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Acute musculoskeletal infection in children: assessment and management

Mark C Sykes[1]
Aashish K Ahluwalia[2]
Daniel Hay[1]
James Dalrymple[2]
Gregory B Firth[3]

Author details can be found at the end of this article

Correspondence to:
Aashish K Ahluwalia;
Aashish.ahluwalia2@nhs.net

Abstract

Musculoskeletal infection in children is challenging to treat, and includes septic arthritis, deep tissue infection, osteomyelitis, discitis and pyomyositis. Delays to diagnosis and management, and under-treatment can be life-threatening and result in chronic disability. The British Orthopaedic Association Standards for Trauma include critical steps in the timely diagnosis and management of acute musculoskeletal infection in children, the principles of acute clinical care and the service delivery requirements to appropriately manage this cohort of patients. Orthopaedic and paediatric services are likely to encounter cases of acute musculoskeletal infection in children and thus an awareness and thorough understanding of the British Orthopaedic Association Standards for Trauma guidelines is essential. This article reviews these guidelines and associated published evidence for the management of children with acute musculoskeletal infection.

Key words: BOAST guidelines; Microbiology; Musculoskeletal infection; Orthopaedics; Paediatrics

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Introduction

Acute musculoskeletal infections in children include septic arthritis, deep tissue infections, osteomyelitis, discitis and pyomyositis. These can lead to long-term disability and can also be life-threatening in the acute phase with multi-organ involvement in severe cases. The incidence of musculoskeletal infections depends on the pathology; osteomyelitis has increased in incidence over the last 10 years, whereas septic arthritis has appeared more static (Nossent et al, 2021; Walter et al, 2021). The increase in the incidence of osteomyelitis may be related to improvements in the quality and availability of magnetic resonance imaging. Although the overall incidence remains low, the detrimental impact these pathologies can have on the child means that clinicians must be alert to the early diagnosis of musculoskeletal infections.

The most common childhood acute musculoskeletal infections are osteomyelitis and septic arthritis. Osteomyelitis in children is predominantly secondary to the haematogenous spread of bacteria to the metaphyseal bone (commonly the femur or tibia) as a result of sluggish blood flow, low oxygen tension, and Haversian and Volkmann canals allowing ongoing focal spread (Trueta, 1959; Dartnell et al, 2012). Septic arthritis is also predominantly caused by haematogenous bacterial seeding, either through the infection breaking through the intra-articular metaphyseal cortex or directly into the vascular synovium. A focus of metaphyseal osteomyelitis may also traverse the physis in young children and result in septic arthritis (Ogden, 1979). The commonest sites of septic arthritis in children are the knee and hip (Cohen et al, 2020).

The clinical diagnosis can be challenging given the variability in clinical presentation. Symptoms will differ based on the virulence of the pathogen, anatomical location, duration of illness and age of the patient. Younger children may also not be able to articulate their symptoms, highlighting the importance of a thorough clinical examination and appropriate diagnostic tests. The heterogeneity of presentation is further complicated by diagnoses that may mimic musculoskeletal infection such as malignancy, transient synovitis, intracranial infections and autoimmune disease.

The British Orthopaedic Association Standards for Trauma (BOAST) (2022) guidelines for the management of children with acute musculoskeletal infection were formulated from the British Society for Children's Orthopaedic Surgery (BSCOS) Musculoskeletal

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Infection Consent Group (BSCOS Musculoskeletal Infection Consensus Group, 2021). The guidelines consolidate the assessment, investigation, diagnosis and treatment into succinct steps that can be easily referred to and followed.

Assessment

The BOAST recommendations for the treatment of acute musculoskeletal infection in children emphasise the importance of joint involvement between orthopaedic and paediatric specialists during inpatient care. A multidisciplinary team approach ensures timely and effective treatment, improves diagnostics, increases identification of the causative organism, improves adherence to antibiotics and reduces changes to antibiotic therapy (Copley et al, 2013).

A thorough examination of the extremities and spine, and an additional systems review should be performed and fully documented to identify the primary source of infection and/or other contributing pathologies. The clinical findings on presentation vary and can often be insidious. Signs, symptoms and the severity of these will depend on the age of the patient, duration of symptoms, underlying organism and site of infection. A retrospective cohort study identified pain, functional limitation and fever as the most common symptoms in children with osteomyelitis. Focal tenderness and swelling were the most common examination findings (Stephan et al, 2022). When considering septic arthritis, the child may have a fever, a painful swollen joint with a reduced range of motion or pseudoparalysis, an inability to weight bear, joint line tenderness, and a warm joint with a temperature differential compared to the unaffected side (Kang et al, 2009).

Blood tests and radiological investigations

Given the heterogeneity of presentation, no single investigation is completely reliable. A multi-faceted approach including the clinical history and examination, blood test results and dedicated imaging should be used to confirm the diagnosis. The Kocher criteria (Kocher et al, 1999) are a well-established guide for the prediction of a septic hip joint (Table 1), although they have limitations (Obey et al, 2019) and cannot be extrapolated to other acute musculoskeletal infections in children. Measurement of the erythrocyte sedimentation rate, white cell count and C-reactive protein level are all common in the investigation of infection. The white cell count is variable and often related to the child's age (Chen et al, 2001), but if used in conjunction with other markers it can add to diagnostic certainty. When considering the accuracy of blood tests in isolation, erythrocyte sedimentation rate and C-reactive protein level appear to have a higher sensitivity than white cell count when used individually, but the combination of a raised erythrocyte sedimentation rate and C-reactive protein level (Caird et al, 2006) is the most sensitive way of diagnosing musculoskeletal infection (Pääkkönen et al, 2010). In addition to these investigations, it is important to take blood cultures to try and identify the organism and assist with sensitivities and choice of antibiotic administration. A multi-factorial approach including clinical, laboratory and radiological findings is essential.

Plain X-rays should be obtained acutely to help guide the diagnosis (Figure 1). Fractures may be identified and radiological differences between septic arthritis, established osteomyelitis and neoplasia may be appreciated. In the acute stages of musculoskeletal infection there should be no bony changes on the X-rays but there may be signs of associated soft tissue swelling.

Table 1. Kocher's criteria

Kocher criteria	Points	Likelihood of septic arthritis
Non-weight-bearing (+1 point)	1	3%
Temperature >38.5°C (+1 point)	2	40%
Erythrocyte sedimentation rate >40 mm/hr (+1 point)	3	93%
White cell count >12 000 cells/mm^3 (+1 point)	4	99%

From Kocher et al (1999)

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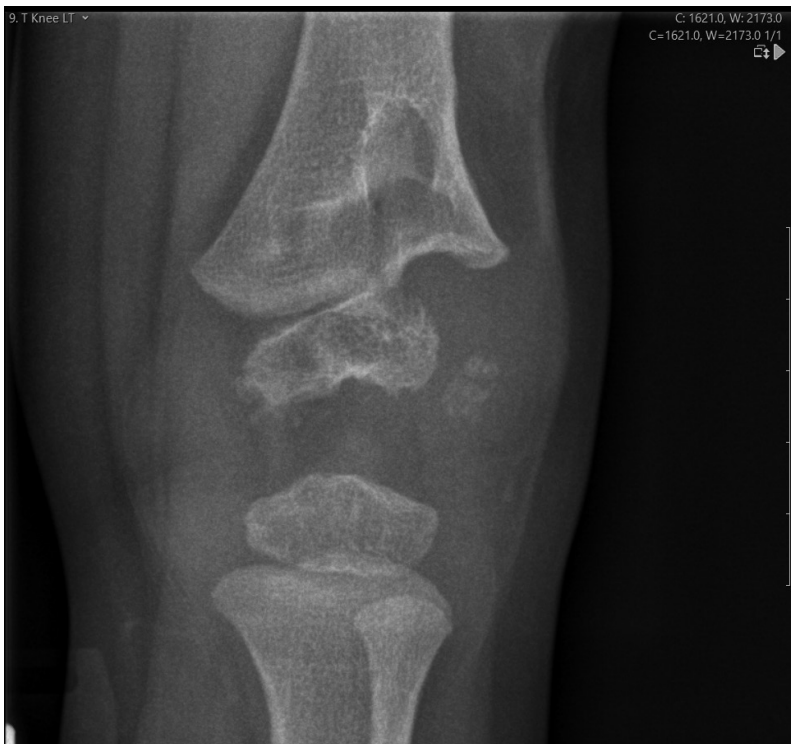

Figure 1. Plain X-ray illustrating osseous destruction associated with chronic osteomyelitis.

Ultrasound can be useful early in the assessment of children in musculoskeletal infections, especially in joints like the hip joint, where an effusion may not be clinically obvious. Demonstrable effusion on ultrasound should be used in conjunction with additional laboratory and clinical signs to support the diagnosis of septic arthritis (Zamzam, 2006).

As long as the clinical presentation does not mandate expedited investigation, magnetic resonance imaging (**Figure 2**) should be completed within 48 hours. This has the highest sensitivity and specificity for musculoskeletal infection (van Schuppen et al, 2012) and avoids the radiation exposure associated with computed tomography and single photon emission computed tomography (SPECT) scans. SPECT scans are not generally used in the acute setting of musculoskeletal infections but can be useful to exclude conditions that may mimic infection (like eosinophilic granuloma), or with chronic infections like osteo-articular tuberculosis (Foss et al, 2019). Advances such as diffusion-weighted magnetic resonance imaging may also reduce the current requirement for contrast (gadolinium) injection when diagnosing infection (Habre et al, 2022). Magnetic resonance imaging is especially useful for joints like the hip where the possibility of juxta-articular infections is high and may be missed with an arthrotomy and drainage of the joint (Mignemi et al, 2014).

Treatment

The timing of initiation of antibiotic therapy to treat musculoskeletal infection depends on the clinical condition of the child. If the child meets the high-risk sepsis criteria as outlined by the National Institute for Health and Care Excellence (2017a,b,c) guidelines, then empirical intravenous antibiotics should be started immediately. The choice of antibiotics should be guided by the local microbiology team or trust guidance and subsequent culture results and sensitivities. However, if the child is stable and surgery is imminently planned, then antibiotics can be delayed to allow deep tissue sampling. The definitive management is then dependent on the pathology. Septic arthritis requires surgical drainage within 24 hours of diagnosis and is one of the only orthopaedic emergencies requiring such rapid treatment. Osteomyelitis, pyomyositis and discitis are managed with intravenous antibiotics in the early stages of infection, unless an abscess forms, in which case incision and drainage should be considered.

The duration of antibiotic course differs in the literature, with multiple publications suggesting different lengths of treatment (Peltola et al, 1997; Lavy and Thyoka, 2007).

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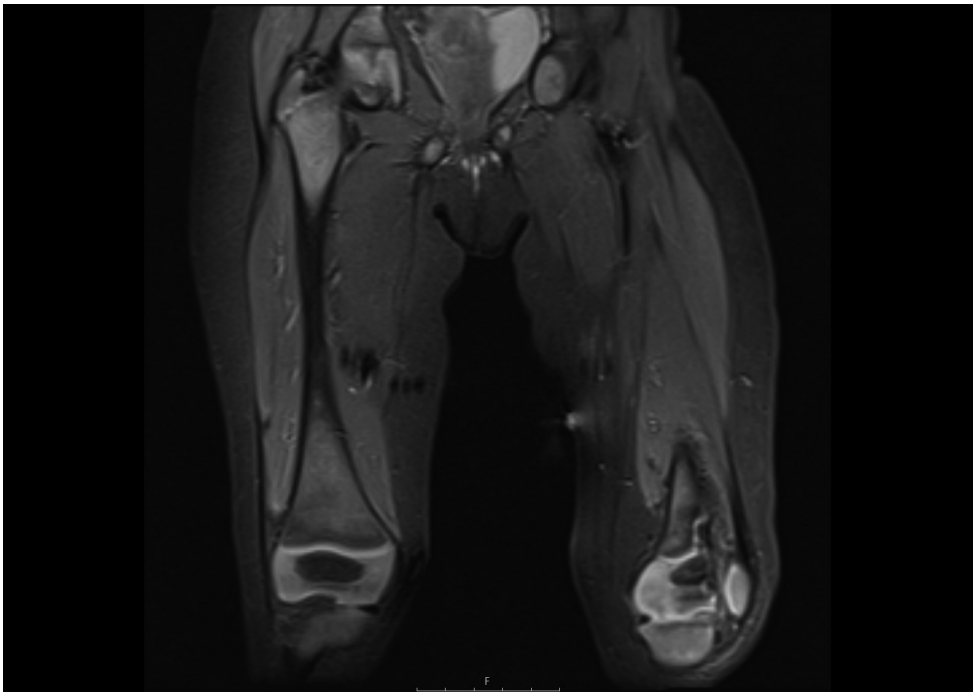

Figure 2. T2 weighted magnetic resonance image illustrating bony destruction and oedema associated with chronic osteomyelitis.

The BOAST guidelines simplify this with practical advice that identifies improvements in C-reactive protein levels, erythrocyte sedimentation rate, white cell count and clinical examination as guides to help gauge both the conversion of intravenous to oral antibiotics and the duration of antibiotic administration. In patients who require prolonged intravenous antibiotics based on the above metrics, peripherally inserted central venous access should be arranged early in the treatment, and paediatric outpatient antibiotic therapy teams should be contacted to avoid delays in discharge. Children with a confirmed diagnosis of musculoskeletal infection should be followed up with clinical and radiological reviews for a minimum of 12 months by an appropriate team to identify any long-term sequelae of infection.

Surgery is indicated in any child with signs of sepsis in addition to signs of a joint effusion. Any collection of pus in the joint will damage the articular cartilage if not rapidly evacuated and washed out (Paterson, 1970). Likewise, any collection of pus in the subperiosteal layer of bone will cause devascularisation and bone necrosis with long-term sequelae. Some centres advocate arthrocentesis of the joint only whereas others encourage washout and drainage (either open or with arthroscopic techniques); the BOAST guidance recommends surgical drainage as soon as possible in septic arthritis but does not specify further procedural advice. It is not clear what the threshold for surgery is to prevent long-term sequelae of either osteomyelitis or septic arthritis (Peltola et al, 1997; Journeau et al, 2011; Smith et al, 2013). Repeat surgery may be required in recalcitrant cases where there is a delay to diagnosis or an extremely virulent organism like Panton–Valentine leucocidin *Staphylococcus aureus* (Albiski et al, 2018; Moutaouakkil et al, 2022). Sequelae of bone and joint infection must be closely monitored for – these include chronic osteomyelitis, articular destruction and osteoarthritis, growth plate injuries and resultant deformities, and leg length discrepancies.

Conclusions

The need for prompt, accurate diagnosis and treatment is extremely important in children with musculoskeletal infections to avoid long-term sequelae. Clarity in diagnosis will ensure that the appropriate management is initiated early and continued for the correct length of time, thus ensuring the best possible outcomes in this vulnerable population.

Author details

[1]Trauma and Orthopaedics Department, Imperial College Healthcare NHS Trust, London, UK

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Key points

- Musculoskeletal infection in children can be life threatening and result in significant morbidity, particularly if management is delayed.
- Musculoskeletal infections in children are challenging to diagnose and treat.
- These patients should be managed by joint orthopaedic and paediatric specialists with competency managing musculoskeletal infection.
- Investigations including a full examination, haematological, and radiological investigations are necessary to accurately diagnose the pathology.
- Antibiotic therapy is first-line treatment with surgery reserved for specific scenarios.

[2]Trauma and Orthopaedics Department, University College London Hospitals NHS Foundation Trust, London, UK

[3]Trauma and Orthopaedics Department, The Royal London Hospital, Barts Health NHS Trust, London, UK

Conflicts of interest

The authors declare that there are no conflicts of interest.

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Curriculum checklist

This article addresses the following requirements from the general internal medicine training curriculum.

- Managing an acute unselected take
- Managing an acute specialty-related take
- Managing medical problems in patients in other specialties and special cases

Lavy CBD, Thyoka M. For how long should antibiotics be given in acute paediatric septic arthritis? A prospective audit of 96 cases. Trop Doct. 2007;37(4):195–197. https://doi.org/10.1258/004947507782332775

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