In the hip and knee literature, there has been a debate with regards to the duration of antibiotic treatment. Some studies have recommended as many as three to six months of antimicrobial therapy following surgical intervention, depending on the organism [6,8]. However, other studies have shown six weeks of IV antibiotics to be a sufficient duration of treatment [9–11].

The theoretical benefit of a shorter course of antibiotics, aside from patient convenience, includes a reduced risk of adverse drug events (ADEs), including anaphylaxis, nephrotoxicity, hepatotoxicity and infectious colitis, as well as bacterial resistance [12]. The International Consensus on Periprosthetic Joint Infection stated that the duration of antibiotic therapy following removal of implants is inconclusive but recommended a period of antibiotic therapy between two to six weeks [13].

The authors of the Infectious Diseases Society of America (IDSA) Guidelines for the Diagnosis and Management of Prosthetic Joint Infection make the following recommendations for the management of hip and knee arthroplasties while suggesting that similar recommendations can be extended for the management of TAA infections [6]. The IDSA recommends four to six weeks of pathogen-specific IV or highly bioavailable oral antibiotic therapy following removal of implants, regardless of organism or in non-staphylococcal PJI treated with DAIR. They recommend two to six weeks of IV antibiotics in combination with oral rifampin, followed by 3 months of rifampin plus a companion oral antibiotic for a staphylococcal TAA PJI treated with DAIR. If rifampin cannot be used because of an allergy or toxicity concern, the IDSA recommends four to six weeks of IV antibiotic therapy. Of note, the IDSA recommendations are the same in the setting of a one-stage exchange as they are following DAIR [6].

Further studies on the treatment and outcomes of infection in TAA are needed. For now, we must rely on the hip and knee arthroplasty literature as well as the recommendations of the MSIS and IDSA.

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QUESTION 3: Is there a role for suppressive antibiotics in patients with perioperative joint infection (PJI) of total ankle arthroplasty (TAA) who have undergone surgical treatment?

RECOMMENDATION: Culture-directed antibiotic therapy is recommended for patients undergoing surgical treatment of infected TAA. Routine administration of suppressive antibiotics in patients with an ankle prosthesis in place is not warranted; however, in certain clinical circumstances, this may be of benefit.

LEVEL OF EVIDENCE: Consensus

DELEGATE VOTE: Agree: 100%, Disagree: 0%, Abstain: 0% (Unanimous, Strongest Consensus)

RATIONALE

There is scant literature related to the management of infected TAA. The available reports have been reviewed to determine if there is a role for routine administration of suppressive antibiotics after surgical management of infected TAA. The published studies do not address the issues of suppressive antibiotic therapy after infected TAA.

Myerson et al. reported on 19 patients with infected TAA [1]. In early acute infections, patients were treated surgically with irrigation and debridement (I&D) and polyethylene exchange, followed by six weeks of antibiotics. Of the four patients treated with this approach, all had persistent infections and required prosthesis removal. No comment was made regarding suppressive antibiotics after staged revision for infection. Patton et al. reported on a series of 29 TAA infections [2]. Acute infections were treated with polyethylene exchange and I&D. Of 14 acute infections, only three were treated successfully with this approach. Again, no comment was made regarding suppressive antibiotics after staged revision.

There is also little related to this question in the hip and knee literature. A recent study supported by The Knee Society evaluating this issue after surgical management of infected TAA found that

administration of suppressive antibiotics after reimplantation of the knee in patients undergoing two-stage exchange arthroplasty resulted in lowering the rate of subsequent failure [3]. The authors of the study stated that the findings were preliminary and further long-term data on the cohort was needed.

There are many potential issues related to administration of routine suppressive antibiotic therapy after surgical management of infected prosthetic joints. Cost, the potential for emergence of antimicrobial resistance, systemic adverse effects and so on are some of these potential issues. Therefore, and in the absence of concrete data, we believe that routine administration of suppressive antibiotic therapy for patients with a prosthetic ankle joint in place is not warranted. We realize that patients with infected TAA need to be treated on an individual basis and administration of oral antibiotics to some patients, such as those with extensive comorbidities, those infected with resistant organisms and those with complex infections may be justified in some circumstances.

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QUESTION 4: What determines the type and dose of antibiotic that is needed to be added to the cement spacer in patients with infected total ankle arthroplasty (TAA)?

RECOMMENDATION: We recommend tailoring the antibiotic in cement spacers to the infecting organism if it has been identified, as is typically done in total knee and hip arthroplasty. Otherwise, broad-spectrum antibiotics may be utilized. Medical comorbidities should always be considered, especially with regard to renal function and allergy profile. A thermostable antibiotic should be added to cement.

LEVEL OF EVIDENCE: Consensus

DELEGATE VOTE: Agree: 100%, Disagree: 0%, Abstain: 0% (Unanimous, Strongest Consensus)

RATIONALE

TAA is performed much less frequently than total hip and knee arthroplasty, and reports related to deep infections and associated management are limited.

Like hip and knee arthroplasty, management of infected TAA may include removal of prosthesis and insertion of an antibiotic-impregnated cement spacer. An antibiotic spacer, as part of two-stage exchange arthroplasty, has been utilized in the management of infected TAA. Lee et al. described the use of cement mixed with 1 gm gentamicin, 1 gm vancomycin and 1 gm cefazolin in nine patients with infected ankle joints, three of whom were status post TAA [1]. The infecting organisms of the three TAA patients included methicillin-resistant *S. aureus* (MRSA), methicillin-resistant *S. epidermidis* (MRSE) and *Enterococcus*. The authors utilized their technique with the intent of permanent spacer use and a return to weightbearing, as multiple lower extremity operations have been associated with amputation.

Given the fragile soft tissue envelope around the ankle, Ferrao et al. also describe the use of a definitive antibiotic spacer after ankle infection [2]. Six of nine patients were status post-TAA and required explantation due to infection. The authors indicated that culture-specific antibiotics were mixed into cement when possible, although the detailed combination was not listed. If the infecting organisms were not isolated by culture, 2 gm vancomycin and 1.9 gm gentamicin were mixed into the cement. Bacteria were isolated in seven of the nine patients: *Staphylococcus aureus* (n = 3), *Staphylococcus epidermidis* (n = 3) and *Streptococcus viridans* (n = 1). Three patients required additional surgery, including two patients who underwent below-the-knee amputations.

In a large series including 966 patients, 29 patients were identified with infection after primary or revision TAA [3]. Cement spacers were placed in 17 cases, although the antibiotic formulation of the spacers was not indicated. The most common infecting organisms included methicillin-sensitive *S. aureus* (MSSA), coagulase-negative staphylococci and polymicrobial infection (one of which included MRSA).

Fifteen deep infections were identified in another series including 613 primary and revision TAAs at a single institution [4]. An additional four deep TAA infections from outside facilities were also treated during the study period. Antibiotic spacers formulated with 1 gm vancomycin and 1.2 gm tobramycin per cement packet were used for chronic infections requiring explantation. The infecting organisms included coagulase-negative Staphylococcus (n = 6), MSSA (n = 4), MRSA (n = 2), *C. acnes* + coagulase-negative Staphylococcus (n = 1), *E. coli* (n = 1), *S. viridans* (n = 1) and polymicrobial including MRSA (n = 1). Four attempted reimplantations were performed, but all subsequently failed due to infection with coagulase-negative Staphylococcus and MSSA.

Another study documented 26 TAA infections in a cohort of 408 patients at a single institution [5]. The most common infecting organisms included *S. aureus* (n = 8), coagulase-negative Staphylococcus (n = 8), *Enterococcus* (n = 4), polymicrobial (n = 4), *Enterobacter* (n = 3), *Klebsiella* (n = 2), *C. acnes* (n = 2) and MRSA (n = 1).

If the infecting organism is known prior to explantation based on preoperative aspiration, the use of tailored antibiotics incorporated into the cement spacer is recommended [3]. This has been recommended in total hip and knee replacement and can be extrapolated for use in the ankle [6,7]. Antibiotic-laden spacers result in higher antibiotic concentration at the infected site for a longer duration than that achieved with systemic antibiotics alone [8]. Tailoring the antibiotic selection is important to avoid breeding unneces-