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## Review article

# Recommendations for the treatment of osteomyelitis



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### ABSTRACT

With the advances in surgical treatment, antibiotic therapy and the current resources for accurate diagnosis and differentiated approaches to each type of osteomyelitis, better results are being obtained in the treatment of this disease. After a careful literature review carried out by a multiprofessional team, some conclusions were made in order to guide medical approach to different types of osteomyelitis, aiming to obtain better clinical outcomes and reducing the social costs of this disease. Acute and chronic osteomyelitis are discussed, with presentation of the general epidemiological concepts and the commonly used classification systems. The main guidelines for the clinical, laboratory and imaging diagnosis of infections are discussed, as well as the guidelines for surgical and antimicrobial treatments, and the role of hyperbaric oxygen as adjuvant therapy.

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## Background

With the advances in surgical treatment, antibiotic therapy, and the current resources for accurate diagnosis and differentiated approaches to each type of osteomyelitis, better results are being obtained in the treatment of this disease. On the other hand, as a result of high-energy trauma with extensive damage to soft tissues requiring more aggressive treatments

for open and closed fractures, we have seen a higher number of infections arising from surgical procedures related to these traumatic lesions, which often take the form of post-traumatic osteomyelitis and serious soft-tissue infections. In this scenario, with the progressive increase in traumatic injuries and their associated complications, osteomyelitis – particularly post-traumatic osteomyelitis – is a significant public health problem. The objective of this review article is to indicate some recommendations based on scientific evidence that will guide

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◇ The members of the Diretrizes Panamericanas para el Tratamiento de las Osteomielitis e Infecciones de Tejidos Blandos Group are listed in [Appendix A](#).

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**Table 1 – Waldvogel classification of osteomyelitis.**

Characteristics	
<i>Mechanism of bone infection</i>	
Hematogenous	Secondary to bacterial transport through the blood. Majority of infections in children
Contiguous	Bacterial inoculation from an adjacent focus. E.g.: Post-traumatic Osteomyelitis, infections related to prosthetic devices
Associated with vascular insufficiency	Infections affecting the feet in patients with diabetes, hanseniasis or peripheral vascular insufficiency
<i>Duration of infection</i>	
Acute	Initial episodes of osteomyelitis. Edema, formation of pus, vascular congestion, thrombosis of the small vessels
Chronic	Recurrence of acute cases. Large areas of ischemia, necrosis and bone sequestra

Adapted from Ref. 2.

the medical approach to different types of osteomyelitis, aiming to obtain better clinical outcomes and at reducing the social costs of this disease. Acute and chronic osteomyelitis are discussed, with presentation of the general epidemiological concepts and the commonly used classification systems. The main guidelines for clinical, laboratory and imaging diagnosis of infections are discussed, as well as the guidelines for surgical and antimicrobial treatments, and the role of hyperbaric oxygen as adjuvant therapy.<sup>1</sup> The conclusions of this multidisciplinary review are summarized below.

#### I. Which classification should be used?

1. An ideal classification of osteomyelitis should consider the different aspects that influence its pathophysiology, addressing all the possible etiologies and parameters of temporal evolution. It should also be closely correlated with the histological data and should include proposals for the treatment of each classification stage. In general, the Waldvogel classification<sup>2</sup> is recommended for its greater clinical applicability, and the Cierny and Mader classification<sup>3</sup> for its clearly defined surgical treatment proposals (Tables 1 and 2).

#### II. Which subsidiary tests are important for the diagnosis of osteomyelitis?

2. The diagnosis of osteomyelitis considers a range of clinical signs and symptoms, laboratory tests, imaging studies and histological analyses, as well as the identification of pathogens by means of bone tissue or blood cultures.
3. In terms of laboratory tests, serum leukocyte count and inflammatory markers, such as erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), can assist in the initial diagnosis of osteomyelitis. However, these are non-specific tests and are more useful in the control of treatment.
4. The histology of biological samples should be carried out in all suspect cases, and bone biopsy, soft tissue, and bone sequestra can confirm the diagnosis of osteomyelitis.

**Table 2 – Cierny and Mader classification of osteomyelitis.**

Characteristics	
<i>Anatomical stage</i>	
1 – Medullary	Infection restricted to the bone marrow
2 – Superficial	Infection restricted to cortical bone
3 – Localized	Infection with clearly defined edges and bone stability preserved
4 – Diffuse	Infection spread to the entire bone circumference, with instability before or after debridement
<i>Classification of the host</i>	
A – Host healthy	Patient without comorbidities
B1 – Local compromise	Smoking, chronic lymphedema, venous stasis, arthritis, large scars, fibrosis by radiotherapy
Bs – Systemic compromise	Diabetes mellitus, malnutrition, renal or hepatic failure, chronic hypoxia, neoplasms, extremes of age
C – Poor clinical conditions	Surgical treatment will have higher risk than the osteomyelitis itself

Adapted from Ref. 3.

5. A definitive diagnosis of osteomyelitis is obtained with microbiological identification of the pathogen in bone, through a bone biopsy. Samples obtained through swabs of the fistula or secretions for use in cultures will result in false positive results, as they identify microorganisms that colonize the skin. At least three different samples of bone tissue should be obtained, in order to increase the positivity of the test. Antimicrobial therapy should be started after collecting culture samples or at the same time as anesthetic induction. Patients should stop any antibiotics two weeks before collecting culture samples, if possible. In cases of osteomyelitis with osteosynthesis or in infected arthroplasties, sonication of the implants significantly increases the identification of pathogens.
6. The use of complementary imaging methods can be important in the early diagnosis of osteomyelitis. It can also assist in rapid start of treatment and follow-up, enabling ineffective treatments to be modified. In acute osteomyelitis, a plain radiography shows osteomyelitis only after two weeks. Magnetic resonance imaging (RMI) is considered the main type of imaging in the evaluation of bone infections, as it can detect osteomyelitis as early as three to five days of infection. Computed tomography (CT) is of little use in the diagnosis of acute infection, but is important for investigating bone sequestra and planning surgery. Three-phase bone scintigraphy, scintigraphy with Gallium-67 and the positron emission tomography (PET-CT) are examinations that help in the differentiation of doubtful cases.

#### III. What are the recommendations for the treatment of osteomyelitis?

7. The success of osteomyelitis treatment, particularly in cases related to implants, is closely linked to extensive surgical debridement and adequate antibiotic therapy.

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