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REVIEW

A comprehensive review of the diagnosis and management of prosthetic joint infections in the absence of positive cultures

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Summary The diagnosis and management of prosthetic joint infections (PJI) with negative cultures remains an enigma without clear definitions and guidelines for its management. In contrast, the literature offers guidelines to the diagnosis and management of culture positive prosthetic joint infections as noted in both the infectious disease literature and the orthopedic literature.

This paper outlines the current state of knowledge of PJI with negative cultures and summarizes the recommendations for the work up and management of this condition. In addition, we propose a simple algorithm that clinicians may find useful for the management of PJI with negative cultures. This algorithm has not been validated with data at this point, but can be applied to practice to help direct the management and diagnosis of prosthetic joint infections in the absence of positive cultures.

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Introduction

Prosthetic joint infections pose an increased problem for physicians due to the lack of standardized guidelines. The risk of an implant infection is high in the first 2 years, but remains a lifelong risk and is related to the presence of a biofilm [1,2]. The current guidelines attempt to address prosthetic joint infections (PJI) caused by the most common bacteria as seen in Table 1.1 [1,3—16], but fail to address PJI with negative cultures. In addition, the type of prosthetic joint infection is also an additive factor. In the early post-operative infections, antibiotics play an important role in detection of the organism, while in the later chronic infections, other factors such as fastidious organisms, patchy distribution of infection, low inoculum of infection, and the presence of non-recoverable biofilm embedded bacteria also play a role in making the diagnosis difficult [5,9,17]. This paper aims to address the risk factors, pathogenesis and diagnostic approach for this group of patients. We have also included a proposal for an algorithm for the approach and management of these patients.

Table 1.1 Microbiology of culture-positive PJI [1,3—16].

Gram-positive	>50%
• *Staphylococcus aureus*	• 24—43%
• Coagulase-negative staphylococcus	• 12—26%
Gram-negative	3—10%
• *Enterobacter* spp.	• 78%
• *Pseudomonas* spp.	• 20%
• *Escherichia coli*	
• *Klebsiella* spp.	
• *Proteus* spp.	
Anaerobes	2—4%
Mycobacterium	0.7%
Fungi	1.2%
Polymicrobial	10%

Epidemiology

In 2014, over one million total prosthetic surgeries were performed worldwide with an incidence of prosthetic joint infections ranging from 1 to 4% after primary knee replacement and 1 to 2% after primary hip replacement [18,19]. Approximately 15—20% of all prostheses are found to be infected after primary revision surgeries [4,5].

Organism isolated from culture-positive specimens is shown in Table 1.1 [1,3—16], Gram-positive bacteria account for over 50% of all prosthetic joint infections. *Staphylococcus aureus* and coagulase-*negative staphylococci* are the two most common organisms with incidence rates of 24—43% and 12—26%, respectively [4,5,7]. In addition, it has been found that *Streptococci* occur in 8—10%, *Enterococci* in 3—7%, and *Corynebacterium diphtheria* in 2% of all PJI [5,7,11].

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