



Hematogenous osteomyelitis in adults

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INTRODUCTION — Hematogenous osteomyelitis accounts for approximately 20 percent of cases of osteomyelitis in adults. For unclear reasons, it is more common in males regardless of age. Long bone and vertebral osteomyelitis are the two major types, but hematogenous osteomyelitis can occur in locations such as the pelvis and clavicle [1]. Patient characteristics that predispose to bacteremia, such as intravenous drug abuse, dialysis, and sickle cell disease, favor the development of hematogenous osteomyelitis.

Hematogenous osteomyelitis in adults will be reviewed here. Hematogenous osteomyelitis in children is discussed separately. (See "[Epidemiology; pathogenesis; and microbiology of hematogenous osteomyelitis in children](#)" and see "[Clinical features of hematogenous osteomyelitis in children](#)" and see "[Evaluation and diagnosis of hematogenous osteomyelitis in children](#)" and see "[Treatment of hematogenous osteomyelitis in children](#)").

EPIDEMIOLOGY — Hematogenous osteomyelitis is primarily a disease of children, with 85 percent of cases occurring in patients younger than 17 years of age [2]. However, the proportion of adult cases may be increasing as the mean age of the population rises in the United States and developed countries [3].

Most cases in adults are seen in patients over age 50, with the exception of intravenous drug users, the majority of whom are under the age of 40 [4]. Hematogenous osteomyelitis is also associated with other risk factors for bacteremia (eg, central lines, dialysis, urethral catheterization, urinary tract infection).

The site of infection varies with age. In children, the most common sites of involvement are the long bones (eg, femur, tibia, and humerus) with vertebral osteomyelitis accounting for only one to two percent of cases [5]. In contrast, the long bones are rarely involved in adults in whom the major sites of infection are the vertebrae and the sternoclavicular and sacroiliac bones (the latter two most commonly occurring in intravenous drug users) [6].

Among patients with vertebral osteomyelitis, the lumbar vertebral bodies are most often involved, followed in frequency by the thoracic and cervical vertebrae. Spread to adjacent vertebral bodies may occur rapidly through the rich venous networks in the spine. Posterior extension may lead to epidural and subdural abscesses or even meningitis. Extension anteriorly or laterally can lead to paravertebral, retropharyngeal, mediastinal, subphrenic, retroperitoneal, or psoas abscesses. (See

["Vertebral osteomyelitis"](#)).

PATHOGENESIS — The mechanism of infection in hematogenous osteomyelitis in children is thought to be due to specific features of the anatomy of long bones [7] . (See ["Epidemiology; pathogenesis; and microbiology of hematogenous osteomyelitis in children"](#), section on Pathogenesis).

Long bones — In adults, infection in long bones usually begins in the diaphysis but may spread to involve the entire medullary canal. Extension into the epiphysis and joint space can occur, since the growth plate has matured and once again shares vessels with the metaphysis. Since the periosteum is firmly adherent to the bone, cortical penetration usually leads to a soft tissue abscess. Subperiosteal abscesses and massive cortical devitalization rarely occur. Sinus tracts connecting the sequestered nidus of infection to the skin can develop over time.

The mechanism of bacterial deposition in the metaphysis is unclear. Examination of the capillary loops of the metaphyseal vessels by electron microscopy has shown that the distal vessels are composed of a single layer of discontinuous endothelium through which tracer particles can escape [8,9] . It is possible that bacteria also pass through these gaps during an episode of septicemia, thereby initiating osteomyelitis [10] . In addition, the metaphyseal capillaries lack phagocytic lining cells, and the sinusoidal veins contain functionally inactive phagocytic cells, both of which allow growth of microorganisms [11] .

Any form of end-capillary obstruction, including a small hematoma as the result of minor trauma, could produce an area of avascular necrosis that is predisposed to infection.

Vertebrae — The mechanism by which bacteria in the bloodstream cause vertebral osteomyelitis is complex. (See ["Vertebral osteomyelitis"](#)).

Bacterial factors — The pathogenesis of hematogenous osteomyelitis is also dependent upon the ability of specific bacteria to bind to host tissue, a critical first step that is required to initiate infection. Staphylococcus aureus can adhere to tissue by binding host proteins, including fibronectin, fibrinogen, and collagen [12] . This ability may well account for the predominance of S. aureus in hematogenous osteomyelitis. (See ["Pathogenesis of osteomyelitis"](#)).

The importance of binding to collagen for the development of osteomyelitis was illustrated in a murine model of acute hematogenous osteomyelitis [13] . Mice infected with a S. aureus collagen-binding adhesin (cna) mutant were less likely to develop osteomyelitis compared to mice infected with a S. aureus strain wild type for this gene (1 of 20 [5 percent] infected with the cna mutant compared to 14 of 20 [70 percent] the wild type strain). These adhesion factors may account for the predominance of S. aureus in bone infections.

However, the presence of the gene encoding collagen-binding adhesin (cna) is not necessary for S. aureus to cause osteomyelitis in children. This was illustrated in a retrospective review of 48 children with S. aureus osteomyelitis [14] . S. aureus isolates carrying the gene encoding the Pantan-Valentine leukocidin (pvl) were associated with more complications in children with osteomyelitis. No other virulence genes studied, including cna, were associated with complications.

MICROBIOLOGY — Hematogenous osteomyelitis occurs after a bacteremic event, although the bacteremia is not apparent in every case. A single pathogenic organism is almost always recovered from the bone [7,15-17] .

Hematogenous osteomyelitis is usually monomicrobial. *S. aureus* remains the most commonly isolated organism in the normal host, but aerobic gram-negative rods are found in 30 percent of cases. *Pseudomonas aeruginosa*, *Serratia marcescens*, and *Mycobacterium tuberculosis* are more common pathogens in intravenous drug users (IVDUs) [18] .

A number of unusual pathogens have also been reported, especially in vertebral osteomyelitis, including *Candida* species [19-21] , *Bartonella henselae* from cat scratch disease [22] , *Coccidioides immitis* [23,24] , and *Propionibacterium acnes* [25] .

CLINICAL FEATURES — Local symptoms referable to bones are frequently absent, soft tissue findings may be more prominent than signs of bony involvement. (See "[Clinical features of hematogenous osteomyelitis in children](#)").

Adults with vertebral osteomyelitis usually present with vague symptoms and signs consisting of dull, constant back pain and spasm of the paravertebral muscles. (See "[Vertebral osteomyelitis](#)" and see "[Epidural abscess](#)").

Among adults with hematogenous long bone osteomyelitis, the clinical signs resulting from soft tissue extension and piriformis muscle and hip involvement often dominate at presentation and can lead to inappropriate diagnostic and therapeutic measures unless the clinical suspicion of an osseous etiology is entertained. Multifocal involvement is most common in IVDUs or in patients with *S. aureus* bacteremia.

Brodie's abscess — Brodie's abscess is a type of subacute osteomyelitis most commonly involving the distal tibia in patients younger than 25 years of age [26] . It is usually of hematogenous origin but can also occur in the setting of trauma.

Patients typically present with the insidious onset of mild to moderate pain, with or without periosteal elevation or fever. If the subacute process progresses to chronic localized bone abscess, patients present with longstanding dull pain in the absence of fever. Manifestations may mimic other conditions (including tumor) given the absence of acute symptoms [27] . Radiography typically demonstrates a single lesion near the metaphysis.

Management should include surgical debridement with antibiotic therapy tailored to culture findings. The most common pathogen is *S. aureus*, although other gram-positive and gram-negative organisms may be seen, and cultures may be sterile in up to one-half of cases.

Sickle cell disease — The clinical presentation of osteomyelitis is often similar to a vasoocclusive crisis (VOC) and the exact diagnosis is often difficult to make. In general, infectious episodes are more likely to be associated with temperature >102°F (38.9°C), long-lasting pain, and decreased range of motion in the case of joint involvement. On the other hand, local warmth, tenderness, and swelling are common in both VOC and osteomyelitis.

DIAGNOSIS — The diagnosis of hematogenous osteomyelitis relies importantly on clinical suspicion. The routine laboratory tests are usually nonspecific as illustrated in a review of 44 children with acute hematogenous osteomyelitis in whom serial tests were obtained during therapy [28] . (See "[Evaluation and diagnosis of hematogenous osteomyelitis in children](#)").

- The white blood cell count was elevated in only 35 percent.
- The erythrocyte sedimentation rate (ESR) was initially elevated (≥ 20 mm/h) in 92 percent of patients (mean 45 mm/h). Peak values (mean 58 mm/h) were seen on days three to five, with a subsequent slow decline to normal by approximately three weeks.
- The serum C-reactive protein (CRP) concentration was elevated in 98 percent on admission. The peak value was seen on day two with a rapid decline to normal at a mean of seven days.

Blood cultures are positive in 41 to 67 percent of children [29] . A CT-guided aspirate or, less commonly, an open biopsy of the involved bone is often necessary when blood cultures are negative (See "[Vertebral osteomyelitis](#)" section on Role of needle biopsy).

The earliest radiographic changes are swelling of the soft tissue, periosteal thickening and/or elevation, and focal osteopenia. Destructive changes in bone lag at least two weeks behind the infection. At least 50 to 75 percent of the bone matrix must be destroyed before radiographs show lytic changes [30] . Subperiosteal collections, myositis, and/or pyomyositis contiguous to an osteomyelitis are most readily detected by MRI. Thus, specialized imaging studies (magnetic resonance imaging or, less often, radionuclide imaging) may be necessary to make the diagnosis and to guide surgical treatment. (See "[Approach to radiographic imaging in the setting of suspected osteomyelitis](#)" and see "[Vertebral osteomyelitis](#)").

A bone biopsy or subperiosteal abscess aspirate for culture is necessary unless the patient has positive blood cultures along with radiographic findings consistent with osteomyelitis. (See "[Overview of osteomyelitis in adults](#)" and see "[Approach to radiographic imaging in the setting of suspected osteomyelitis](#)").

Sickle cell disease — The optimal diagnostic approach in patients with SCD remains unclear. Plain films, MRI, and bone scintigraphy all show positive results in VOC and osteomyelitis, and have been used with variable success [4,22-25] . Even a biopsy may not definitively rule out a vasoocclusive crisis, especially if no infectious agent is found [29] . Both VOC and bony infections will show an infiltrate of neutrophils and macrophages, as well as necrotic tissue.

Despite these difficulties, it is important to try to make a diagnosis of osteomyelitis, especially if the patient is febrile, appears ill, or complains of severe localized pain despite aggressive pain management.

TREATMENT

Antibiotics

General principles — After cultures are obtained, empiric antibiotics should be selected to

cover the most probable pathogens including *S. aureus* (most common) and a variety of aerobic and anaerobic cocci and bacilli [1,31,32]. The initial regimen can be amended once culture and susceptibility results are known.

Recommended empiric regimens include:

- [Nafcillin/oxacillin](#) (2 g every four hours) or
- [Cefazolin](#) (2 gm every eight hours) or
- [Vancomycin](#) (30 mg/kg per 24 hours in two equally divided doses, not to exceed 2 g per 24 hours unless concentrations in serum are inappropriately low)

Once the etiologic organism is identified, the antibiotic regimen should be modified, if needed, based upon susceptibility patterns [33].

Hematogenous osteomyelitis in adults is often refractory to therapy. Patients have traditionally been treated for four weeks with appropriate parenteral antimicrobial therapy, dating from the initiation of therapy or after the last major debridement surgery. This remains our recommendation for vertebral osteomyelitis and for many with hematogenous (nonvertebral) osteomyelitis. However, for select patients with hematogenous (nonvertebral) osteomyelitis we treat with at least two weeks of parenteral antibiotics followed, if the patient is improving, by two to four weeks of oral antibiotic therapy.

Special populations — The most common bacterial isolate in patients with sickle cell anemia is *Salmonella*, but other gram-negative bacilli should also be covered. The recommended empiric regimen is [ciprofloxacin](#) (750 mg orally or 400 mg intravenously every 12 hours) or other fluoroquinolone.

The common bacterial isolates in intravenous drug users can vary; empiric treatment should cover both *S. aureus* and gram-negative bacilli. The recommended empiric regimen is a fluoroquinolone ([ciprofloxacin](#) 750 mg orally or 400 mg intravenously every 12 hours) plus either [nafcillin/oxacillin](#) (2 g every four hours) or [vancomycin](#) (30 mg/kg per 24 hours in two equally divided doses, not to exceed 2 g per 24 hours unless concentrations in serum are inappropriately low)

Surgery — Once the diagnosis of long bone osteomyelitis is made, usually by isolating the pathogen(s) from the bone lesion, blood, or joint cultures [31], surgical intervention is frequently necessary in both adults and children. In hematogenous osteomyelitis, the nidus of infection is usually within the medullary canal of the bone. Because of the location, surgical treatment is typically more straightforward than in other forms of osteomyelitis.

Surgical intervention is indicated if:

- The patient has not responded to specific antimicrobial therapy
- There is evidence of a persistent soft tissue abscess or subperiosteal collection
- Concomitant joint infection is suspected or diagnosed

In adults with hematogenous osteomyelitis, a thorough intramedullary reaming and unroofing is usually performed with or without bone grafting. Debridement of necrotic bone is often necessary in patients with sternoclavicular and pubic osteomyelitis [34]. Soft tissues are reapproximated and the limb is protected by external means (brace or cast) until the structural integrity of the bone is reestablished by normal remodeling.

PROGNOSIS — Adults with vertebral osteomyelitis, the major form of hematogenous osteomyelitis in this age group, have a mortality rate in the antibiotic era of less than 5 percent, and a rate of residual neurologic deficits among survivors of less than 7 percent (See "[Vertebral osteomyelitis](#)").

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REFERENCES

1. [Lew, DP, Waldvogel, FA. Osteomyelitis. Lancet 2004; 364:369.](#)
2. [Mader, JT, Shirtliff, M, Calhoun, JH. The host and the skeletal infection: classification and pathogenesis of acute bacterial bone and joint sepsis. Baillieres Best Pract Res Clin Rheumatol 1999; 13:1.](#)
3. [Espersen, F, Frimodt-Moller, N, Thandrup Rosdahl, V, et al. Changing pattern of bone and joint infections due to Staphylococcus aureus: Study of cases of bacteremia in Denmark: 1959-1988. Rev Infect Dis 1991; 13:347.](#)
4. [Chandrasekar, PH, Narula, AP. Bone and joint infections in intravenous drug abusers. Rev Infect Dis 1986; 8:904.](#)
5. [Fernandez, M, Carrol, CL, Baker, C. Discitis and vertebral osteomyelitis in children: an 18-year review. Pediatrics 2000; 105:1299.](#)
6. [Gordon, RJ, Lowy, FD. Bacterial infections in drug users. N Engl J Med 2005; 353:1945.](#)
7. [Waldvogel, FA, Medoff, G, Swartz, MN. Osteomyelitis: A review of clinical features, therapeutic considerations, and unusual aspect. N Engl J Med 1970; 282:198.](#)
8. [Ham, KN, Hurley, JV, Ryan, GB, Storey, E. Localization of particulate carbon in metaphyseal vessels of growing rats. Aust J Exp Biol Med Sci 1965; 43:625.](#)
9. [Anderson, CE, Parker, J. Invasion and resorption in enchondral ossification. An electron microscopic study. J Bone Joint Surg Am 1966; 48:899.](#)
10. [Emslie, KR, Nade, S. Pathogenesis and treatment of acute hematogenous osteomyelitis: evaluation of current views with reference to an animal model. Rev Infect Dis 1986; 8:841.](#)
11. [Hobo, T. Zur pathogenese de akuten haematatogenen Osteomyelitis, mit Beruckishtigung der Vitalfarbungslehre. Acta Sch Med Univ Imp Kioto 1922; 4:1.](#)
12. [Patti, JM, Allen, BL, McGavin, MJ, Hook, M. MSCRAMM-mediated adherence of microorganisms to host tissues. Annu Rev Microbiol 1994; 48:585.](#)
13. [Elasri, MO, Thomas, JR, Skinner, RA, et al. Staphylococcus aureus collagen adhesin contributes to the pathogenesis of osteomyelitis. Bone 2002; 30:275.](#)
14. [Martinez-Aguilar, G, Avalos-Mishaan, A, Hulten, K, et al. Community-acquired, methicillin-resistant and methicillin-susceptible Staphylococcus aureus musculoskeletal infections in children. Pediatr Infect Dis J 2004; 23:701.](#)
15. [Mader, JT, Ortiz, M, Calhoun, JH. Update on the diagnosis and management of osteomyelitis. Clin Podiatr Med Surg 1996; 13:701.](#)
16. [Waldvogel, FA, Medoff, G, Swartz, MN. Osteomyelitis: a review of clinical features, therapeutic considerations and unusual aspects \(second of three parts\). N Engl J Med](#)

- 1970; 282:260.
17. Waldvogel, FA, Medoff, G, Swartz, MN. Osteomyelitis: a review of clinical features, therapeutic considerations and unusual aspects. 3. Osteomyelitis associated with vascular insufficiency. *N Engl J Med* 1970; 282:316.
 18. Holzman, RS, Bishko, F. Osteomyelitis in heroin addicts. *Ann Intern Med* 1971; 75:693.
 19. [Garbino, J, Schnyder, I, Lew, D, et al. An unusual cause of vertebral osteomyelitis: Candida species. *Scand J Infect Dis* 2003; 35:288.](#)
 20. [Miller, DJ, Mejicano, GC. Vertebral osteomyelitis due to Candida species: case report and literature review. *Clin Infect Dis* 2001; 33:523.](#)
 21. [Hendrickx, L, Van Wijngaerden, E, Samson, I, Peetermans, WE. Candidal vertebral osteomyelitis: report of 6 patients, and a review. *Clin Infect Dis* 2001; 32:527.](#)
 22. [Rolain, JM, Chanut, V, Laurichesse, H, et al. Cat scratch disease with lymphadenitis, vertebral osteomyelitis, and spleen abscesses. *Ann N Y Acad Sci* 2003; 990:397.](#)
 23. [Caraway, NP, Fanning, CV, Stewart, JM, et al. Coccidioidomycosis osteomyelitis masquerading as a bone tumor. A report of 2 cases. *Acta Cytol* 2003; 47:777.](#)
 24. [Holley, K, Muldoon, M, Tasker, S. Coccidioides immitis osteomyelitis: a case series review. *Orthopedics* 2002; 25:827.](#)
 25. [Do, TT, Strub, WM, Witte, D. Subacute Propionibacterium acnes osteomyelitis of the spine in an adolescent. *J Pediatr Orthop B* 2003; 12:284.](#)
 26. [Miller, WB Jr, Murphy, WA, Gilula, LA. Brodie abscess: reappraisal. *Radiology* 1979; 132:15.](#)
 27. [Gould, CF, Ly, JQ, Lattin, GE Jr, et al. Bone tumor mimics: avoiding misdiagnosis. *Curr Probl Diagn Radiol* 2007; 36:124.](#)
 28. [Unkila-Kallio, L, Kallio MJT, Eskola, J, et al. Serum CRP, erythrocyte sedimentation rate and WBC in acute hematogenous osteomyelitis of children. *Pediatrics* 1994; 93:59.](#)
 29. [Ibia, EO, Imoisili, M, Pikis, A. Group A beta-hemolytic streptococcal osteomyelitis in children. *Pediatrics* 2003; 112:e22.](#)
 30. Butt, WP. The radiology of infection. *Clin Orthop* 1973; 96:20.
 31. Berbari, EF, Steckelberg, JM, Osmon, DR. Osteomyelitis. In: Principles and Practice of Infectious Diseases, 6th ed. Mandell, GL, Bennett, JE, Dolin, R, (Eds), Churchill Livingstone, Philadelphia, PA 2005, p. 1322.
 32. Cierny, G, Mader, JT. Adult chronic osteomyelitis. *Orthopedics* 1984; 7:1557.
 33. Ericsson, HM, Sherris, JC. Antibiotic sensitivity testing: Report of an international collaborative study. *Acta Pathol Microbiol Scand* 1971; 227(Suppl B):1.
 34. [Sexton, DJ, Heskestad, L, Lambeth, WR, et al. Postoperative public osteomyelitis misdiagnosed as osteitis pubis: report of four cases and review. *Clin Infect Dis* 1993; 17:695.](#)