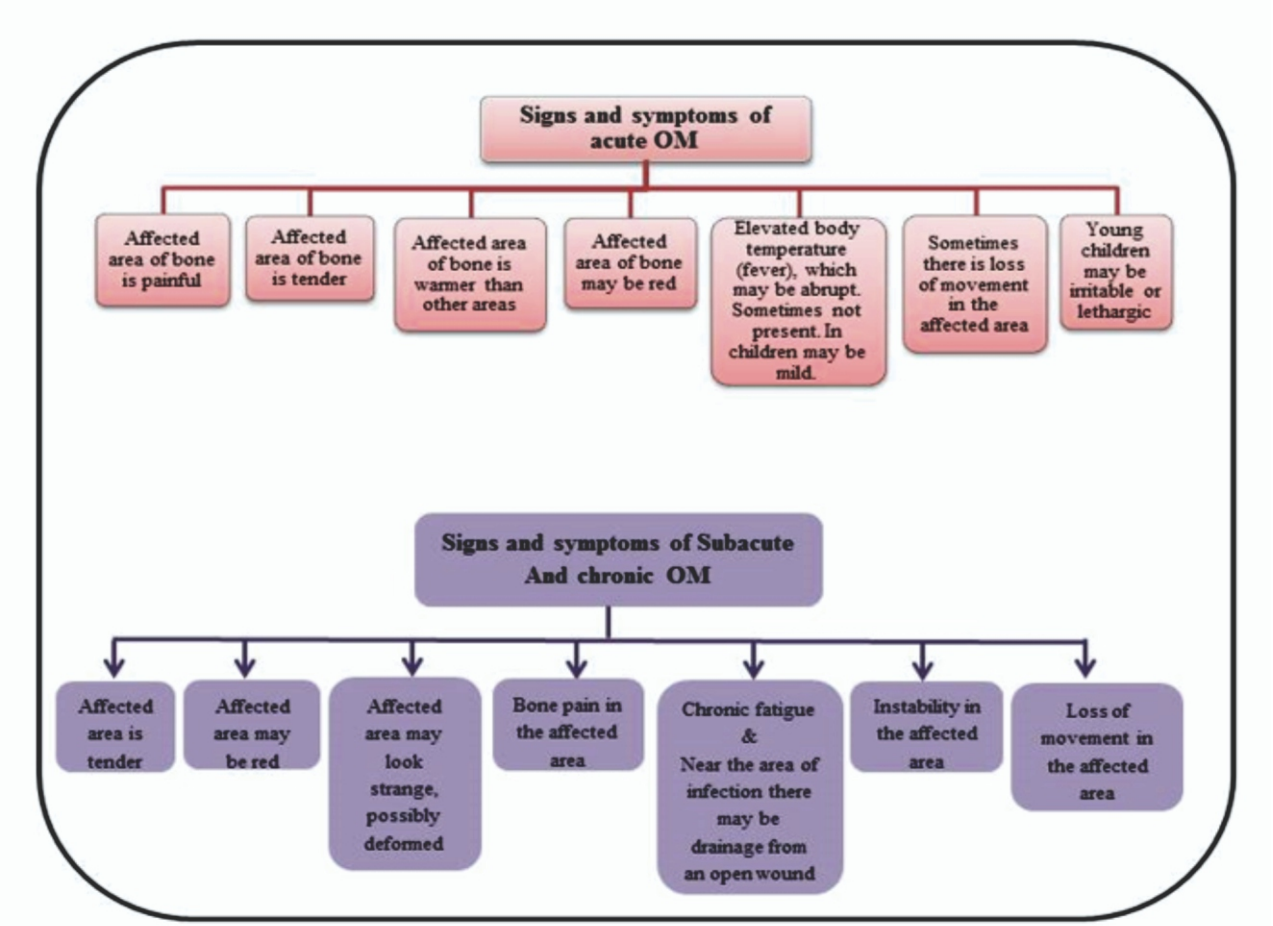

Figure 1: Above flow chart representing sign and symptoms of acute and chronic osteomyelitis [4].

formation of pus that result in inflammation; it can occur in almost every bone in the body, including the bones of the hand and wrist. As soon as the pathogen penetrates the tissue it replicates spreads more at the sites where the areas are least resistant. While intact cortex of bone provides at least a mechanical barrier to pathogen penetration, traumatized bone is easily infected. Local inflammation leads to increased tissue pressure, lower pH and oxygen tension, leading to the formation of microthrombi within the intraosseous vessels and bony necrosis [2].

In children, osteomyelitis is primarily hematogenous in origin and acute in nature. The principal cause of osteomyelitis in children is Staphylococcus aureus, and both the epidemiology and pathogenesis of S. aureus infections, including osteomyelitis, have changed in recent years owing to the emergence of community-associated methicillin-resistant S. aureus. This review focuses on advances in the diagnosis and overall management of acute hematogenous osteomyelitis in children.

Types of OM and important cause of infection in Paediatric Age Group:

OM can be classified according to the area of infection or area of skeleton where it is present. For example, OM of the jaws is different in several respects from OM present in long bones. Vertebral OM is another possible presentation. There are three types of osteomyelitis, the first is Acute OM; the infection develops within two weeks of an injury, initial infection, or the start of an underlying disease. Second one is Subacute OM; the infection develops within one or two months of an injury, initial infection, or the start of an underlying disease. Third one is Chronic OM; the bone infection starts at least two months after an injury, initial infection, or the start of an underlying disease [3].

The major causes for the root of infection are: hematogenous route i.e by the way of blood supply, direct inoculation, and local extension from contiguous infection, i.e from sexually transmitted infections, but the hematogenous route of infection represents only 20% of the cases of OM in adults, this route is the most common one in the pediatric population [5]. Estimates of the

Table 1: Usual infectious causes of pediatric osteomyelitis [8]

Age	Organism
Infants 0 –2 months	*Staphylococcus aureus* *Streptococcus agalactiae* Gram-negative enteric bacteria Candida
= 5 Years	*S. aureus* *Haemophilus influenzae* type b (if child not completely immunized with conjugate Hib vaccine)
> 5 Years	*S. aureus*
Adolescent	*Neisseria gonorrhoeae*

incidence of pediatric osteomyelitis vary, but pediatric OM is generally considered rare, the incidence is 6.0 per 1000 admitted patients [6]. Approximately 50% of cases of OM occur in the first 5 years of life. Boys are more likely than girls to be affected. The long bones of the lower extremities are most often involved, although any bone may be affected [7].

Puncture wounds to the foot may result in OM caused by mixed flora, including Pseudomonas, S. aureus, enteric gram-negative bacteria, and anaerobes. The source of bacteria is usually from moist colonized soles of tennis shoes. A series of cases describes OM of the metatarsals occurring as a result of toothpick puncture injuries. The organisms isolated included skin and environmental organisms; others have reported infection with mouth organisms as a result of toothpick injuries [8]. Anaerobes are a rare cause of pyogenic osteomyelitis in healthy children. Predominant organisms are Bacteroides, Fusobacterium, Clostridium, and Peptostreptococcus. Anaerobic osteomyelitis can occur as the result of a bite, chronic sinusitis, mastoiditis, or dental infection.

Infecting microbes and age group:

The type of infecting organism depends on the age of the child and underlying medical problem (Table 1) [8]. Staphylococcus aureus is the most common cause of OM in all age groups, accounting for 70% to 90% of infections [7]. In addition to S. aureus, young infants may develop OM caused by Streptococcus agalactiae or enteric gram-negative bacteria. Organisms other than S. aureus causing infection in older children include Streptococcus pyogenes, Streptococcus pneumoniae, and Kingella kingae [9]. S. pyogenes causes approximately 10% of cases of acute hematogenous osteomyelitis with a peak incidence of disease in preschool-age and early school–age children [10]. Children with S. pyogenes osteomyelitis often have a recent history of varicella infection and present with higher fever and white blood cell (WBC) counts compared with children infected with S. aureus. Children with osteomyelitis caused by S. pneumoniae are younger than children infected with S. aureus and S. pyogenes. They are more likely to have joint involvement [11].

The proportion of bone infections caused by S. pneumoniae is relatively small (approximately 1–4%); the impact of heptavalent pneumococcal conjugate vaccine on the incidence of OM is limited. K. kingae is reported as a pathogen with increasing frequency [12]. A cluster of bone and joint infections caused by K. kingae at a daycare center underscores the importance of this organism in children with musculoskeletal infections [13]. K. kingae is a fastidious gram-negative coccobacillary bacterium found in normal respiratory flora. Infection with this organism often is preceded by an upper respiratory tract infection or stomatitis; disrupted respiratory mucosa may facilitate invasion and hematogenous dissemination.

Current Recommendations in the Management

S. aureus is a virulent organism capable of causing significant tissue invasion and bone destruction. The rapid emergence of community associated methicillin resistant S. aureus (CA-MRSA) since the 1990's has changed antimicrobial management for osteomyelitis; CA-MRSA are not susceptible to beta-lactam antibiotics, and therefore vancomycin must generally be included in empiric therapy for osteomyelitis when CA-MRSA is a potential pathogen [16, 17]. Though CA-MRSA isolates are often susceptible to

clindamycin, trimethoprim-sulfamethoxazole, macrolides, and quinolones.

Management of OM should consist of a combined surgical and medical approach to achieve the most favorable outcome. Non-surgical cure is occasionally achieved in acute osteomyelitis, but should not be routinely attempted. Infected hardware should be removed, at least temporarily, whenever possible [18]. Temporary external fixation prior to hardware re-implantation should be considered. When hardware removal is not possible, chronic suppressive therapy after initial antimicrobial treatment is often necessary.

In general, bactericidal, parenteral antimicrobials are preferred for treatment of OM. Initial empiric therapy should include antimicrobials that are active against gram positive and gram negative bacteria. Many clinicians prefer vancomycin for gram positive coverage, with target troughs from 15 to 25 mcg/ml. Newer agents such as daptomycin and linezolid may be effective as well, though there is less experience with their use in osteomyelitis. In addition, empiric therapy should include gram negative coverage, such as a third or fourth-generation cephalosporin, or a flouroquinolone. Additional or alternative antimicrobials may be appropriate for specific situations according to suspected microbiology of the infection.

Once causative pathogens are identified, empiric therapy should be changed to pathogen specific therapy. Parenteral antimicrobials with less frequent dosing may be desirable for outpatient parenteral antimicrobial therapy. Switching to oral antimicrobials with excellent bioavailability is sometimes possible, but should be done cautiously and with consultative advice. Optimal duration of treatment has not been adequately studied. We commonly treat for 4 to 6 weeks, and sometimes longer based on severity and response to therapy.

Conclusion

On the basis of penetrating antibiotics, bone-to-tissue concentrations of first generation cephalosporins were 7% or less, and concentrations for vancomycin and quinolones were 12–15% [19]. Clindamycin concentrations in debrided bone have generally been above the minimum inhibitory concentration for isolated pathogens [20]. OM of the hand and wrist can result in significant morbidity and functional loss. As a result of which optimal management requires a multidisciplinary approach, involving surgeons and infectious diseases specialists to preserve function and maximize the positive outcome.

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