

based with a protocol of 6 weeks intravenous and 6 months of oral antibiotics if > 2 cultures were positive. Zero percent of patients had recurrence of infection with this protocol in both the positive culture and negative culture groups [8]. On the other hand, the risks of prolonged antibiotic use are significant. Two studies reported a 19-42% complication side-effect rate associated with prolonged antibiotic administration, which was seen in both oral and intravenous medication use [4,8].

The long-term consequences for an unexpected indolent positive culture after revision shoulder arthroplasty are unknown. However, despite lacking randomized comparative methodologies, the literature shows limited evidence that prolonged antibiotic use is not necessary in this scenario. Furthermore, there are well-reported risks of antibiotic-related side-effects and resistance with widespread use.

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3.2. TREATMENT: ANTIBIOTIC FOR PERIPROSTHETIC JOINT INFECTION

Authors: William Levine, Paul Pottinger, Sandra Bliss Nelson, Iván Encalada, John Itamura

QUESTION 1: Is there a need for antibiotic therapy following irrigation and debridement of patients with acute shoulder periprosthetic joint infection (PJI) caused by a virulent organism (e.g., methicillin-resistant *Staphylococcus aureus* (MRSA), methicillin-sensitive *Staphylococcus aureus* (MSSA) or *E. coli*)?

RECOMMENDATION: In the absence of high level data, we propose that patients with acute PJI of shoulder caused by virulent organisms, such as MRSA, MSSA or *E. coli*, receive postoperative antibiotics. The optimal antibiotic, route of administration and duration of treatment are unknown and should be individualized after consultation with infectious disease specialists.

LEVEL OF EVIDENCE: Consensus

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

RATIONALE

A systematic review was performed using PubMed and Google Scholar databases in February, 2018 to identify studies regarding the treatment outcomes after shoulder arthroplasty. The keywords included “shoulder AND (replacement OR arthroplasty) AND infection.” This search identified 46 articles with relevance to surgical treatment of shoulder prosthetic joint infection, 9 of which described treatment with irrigation and debridement with or without modular component exchange for acute infection (<3 months from surgery or acute hematogenous spread) [1-9]. These nine studies only included small numbers of patients with only 6 patients with acute PJI caused by a virulent organism [1].

There were no studies identified that directly compared irrigation and debridement versus irrigation and debridement with postoperative antibiotics for the treatment of acute PJI. The nine studies had varied definitions of “acute,” with periods ranging from four weeks to three months [1-9]. Data regarding the pathogenic organism was not clearly reported, thus making it difficult to determine whether the virulence was a factor in the treatment or outcome. The surgical management of the acute infections varied,

including arthroscopic irrigation and debridement, open irrigation and debridement, and open irrigation and debridement with modular component exchange. Given the limitations of the data, it is not possible to answer the narrow question of whether there is a role for antibiotic therapy in the management of acute shoulder PJI caused by a virulent organism (MRSA, MSSA, *E. coli*) after irrigation and debridement.

Nevertheless, postoperative antibiotics were always part of the treatment of acute PJI in the published literature. Treatment types and length varied; both intravenous and oral regimens were employed, and treatment lengths ranged from 13 days to chronic lifetime suppression [1,2]. Most studies used a four to six-week protocol of postoperative antibiotic therapy [1,3-8]. It appears to be the consensus opinion that acute shoulder PJI treated with irrigation and debridement should be followed by a course of antibiotic therapy. The type, dose and route of administration of the antibiotic should be individualized and determined after consultation with an infectious disease specialist.

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Authors: John Itamura, William Levine, Sandra Bliss Nelson, Iván Encalada, John Itamura

QUESTION 2: Is there a role for antibiotic therapy in the management of acute shoulder periprosthetic joint infection (PJI) with an indolent organism (e.g., *C. acnes* or Coagulase Negative *Staphylococcus*) after irrigation and debridement (I&D)?

RECOMMENDATION: Antibiotic therapy following I&D for management of acute shoulder PJI with an indolent organism has not been well-studied in the literature. The limited data available suggests treatment should consist of antibiotic therapy; however, the optimal antibiotic, route of administration and duration of treatment are unknown.

LEVEL OF EVIDENCE: Consensus

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

RATIONALE

Treatment strategies for PJI include chronic antibiotic suppression, irrigation and debridement with or without component retention, one or two-stage revision, placement of antibiotic spacer, resection arthroplasty, or arthrodesis. These strategies have been adopted from the hip and knee arthroplasty experience and literature. Most of the data published specifically addressing acute PJI commingles shoulder PJIs with hip and knee PJIs with very little data specific to treatment of acute shoulder PJI alone. The role of antibiotic, the ideal duration or specific antibiotic are not well described. PubMed, Google Scholar, Ovid-Medline, Cochrane and Web of Science were all searched for the following keywords: “shoulder,” “infection,” “periprosthetic,” “arthroplasty,” “antibiotic” to identify relevant articles through a title screen, abstract review and, finally, a full text review to identify the relevant manuscripts.

After an extensive review of the literature, we identified a case series of 10 shoulders in 9 patients treated with I&D and antibiotics for acute PJI.

In 2017, Dennison et al. [1] published a retrospective case series of acute PJI treated at the Mayo clinic. They defined acute PJI as any infection requiring I&D within 6 weeks of the index arthroplasty or within 3 weeks of symptoms from a delayed-onset acute hematogenous infection. Anything outside of this time frame was excluded.

They found 10 shoulders in 9 patients with 4 acute postoperative and 6 delayed-onset acute hematogenous infections. Five of the shoulders had a positive culture for indolent bacteria, the other 5 cultured more virulent bacteria. No patient underwent component exchange. The postoperative antibiotic treatment ranged from 3 to 6 weeks with a mean of 5.2 weeks. Antibiotics were determined by an orthopaedic infectious disease specialist based on organism susceptibility and host factors. Nine of the 10 shoulders underwent additional oral antibiotic therapy, which included trimethoprim-sulfamethoxazole with or without rifampin, penicillin or a combi-

nation of trimethoprim-sulfamethoxazole with penicillin. Chronic suppression was maintained in 6 shoulders. Of the 10 shoulders, 3 had failure requiring resection arthroplasty. The authors concluded that I&D with antibiotics allowed component retention in 70% of patients treated for acute PJI, although nearly all were prescribed chronic antibiotic suppression.

No studies reported on duration of therapy specific to acute shoulder PJI caused by indolent organisms. Publications reporting on acute shoulder PJI caused by both virulent and indolent organisms describe a wide duration of therapy from 2 weeks to 3 months with poorly described “additional” periods of antibiotics or indefinite therapy. There is conflicting literature regarding the importance of combining therapy with rifampin.

Given the limited nature of the data available, the exact role and protocol for antibiotic treatment after I&D for the treatment of acute shoulder periprosthetic joint infection caused by indolent organism remains unclear. Further studies are required to determine the optimal treatment. Nevertheless, postoperative antibiotics are traditionally prescribed as part of the treatment of acute PJI. Treatment types and length varied; both intravenous and oral regimens were employed, and treatment lengths ranged from 13 days to chronic lifetime suppression [1,2]. Most studies used a four to six-week protocol of postoperative antibiotic therapy [1,3,4]. By consensus we believe that cases of acute shoulder PJI treated with irrigation and debridement should followed by a course of antibiotic therapy.

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