

## QUESTION 2: Is there a role for postoperative antibiotic treatment for revision arthroplasty with subsequent unexpected positive cultures for a virulent organism (e.g., methicillin-resistant *S. aureus* (MRSA), methicillin-sensitive *Staphylococcus aureus* (MSSA) or *E. coli*)?

**RECOMMENDATION:** In aggregate, published studies do not clearly show superiority for prolonged antibiotic use over no prolonged antibiotic treatment in the setting of revision shoulder arthroplasty with subsequent cultures positive for virulent organisms. However, the data on this specific clinical scenario is limited as the vast majority of unexpected positive cultures are with less virulent organisms (e.g., *C. acnes*, Coagulase-negative *Staphylococcus* (CNS)).

**LEVEL OF EVIDENCE:** Limited

**DELEGATE VOTE:** Agree: 96%, Disagree: 4%, Abstain: 0% (Unanimous, Strongest Consensus)

### RATIONALE

A comprehensive literature review was performed to identify all studies on prophylactic/suppressive antibiotics after revision shoulder arthroplasty. Searches for the terms “shoulder replacement,” “infection,” “antibiotics,” “postoperative” and “joint replacement” were performed using the search engines PubMed, Google Scholar and Cochrane review, which were searched through February 2018. Inclusion criteria for our systematic review were all English studies (Level I-IV evidence) that reported on antibiotic prophylaxis, or lack thereof, in cases of revision shoulder arthroplasty. Exclusion criteria were non-English language articles, nonhuman studies, retracted papers, incomplete antibiotic records, case reports, review papers, studies without clinical follow-up/infection rates, and technique papers without patient data. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria were followed.

The prevalence of subclinical infections (unexpected positive culture (UPC)) is common with shoulder arthroplasty due to anatomic and demographic factors. The rate of positive cultures in primary and revision arthroplasty settings have been reported as high as 56 % [1–3], although much lower for virulent organisms. However, the significance and optimal treatment for UPCs caused by virulent organisms remains unknown. There is limited data in the shoulder literature for or against any role for postoperative prophylactic/suppressive antibiotics after revision shoulder arthroplasty without clinical or radiographic signs of infection. While several studies described the use of prophylactic or suppressive antibiotics after revision shoulder arthroplasty, there were no prospective randomized studies and none of the studies specifically evaluated efficacy by antibiotic or organism type.

Among the published studies for outcomes after revision shoulder arthroplasty with subclinical presentations and unexpected positive cultures, all were retrospective studies with differing methodologies [4–8]. All of the studies reported the majority of positive cultures (> 80%) from indolent organisms (*C. acnes* and/or CNS). None of the studies found a detrimental effect to NOT prescribing prolonged antibiotics postoperative, although one study with no comparison group reported a 25% recurrence rate after UPC. In studies that treated UPC with prolonged antibiotics, recurrence rates were low (0–3.5%). One systematic review confirmed a pooled “true infection” rate after UPC of 10.2%, with antibiotic use not influencing the rate of occurrence of “true infection” after UPCs ( $P = 0.498$ ) [9].

Grosso et al. used antibiotic cement and 24 hours routine postoperative antibiotics with 1 superficial infection and no deep infections after revision shoulder arthroplasty [4]. Foruria et al. reported at least a 10% persistent infection rate after single stage shoulder

arthroplasty revision, although antibiotic use and positive cultures did not influence the rate of true infection. [5]. Padegimas et al. reported a 23.9% UPC rate after revision shoulder arthroplasty with standardized UPC treatment of 6 weeks antibiotics or 2 weeks antibiotics at surgeon discretion. They found only 1 recurrent infection in the UPC group, 3.5% versus 3.4% in the non-UPC group [6]. Kelly et al. reported 8/28 (29%) UPC rate after revision shoulder arthroplasty, and only treated one with antibiotics postoperatively for 4 weeks (due to superficial wound infection). Of 8 patients, 2 (25%) developed late clinical infection with *C. acnes* [8]. Lastly, Hsu et al. reported a 49% positive culture rate after revision shoulder arthroplasty, and treated patients based on a protocol of 6 weeks IV and 6 months of oral antibiotics if > 2 cultures positive. Zero percent of patients had recurrence of infection with this protocol in the positive culture group and negative culture groups [7]. On the other hand, risks from prolonged antibiotic use are significant. Two studies reported a 19–42% complication side-effect rate from its use, which was seen in both oral and intravenous medication use [4,7].

The vast majority (> 80%) of UPCs reported in the shoulder literature were *P. acnes* or CNS organisms. Due to small numbers, meaningful comparisons to more virulent organisms could not be performed. Other studies in the lower extremity literature suggest that periprosthetic joint infections from virulent organisms have higher reinfection rates despite surgery (45–49%) for MRSA, Enterococcus and Streptococcus [10–12]. In the lower extremity arthroplasty literature, there was one randomized controlled study which found a limited benefit associated with prolonged oral antibiotic therapy after two-stage revision with negative cultures (5% versus 19%), although culture profiles from the reinfections (mostly virulent) tended to differ from the original infection organism profile [13].

In aggregate, these studies do not clearly show superiority for prolonged antibiotic use over no prolonged antibiotic treatment in the setting of revision shoulder arthroplasty with subsequent cultures returning for virulent organisms. The clinical implications may differ between occult PJs and unsuspected PJs in that preoperative diagnostic tests may be performed in the occult PJ setting, which may guide future treatment pathways. Prolonged antibiotic therapy may not be necessary in those patients with low suspicion of infection. In addition, there are well-reported risks of antibiotic related side-effects and resistance with widespread use.

### REFERENCES

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**QUESTION 3:** Is there a role for postoperative antibiotic treatment when a revision arthroplasty is performed with subsequent unexpected positive cultures of the shoulder caused by an indolent organism (e.g., *C. acnes* or coagulase-negative *Staphylococcus*(CNS))?

**RECOMMENDATION:** Postoperative antibiotic treatment beyond 24 hours after revision arthroplasty with unexpected positive cultures for an indolent organism does not appear to reduce the risk of subsequent infection.

**LEVEL OF EVIDENCE:** Limited

**DELEGATE VOTE:** Agree: 84%, Disagree: 4%, Abstain: 12% (Super Majority, Strong Consensus)

## RATIONALE

A comprehensive literature review was performed to identify all studies on prophylactic/suppressive antibiotics after revision shoulder arthroplasty. Searches for the terms “shoulder replacement,” “indolent,” “infection,” “antibiotics,” “postoperative” and/or “joint replacement” were performed using the search engines PubMed, Google Scholar and Cochrane review, which were searched through February 2018. Inclusion criteria for our systematic review were all English studies (Level I-IV evidence) that reported on antibiotic prophylaxis, or lack thereof, in cases of revision shoulder arthroplasty. Exclusion criteria were non-English language articles, nonhuman studies, retracted papers, incomplete antibiotic records, case reports, review papers, studies without clinical follow-up/infection rates and technique papers without patient data. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria were followed.

The prevalence of subclinical infections (unexpected positive culture (UPC)) is common after shoulder arthroplasty due to anatomic and demographic factors. In fact, the rate of positive cultures in primary and revision arthroplasty settings have been reported as high as 56% [1–3]. The significance of such cultures remains unknown. There is limited data in the shoulder literature for or against the role for postoperative antibiotics after revision shoulder arthroplasty without clinical or radiographic signs of infection. While several studies described the use of prophylactic or suppressive antibiotics after revision shoulder arthroplasty, there were no prospective randomized studies and none of the studies specifically evaluated efficacy by antibiotic or organism.

Among the published studies for outcomes after revision shoulder arthroplasty with subclinical presentations and unexpected positive cultures, all were retrospective studies with differing methodologies [4–8]. All of the studies reported the majority of positive cultures (> 80%) from indolent organisms (*C. acnes* and/or CNS). None of the studies found a detrimental effect to not prescribing prolonged antibiotics postoperatively, although one study with no comparison group reported a 25% recurrence rate after UPC. One systematic review confirmed a pooled true infection rate after UPC of 10.2%, with antibiotic use not influencing the rate of occurrence of true infection after UPCs ( $P = 0.498$ ) [9].

Grosso et al. used antibiotic-impregnated cement and 24 hours of routine postoperative antibiotics after revision shoulder arthroplasty and reported 1 superficial infection and no deep infections (91% of organisms cultured were indolent) [4]. Foruria et al. reported 10% persistent infection rate after single stage revision shoulder arthroplasty, although postoperative antibiotic use and positive cultures did not influence the rate of true infections (83% of cultures were positive for indolent organisms) [5]. Padegimas et al. reported a 23.9% UPC rate after revision shoulder arthroplasty with standardized UPC treatment of 6 weeks antibiotics or 2 weeks antibiotics at surgeon discretion. They found only 1 recurrent infection in the UPC group, 3.5% versus 3.4% in the non-UPC group [6]. Kelly et al. reported 8/28 (29%) UPC rate after revision shoulder arthroplasty and only treated one with antibiotics postoperatively for 4 weeks (due to superficial wound infection). Of 8 patients, 2 (25%) developed late clinical infection with *C. acnes* [7]. Lastly, Hsu et al. reported a 49% positive culture rate after revision shoulder arthroplasty and treated patients