Paper #35 PREOPERATIVE CHLORHEXIDINE SHOWERS CAN LOWER THE SKIN LEVELS OF COAGULASE-NEGATIVE STAPHYLOCOCCUS BUT NOT PROPIONIBACTERIUM

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Background: *Propionibacterium* and coagulase-negative Staphylococcus (CoNS) are the two most common bacteria involved in periprosthetic shoulder infections. These bacteria are found on and under the skin surface of healthy shoulders and can be inoculated into the deep tissues at the time of primary shoulder arthroplasty. Interventions aimed at decreasing skin bacterial load prior to surgery are intended to decrease the potential infection rate. Chlorhexidine washes the day prior to surgery are commonly employed in clinical practice, but their effectiveness in eliminating these bacteria has not been thoroughly tested. The objectives of this study were to answer two questions:

1) Do chlorhexidine washes the day prior to surgery effectively eliminate *Propionibacterium* and CoNS from the skin surface?
2) Are the results of preoperative skin cultures predictive of the results of cultures of the freshly incised dermal edge at surgery?

Methods: Twenty-nine patients (20 males, 9 females) with an average age of 63 ± 10 underwent primary shoulder arthroplasty between August 2017 and March 2018. Patients were instructed to shower with chlorhexidine (Hibiclens, Molylycke Health Care, Norcross, Georgia) the night before and the morning of surgery. Each patient had three skin swabs cultured: 1) one taken over the coracoid process at pre-operative clinic appointment (Clinic swab), 2) one from the same anatomic location immediately prior to skin preparation in the operating room (Pre-Prep swab), and 3) one taken from the incised dermal edge just after skin incision (Dermal swab). Culture results were reported semi-quantitatively as the Specimen Propi Value (SpPV) for *Propionibacterium* and Specimen CoNS Value (SpCV) for CoNS. The bacterial load of Propionibacterium and CoNS were compared for the clinic skin surface culture (Clinic SpPV/Clinic SpCV), the immediate preoperative skin surface culture (Pre-Prep SpPV/Pre-Prep SpCV) (after the chlorhexidine showers), and the culture of the incised dermis (Dermal SpPV/Dermal SpCV).

Results: The mean (±SD) skin surface CoNS load decreased significantly from a Clinic SpCV of 0.7 ± 0.8 to a Pre-Prep SpCV of 0.1 ± 0.3 ($P = .024$) after preoperative chlorhexidine showers. In 20 patients that had positive Clinic skin cultures for CoNS, the CoNS load decreased after the showers in 18 patients (90%).

The mean (±SD) skin surface Propionibacterium load did not decrease after preoperative chlorhexidine showers: the average Clinic SpPV was 1.0 ± 0.9 and average Pre-Prep SpPV was 1.3 ± 1.3 (P = .435). In 24 patients that had positive Clinic skin cultures for Propionibacterium, the Propionibacterium load decreased after the showers in only 7 patients (29%).

Seven of 29 patients (24%) had positive Dermal cultures for Propionibacterium; only 1 of 29 patients (3%) had a positive Dermal culture for CoNS. All seven of the patients with a positive Dermal cultures for Propionibacterium had both positive Clinic swabs and positive Pre-Prep and had significantly higher Clinic SpPV (1.6 ± 0.5 vs. 0.9 ± 0.9, P = .029) and Pre-Prep SpPV (2.4 ± 1.3 vs. 1.0 ± 1.1, P = .012) than those with negative dermal cultures.

Conclusions: The results of preoperative skin surface cultures for *Propionibacterium* are predictive of results of cultures of the dermal edge at primary shoulder arthroplasty. Shoulders with positive dermal wound cultures have higher loads of *Propionibacterium* on the skin surface than shoulders with negative dermal wound cultures.

Preoperative skin showers with chlorhexidine are effective in decreasing CoNS load on the skin but are not effective in reducing Propionibacterium load on the skin. These results suggest that Propionibacterium from the dermal sebaceous glands can rapidly repopulate the skin surface after chlorhexidine showers.

Paper #36 VANCOMYCIN HAS COMPARABLE EFFICACY IN ELIMINATING PROPIONIBACTERIUM ACNES BIOFILM AS DOXYCYCLINE AND PENICILLIN IN AN IN VITRO MODEL

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Introduction: *Propionibacterium acnes* (*Cutibacterium acnes*) is a common pathogen identified in periprosthetic shoulder infections and can be routinely cultured in primary shoulder arthroplasty. Biofilm production by *P. acnes* is thought to be a contributing factor to both its ability to resist eradication by routine antibiotic prophylaxis and its persistence on implanted materials, despite attempts at removal. Given its propensity to form biofilm, there has been significant interest in determining the appropriate type and dose of antibiotic to both treat and prevent *P. acnes* periprosthetic infections in shoulder arthroplasty. The purpose of our study was to determine if routinely used antibiotics would be effective against mature *P. acnes* biofilm in an *in vitro* model.

Methods: One laboratory strain (ATCC 6919) and three clinical isolates of *P. acnes* from confirmed periprosthetic shoulder infections were tested. Bacteria was inoculated at a concentration of $1x10^6$ colony forming units (CFU) per mL and cultured anaerobically on flat bottom 96 well polystyrene plates. For planktonic analysis, cultures were subjected to 3 days of antibiotic treatment at varied logarithmic doses. Planktonic minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) were assed using a PrestoBlue viability stain and CFU analysis on blood agar plates. For mature biofilm analysis, strains were cultured for 7 days and then subjected to the same antibiotic regimen. Mature biofilm MIC (MBIC) and MBC (MBBC) was determined using similar modified PrestoBlue viability reagent and CFU drop plate assays. Antibiotics tested were: vancomycin, doxycycline, and penicillin.

Results: The planktonic MIC for vancomycin, doxycycline, and penicillin was within clinical dosing ranges for all strains. The planktonic MBC for vancomycin and doxycycline was within clinical dosing ranges for all strains. For penicillin, the dose needed to achieve planktonic MBC was above clinical dosing levels in 50% of the strains, indicating increased tolerance to penicillin as compared to doxycycline and vancomycin in the planktonic form (Fig. 1, *A*). The biofilm MIC and MBC for all antibiotics were one to three orders of magnitude above planktonic levels, however all antibiotics had a measurable biofilm MIC within routine clinical dosing levels. The biofilm MBC for doxycycline and vancomycin within clinical dosing ranges in 75% of the strains indicating minimal tolerance of *P. acnes* biofilm to these antibiotics. The biofilm MBC for penicillin was within clinical dosing ranges in only 25% of strains indicating relative tolerance of *P. acnes* to this antibiotic (Fig. 1, *B*).

Conclusion: *P. acnes* has an increased tolerance to antibiotics in mature biofilms as compared to its planktonic state. Vancomycin has comparable *in vitro* efficacy to doxycycline and penicillin for planktonic and biofilm MIC and MBC. These values are within concentrations achieved by systemic or topical delivery.

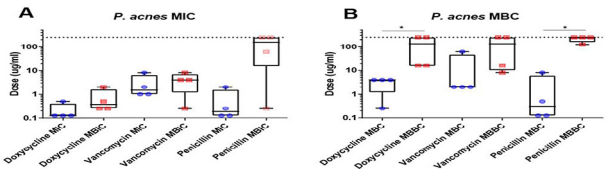

Figure 1 P. acnes planktonic and mature biofilm MIC and MBC. (A) Planktonic MIC (blue) and mature biofilm MIC (red). (B) Planktonic MBC (blue) and mature biofilm MBC (red).