these joint infections develop later after joint replacement and are the result of hematogenous spread or direct inoculation. The presentation may be acute, with fever, pain, and local signs of inflammation, especially in infections due to *S. aureus*, pyogenic streptococci, and enteric bacilli. Alternatively, infection may persist for months or years without causing constitutional symptoms when less virulent organisms, such as coagulase-negative staphylococci or diphtheroids, are involved. Such indolent infections usually are acquired during joint implantation and are discovered during evaluation of chronic unexplained pain or after a radiograph shows loosening of the prosthesis; the erythrocyte sedimentation rate and C-reactive protein level are usually elevated in such cases.

The diagnosis is best made by needle aspiration of the joint; accidental introduction of organisms during aspiration must be avoided meticulously. Synovial fluid pleocytosis with a predominance of polymorphonuclear leukocytes is highly suggestive of infection, since other inflammatory processes uncommonly affect prosthetic joints. Culture and Gram's stain usually yield the responsible pathogen. Sonication of explanted prosthetic material can improve the yield of culture, presumably by breaking up bacterial biofilms on the surfaces of prostheses. Use of special media for unusual pathogens such as fungi, atypical mycobacteria, and *Mycoplasma* may be necessary if routine and anaerobic cultures are negative.

TREATMENT PROSTHETIC JOINT INFECTIONS

Treatment includes surgery and high doses of parenteral antibiotics, which are given for 4–6 weeks because bone is usually involved. In most cases, the prosthesis must be replaced to cure the infection. Implantation of a new prosthesis is best delayed for several weeks or months because relapses of infection occur most commonly within this time frame. In some cases, reimplantation is not possible, and the patient must manage without a joint, with a fused joint, or even with amputation. Cure of infection without removal of the prosthesis is occasionally possible in cases that are due to streptococci or pneumococci and that lack radiologic evidence of loosening of the prosthesis. In these cases, antibiotic therapy must be initiated within several days of the onset of infection, and the joint should be drained vigorously by open arthrotomy or arthroscopically. In selected patients who prefer to avoid the high morbidity rate associated with joint removal and reimplantation, suppression of the infection with antibiotics may be a reasonable goal. A high cure rate with retention of the prosthesis has been reported when the combination of oral rifampin and ciprofloxacin is given for 3–6 months to persons with staphylococcal prosthetic joint infection of short duration. This approach, which is based on the ability of rifampin to kill organisms adherent to foreign material and in the stationary growth phase, requires confirmation in prospective trials.

PREVENTION

To avoid the disastrous consequences of infection, candidates for joint replacement should be selected with care. Rates of infection are particularly high among patients with rheumatoid arthritis, persons who have undergone previous surgery on the joint, and persons with medical conditions requiring immunosuppressive therapy. Perioperative antibiotic prophylaxis, usually with cefazolin, and measures to decrease intraoperative contamination, such as laminar flow, have lowered the rates of perioperative infection to <1% in many centers. After implantation, measures should be taken to prevent or rapidly treat extra-articular infections that might give rise to hematogenous spread to the prosthesis. The effectiveness of prophylactic antibiotics for the prevention of hematogenous infection after dental procedures has not been demonstrated; in fact, viridans streptococci and other components of the oral flora are extremely unusual causes of prosthetic joint infection. Accordingly, the American Dental Association and the American Academy of Orthopaedic Surgeons do not recommend antibiotic prophylaxis for most dental patients with total joint replacements and have stated that there is no convincing evidence to support its use. Similarly, guidelines issued by the American Urological Association and the American Academy of Orthopaedic Surgeons do not recommend the use of prophylactic antibiotics for most patients with prosthetic joints who are undergoing urologic procedures but state that prophylaxis should be considered in certain situations—e.g., for patients (especially immunocompromised patients) who are undergoing a procedure posing a relatively high risk of bacteremia (such as lithotripsy or surgery involving bowel segments).

158 Osteomyelitis
Werner Zimmerli

Osteomyelitis, an infection of bone, can be caused by various microorganisms that arrive at bone through different routes. Spontaneous hematogenous osteomyelitis may occur in otherwise healthy individuals, whereas local microbial spread mainly affects either individuals who have underlying disease (e.g., vascular insufficiency) or patients who have compromised skin or other tissue barriers, with consequent exposure of bone. The latter situation typically follows surgery involving bone, such as sternotomy or orthopedic repair.

The manifestations of osteomyelitis are different in children and adults. In children circulating microorganisms seed mainly long bones, whereas in adults the vertebral column is the most commonly affected site.

Management of osteomyelitis differs greatly depending on whether an implant is involved. The most important aim of the management of either type of osteomyelitis is to prevent progression to chronic osteomyelitis by rapid diagnosis and prompt treatment. Device-related bone and joint infection necessitates a multidisciplinary approach requiring antibiotic therapy and, in many cases, surgical removal of the device. The optimal duration of antibiotic treatment has not been established for any type of osteomyelitis in clinical trials. Therefore, the recommendations for therapy in this chapter reflect only expert opinions.

CLASSIFICATION

There is no generally accepted, comprehensive system for classification of osteomyelitis, primarily because of the multifaceted presentation of this infection. Different specialists are confronted with different facets of bone disease. Most often, however, general practitioners or internists are the first to encounter patients with the initial signs and symptoms of osteomyelitis. These primary care physicians should be able to recognize this disease in any of its forms. Osteomyelitis cases can be classified by various criteria, including pathogenesis, duration of infection, location of infection, and presence or absence of foreign material. The widely used Cierny-Mader staging system classifies osteomyelitis according to anatomic site, comorbidity, and radiographic findings, with stratification of long-bone osteomyelitis to optimize surgical management; this system encompasses both systemic and local factors affecting immune status, metabolism, and local vascularity.

Any of three mechanisms can underlie osteomyelitis: (1) hematogenous spread; (2) spread from a contiguous site following surgery; and (3) secondary infection in the setting of vascular insufficiency or concomitant neuropathy. Hematogenous osteomyelitis in adults typically involves the vertebral column. In only about half of patients can a primary focus be detected. The most common primary foci of infection are the urinary tract, skin/soft tissue, intravascular catheterization