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QUESTION 3: Is there a role for topical skin treatments prior to primary or revision shoulder arthroplasty?

RECOMMENDATION: At this time, there is no evidence for or against the use of topical skin treatments to reduce the rate of shoulder periprosthetic joint infection (PJI).

LEVEL OF EVIDENCE: Limited

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

RATIONALE

The use of chlorhexidine gluconate (CHG) topical skin treatment preoperatively has been recommended by the International Consensus on Periprosthetic Joint Infection. However, specific to shoulder arthroplasty, the use of topical skin treatments has not been shown to significantly reduce the superficial bacterial load of *Cutibacterium acnes* (formerly known as *Propionibacterium acnes*), nor reduce culture positivity of deep samples retrieved from the surgical site during primary shoulder arthroplasty [1–6].

C. acnes has been reported as the most common pathogen in shoulder PJI and, as well as being present on the skin, is also present within the sebum-rich pilosebaceous hair follicles of the deep dermis, making it difficult to eradicate with topical antiseptic techniques. Surgical incisions, transecting thousands of these *C. acnes*-filled dermal glands, can lead to contamination of deeper tissues.

C. acnes is also implicated in the pathogenesis of acne vulgaris for which the anti-bacterial agent benzoyl peroxide (BPO) has been used as topical therapy. BPO releases free-radical oxygen which oxidizes bacterial proteins in the sebaceous follicles, decreasing the burden of anaerobic bacteria in the deeper tissues and also inflammation due to the reduction of irritating-type free fatty acids. Leyden described a 90% reduction in *P. acnes* after 48 hours of topical treatment and a 99% reduction after 72 hours of treatment [7]. The addition of topical clindamycin phosphate 1.2% has also been demonstrated to further decrease bacterial load [8]. Although BPO with clindamycin may therefore be the optimal treatment for use prior to shoulder surgery to decrease *C. acnes* contamination, further research is needed to correlate superficial decontamination with decreased infection rates and shoulder PJI [9].

Specific to primary shoulder joint replacement, Levy et al. reported 23 of 55 patients had *P. acnes* growth in the joint synovial fluid collected during surgery [10]. Despite their protocol of washing the shoulder, arm and axilla with 4% CHG, they reported high incidence of *P. acnes* [10]. Other recent studies evaluated colonization rates for primary shoulder arthroplasties and found around 70% of cases had positive cultures for *C. acnes* despite using CHG, and patients of male gender and those with body hair had higher rates of superficial *C. acnes* [4,5,11,12]. In study by Koh et al., 30 patients undergoing primary shoulder arthroplasty had superficial swabs and deep tissue samples sent for culture at various stages of the operation following CHG application. After the chlorhexidine skin scrub in the operating room, 40% (12/30) had positive skin swab cultures and 27% (8/22) after dual application of chlorhexidine to the skin. Forty-three percent had positive deep cultures on entering the glenohumeral joint, and deep cultures after implantation of the prosthesis were positive in 37%. After closure, 43% had positive superficial cultures. In total, 73% of patients had positive cultures and the authors concluded that topical antiseptic measures did not completely eliminate *C. acnes* [12]. Despite its proven antiseptic effects, dermal application of aqueous CHG during shoulder surgery fails to eradicate or reduce *C. acnes* on deep cultures. The current literature is limited by the lack of high quality studies which can provide definitive answers regarding the clinical effectiveness of various CHG preparations preventing prosthetic shoulder joint infections [13].

Sabetta et al. described the preoperative application of topical 5% BPO in addition to the standard use of CHG preoperative skin preparation to reduce *C. acnes* rates in patients undergoing arthroscopic shoulder procedures. BPO was applied twice daily for a total of 5 applications in the 48 hours prior to operation in 50 patients undergoing primary arthroscopic shoulder surgery [14]. Sixteen percent (8 of 50) of skin swab cultures surgical skin prior to preparation with ChloraPrep from the anterior deltoid of the BPO-treated arm were positive, compared with 32% (16 of 50) of the skin on the anterior deltoid of the untreated arm ($p = .001$). The addition of BPO cream to their standard ChloraPrep protocol appeared to provide an improved method of skin cleansing; however, due to the design of the study (non-randomized), differences in deep culture rates could not be determined [14]. Dizay et al. prospectively studied 65 patients undergoing shoulder arthroscopy using topical 5% benzoyl peroxide plus clindamycin phosphate 1.2% (BPO/C) [15]. The preparation was applied for more than two days prior to surgery. Skin surface swab cultures were taken preoperatively and in the operating room before the standard chlorhexadine preparation. A third set of cultures were taken by swabbing the shoulder tissue at the operative site under direct arthroscopic visualization through an arthroscopic cannula upon completion of the procedure. The topical gel was effective in eliminating 74.2% (23 of 31 patients with positive preoperative

cultures) of *C. acnes* skin colonization by day of surgery. The rate of positive cultures from the deep shoulder joint was 3.1% (2/65 patients) with preoperative BPO/C topical treatment, much lower than similar studies which described up to 19.6% positive deep cultures [9,15].

In summary, there is evidence that topical skin treatments can reduce bacterial loads, such as *C. acnes*. However, no studies examined the effect of skin preparations on the most clinically significant end-point—the rate of shoulder PJI. The use of topical BPO with or without clindamycin, whilst encouraging and warranting further study, cannot currently be fully endorsed as standard practice for prevention of shoulder PJI, until further data is available.

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QUESTION 4: Should the subcutaneous and dermal tissues be disinfected during shoulder arthroplasty?

RECOMMENDATION: There is insufficient evidence for or against disinfection of the subcutaneous and dermal tissues during shoulder arthroplasty.

LEVEL OF EVIDENCE: No Evidence

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

RATIONALE

A review of PubMed "(subcutaneous OR irrigation OR disinfection OR topical OR local) AND shoulder AND arthroplasty)" and Google Scholar "shoulder arthroplasty subcutaneous irrigation disinfection topical local" was performed to identify articles comparing strategies for disinfection of the subcutaneous and dermal tissues during shoulder arthroplasty. No such literature was identified. In the absence of specific evidence, basic science research and research in other fields of surgery were reviewed.

Lee et al. [1] performed punch biopsy cultures from the shoulders of volunteers after standard surgical preparation of the skin. Seven of ten subjects revealed positive cultures for *Cutibacterium*. On this basis, the authors concluded that surgical preparation could leave bacteria under the surface of the skin, and further disinfection should be performed.

In a retrospective hip and knee arthroplasty series, Brown et al. [2] compared dilute betadine lavage prior to closure of total hip and knee arthroplasty incisions to controls. The deep infection rate was lower in the group undergoing betadine lavage compared to the control group. In contrast, a similar methodology using chlorhexidine gluconate (CHG) showed no difference between CHG irrigation groups and controls. However, the conclusions may have been confounded by the fact that povidone-iodine was also utilized in the control group [3]. A broader meta-analysis of randomized controlled trials across various surgical specialties found that lavage with dilute betadine reduced the occurrence of surgical site infections in the majority of trials with no reported complications [4].

An intra-articular injection of gentamicin [5] and the application of topical vancomycin powder [6] have also both been described as operative measures to reduce periprosthetic joint infection in shoulder arthroplasty. Although there was no clinical evidence for the use of vancomycin powder in the shoulder, recent literature in the field of spinal surgery has shown a significantly decreased risk of surgical site infection with the use of topical vancomycin