open biopsy depends on the experience of personnel at the specific center. Bone samples should be cultured for aerobic, anaerobic, and fungal agents, with a portion of the sample sent for histopathologic study. In cases with a subacute/chronic presentation, a suggestive history, or a granuloma detected during histopathologic analysis, mycobacteria and brucellae also should be sought. When blood and tissue cultures are negative despite suggestive histopathology, broad-range polymerase chain reaction analysis of biopsy specimens or aspirated pus should be considered. This technique allows detection of unusual pathogens such as *Tropheryma whipplei*.

Given that signs and symptoms of osteomyelitis are nonspecific, the clinical differential diagnosis of febrile back pain is broad, including pyelonephritis, pancreatitis, and viral syndromes. In addition, multiple noninfectious pathologies of the vertebral column, such as osteoporotic fracture, seronegative spondylitis (ankylosing spondylitis, psoriasis, reactive arthritis, enteropathic arthritis), and spinal stenosis must be considered.

Imaging procedures are the most important tools not only for the diagnosis of vertebral osteomyelitis but also for the detection of pyogenic complications and alternative conditions (e.g., bone metastases or osteoporotic fractures). Plain radiography is a reasonable first step in evaluating patients without neurologic symptoms and may reveal an alternative diagnosis. Because of its low sensitivity, plain radiography generally is not helpful in acute osteomyelitis, but it can be useful in subacute or chronic cases. The gold standard is MRI, which should be performed expeditiously in patients with neurologic impairment in order to rule out a herniated disk or to detect pyogenic complications in a timely manner. Even if the pathologic findings on MRI suggest vertebral osteomyelitis, alternative diagnoses should be considered, especially when blood cultures are negative. The most common alternative diagnosis is erosive osteochondrosis. Septic bone necrosis, gouty spondylodiskitis, and erosive diskovertebral lesions (Andersson lesions) in ankylosing spondylitis may likewise mimic vertebral osteomyelitis. CT is less sensitive than MRI but may be helpful in guiding a percutaneous biopsy. In the future, positron-emission tomography (PET) with ^{18}F-fluorodeoxyglucose, which has a high degree of diagnostic accuracy, may be an alternative imaging procedure when MRI is contraindicated. ^{18}F-fluorodeoxyglucose PET should be considered for patients with implants and patients in whom several foci are suspected.

TREATMENT VERTEBRAL OSTEOMYELITIS

The aims of therapy for vertebral osteomyelitis are (1) elimination of the pathogen(s), (2) protection from further bone loss, (3) relief of back pain, (4) prevention of complications, and (5) stabilization, if needed.

ANTIMICROBIAL THERAPY

Table 158-1 summarizes suggested antimicrobial regimens for infections attributable to the most common etiologic agents. For optimal antimicrobial therapy, identification of the infecting agent is required. Therefore, in patients without sepsis syndrome, antibiotics should not be administered until the pathogen is identified in a blood culture, a bone biopsy, or an aspirated pus collection. Traditionally, bone infections are at least initially treated by the IV route. Unfortunately, relevant controlled trials are lacking, and the preference for the IV route is not evidence based. There are no good arguments for the assumption that IV therapy is superior to oral administration if the following requirements are met: (1) optimal antibiotic spectrum, (2) excellent bioavailability of the oral drug, (3) clinical studies confirming efficacy of the oral drug, (4) normal intestinal function, and (5) no vomiting. However, a short initial course of parenteral therapy with a β-lactam antibiotic may lower the risk of emergence of fluoroquinolone resistance, especially if *P. aeruginosa* infection is treated with ciprofloxacin or staphylococcal infection with the combination of a fluoroquinolone plus rifampin. These suggestions are based on observational studies and expert opinion. There are no data from controlled trials on the optimal duration of therapy. Most experts suggest 6 weeks for patients who have acute osteomyelitis without an implant. According to an observational study, prolonging antibiotic therapy beyond 6 weeks does not improve the rate of recovery or lower the risk of recurrence. However, prolonged antibiotic therapy is recommended for patients with abscesses that have not been drained and patients with spinal implants. Treatment efficacy should be regularly monitored through inquiries about signs and symptoms (fever, pain) and assessment for signs of inflammation (elevated CRP concentrations). Follow-up MRI is appropriate only for patients with pyogenic complications, since the correlation between clinical healing and improvement on MRI is very poor.

Surgical treatment generally is not needed in acute hematogenous vertebral osteomyelitis. However, it is always necessary in implant-associated spinal infection. Early infections (those occurring up to 30 days after internal stabilization) can be cured with debridement, implant retention, and a 3-month course of antibiotics **(Table 158-2)**. In contrast, in late infection with a duration of >30 days, implant removal and a 6-week-course of antibiotics (Table 158-1)

TABLE 158-1 ANTIBIOTIC THERAPY FOR OSTEOMYELITIS IN ADULTS WITHOUT IMPLANTS[a]

Microorganism	Antimicrobial Agent (Dose,[b] Route)
Staphylococcus spp.	
Methicillin-susceptible	Nafcillin *or* oxacillin[c] (2 g IV q6h)
	followed by
	Rifampin (300–450 mg PO q12h) *plus* levofloxacin (750 mg PO q24h or 500 mg PO q12h)
Methicillin-resistant	Vancomycin[d] (15 mg/kg IV q12h) *or* daptomycin (>6–8 mg/kg IV q24h)
	followed by
	Rifampin (300–450 mg PO q12h)
	plus
	Levofloxacin (750 mg PO q24h or 500 mg PO q12h) *or* TMP-SMX[e] (1 double-strength tablet PO q8h) *or* fusidic acid (500 mg PO q8h)
Streptococcus spp.	Penicillin G[c] (5 million units IV q6h) *or* ceftriaxone (2 g IV q24h)
Enterobacteriaceae	
Quinolone-susceptible	Ciprofloxacin (750 mg PO q24h)
Quinolone-resistant[f]	Imipenem (500 mg IV q6h)
Pseudomonas aeruginosa	Cefepime *or* ceftazidime (2 g IV q8h) *plus* an aminoglycoside[g]
	or
	Piperacillin-tazobactam (4.5 g IV q8h) *plus* an aminoglycoside[g] for 2–4 weeks
	followed by
	Ciprofloxacin[h] (750 mg PO q12h)
Anaerobes	Clindamycin (600 mg IV q6–8h) for 2–4 weeks
	followed by
	Clindamycin[i] (300 mg PO q6h)

[a]Unless otherwise indicated, the total duration of antimicrobial treatment is generally 6 weeks. [b]All dosages are for adults with normal renal function. [c]When the patient has delayed-type penicillin hypersensitivity, cefuroxime (1.5 g IV q6–8h) can be administered. When the patient has immediate-type penicillin hypersensitivity, the penicillin should be replaced by vancomycin (1 g IV q12h). [d]Target vancomycin trough level: 15–20 μg/mL. [e]Trimethoprim-sulfamethoxazole. A double-strength tablet contains 160 mg of trimethoprim and 800 mg of sulfamethoxazole. [f]Including isolates producing extended-spectrum β-lactamase. [g]The need for addition of an aminoglycoside has not yet been proven. However, this addition may decrease the risk of emergence of resistance to the β-lactam. [h]The rationale for starting ciprofloxacin treatment only after pretreatment with a β-lactam is the increased risk of emergence of quinolone resistance in the presence of a heavy bacterial load. [i]Alternatively, penicillin G (5 million units IV q6h) or ceftriaxone (2 g IV q24h) can be used against gram-positive anaerobes (e.g., *Propionibacterium acnes*), and metronidazole (500 mg IV/PO q8h) can be used against gram-negative anaerobes (e.g., *Bacteroides* spp.).

Source: From W Zimmerli: N Engl J Med 362:1022, 2010. © Massachusetts Medical Society. Reprinted with permission.