Prevention

1.1. PREVENTION: ANTIBIOTICS

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QUESTION 1: What are the optimal perioperative antibiotics for primary shoulder arthroplasty?

RECOMMENDATION: Patients undergoing primary shoulder arthroplasty should receive antibiotics that cover gram-positive and gram-negative organisms specific to the regionally encountered organisms. Peer-reviewed literature supports cefazolin dosing based on body weight (Table 1). Patients with methicillin-resistant *Staphylococcus aureus* (*S. aureus*), or MRSA, colonization should receive weight-adjusted glycopeptide, preferably in combination with cefazolin (Table 1). Patients who are believed to have an intolerance to beta-lactam antibiotics should be further evaluated to determine if they can receive cefazolin. Patients with a true hypersensitivity reaction or adverse reaction that precludes the use of cefazolin should receive vancomycin or clindamycin.

LEVEL OF EVIDENCE: Consensus

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

RATIONALE

A thorough search of the PubMed database for all available literature on the topic of optimal perioperative antibiotics for primary shoulder arthroplasty was undertaken. There are no prospective controlled studies comparing surgical antibiotic prophylaxis strategies for shoulder arthroplasty that adequately assess clinical outcomes. Studies measuring microbial burden (primarily *Cutibacterium acnes*) at the time of incision after surgical antimicrobial prophylaxis in the setting of shoulder surgery have been disappointing. One small randomized controlled study comparing preoperative doxycycline administration to placebo did not demonstrate a reduction in *Cutibacterium acnes* colonization [1]. The relevance of these findings with respect to surgical prophylaxis in the shoulder is not known. Surgical prophylaxis in total joint arthroplasty does reduce the burden of other cutaneous microorganisms and is recommended for all orthopaedic implant surgery [2–4].

Prophylaxis should target organisms most likely to cause prosthetic shoulder infection. The most common organisms to cause shoulder surgical site infection and periprosthetic joint infection (PJI) are coagulase-negative Staphylococcus species, *Cutibacterium acnes* and *S. aureus* [5–9]. In addition to antimicrobial spectrum, agents selected for prophylaxis should also achieve bactericidal tissue concentration at the time of incision. In the absence of shoulder-specific literature and recognizing the microbiology and other factors we believe it is reasonable to extrapolate from the non-shoulder arthroplasty literature. The agent most likely to provide optimal tissue concentrations for prophylaxis against these organisms is cefazolin, dosed based on patient body weight [10]. Vancomycin should be utilized when patients have a personal history of MRSA colonization or infection. Close attention to dosing based on body-weight and the earlier timing of prophylaxis when vancomycin is utilized is paramount [4,11]. Ideally, vancomycin should not be given alone, however, as studies have identified an increased risk of PJI and surgical site infection potentially due to the narrower spectrum of vancomycin when compared with cefazolin [12,13]. Combination therapy with vancomycin and cefazolin has not been prospectively demonstrated to reduce surgical site infection risk in

TABLE 1. Recommended antimicrobial prophylaxis for patients undergoing primary shoulder arthroplasty

Clinical Situation	Antimicrobial Recommended
No beta-lactam allergy	Cefazolin 2 gm IV (3 gm if patient weighs > 120 kg) starting within 30-60 minutes prior to incision; re-dose Q4 hours; postoperative doses not required and should not be given beyond 24 hours.
Personal history of MRSA infection or colonization	Vancomycin 15 mg/kg (max dose 2 gm) starting within 2 hours prior to incision; postoperative doses not required and should not be given beyond 24 hours. We favor the addition of cefazolin to vancomycin.
Proven, serious beta-lactam allergy	Vancomycin 15 mg/kg (max dose 2 gm) starting within 2 hours prior to incision; postoperative doses not required and should not be given beyond 24 hours.

MRSA, methicillin-resistant *Staphylococcus aureus*

arthroplasty over cefazolin alone, although two studies suggest a trend towards reduced infection [14,15]. Combination therapy may be associated with higher rates of nephrotoxicity than vancomycin alone [14]. However, the value of preventing prosthetic joint infections may still justify its use. Additional study to clarify risks and benefits of these strategies is warranted.

One of the most common causes for use of an alternative perioperative antibiotic other than cefazolin is beta-lactam allergy or intolerance. Most of these patients are not actually allergic and will be able to safely receive cefazolin after evaluation by an allergist [16]. Patients with a true hypersensitivity reaction or adverse reaction that prohibits cefazolin should receive vancomycin or clindamycin in agreement with the Clinical Practice Guidelines for Antimicrobial Prophylaxis in Surgery [4].

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QUESTION 2: What are the optimal perioperative antibiotics for patients undergoing revision shoulder arthroplasty?

RECOMMENDATION: Patients undergoing revision shoulder arthroplasty should receive prophylactic antibiotics as discussed in Question 1. As addressed in Question 5, if there is suspicion for preexisting infection during surgery, consider oral amoxicillin or first-generation cephalosporin (or oral doxycycline if beta-lactam allergic) until cultures are finalized.

LEVEL OF EVIDENCE: Consensus

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

RATIONALE

After a thorough search of the PubMed database for studies evaluating the optimal perioperative antibiotic for patients undergoing revision shoulder arthroplasty, there are no prospective controlled studies comparing surgical antibiotic prophylaxis strategies for revision shoulder arthroplasty that adequately assess clinical outcomes.

Prophylaxis should target organisms most likely to cause prosthetic shoulder infection. The most common organisms to cause shoulder surgical site infection and PJI are coagulase-negative Staphylococcus species, *Cutibacterium acnes* (formerly known as *Proprionibacterium acnes*) and *Staphylococcus aureus* [1–3]. In the setting of revision surgery without an obvious reason for joint failure such as trauma, there may be a question of whether the patient's pain and/or stiffness may be caused by an occult perioperative joint infection (PJI) acquired during a prior case or joint injection. *C. acnes*, in particular, has emerged as a pathogen often cultivated from deep operative specimens in patients undergoing revision for pain and/or stiffness [4].

Unfortunately, inflammatory markers are often normal in these patients, and intraoperative evaluation is often benign-appearing, making it difficult to predict who will ultimately have substantially positive cultures after 14 days of incubation. Thus, surgeons may consider postoperative oral antibiotics to cover the most likely pathogen that may be detected after discharge—*C. acnes*—until cultures are finalized as negative [5]. This is distinctly different from the antibiotic prophylactic strategy for primary shoulder arthroplasty cases, which usually stops when the case concludes, certainly within 24