



# The effect of axillary hair on surgical antisepsis around the shoulder



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**Background:** Infection after shoulder surgery can have devastating consequences. Recent literature has implicated *Propionibacterium acnes* as a causative agent for postoperative shoulder infections. Axillary hair removal has been suggested as a method for infection prevention, although data quantifying its effect on the bacterial load around the shoulder are lacking.

**Methods:** We clipped one randomly selected axilla in 85 healthy male volunteers with commercially available surgical clippers. Aerobic and anaerobic culture specimens were taken from the clipped and unclipped axillae. Each shoulder was then prepared with 2% chlorhexidine gluconate and 70% isopropyl alcohol. Repeated culture specimens were then taken from both axillae. Cultures were held for 14 days and recorded with a semiquantitative system (0-4 points). Results were compared by the Wilcoxon signed rank test.

**Results:** There was no difference in the burden of *P. acnes* between the clipped and unclipped axillae before or after surgical preparation ( $P = .109$ ,  $P = .344$ , respectively). There was a significantly greater bacterial burden in the clipped shoulder compared with the unclipped shoulder before preparation ( $P < .001$ ) but not after preparation ( $P = .285$ ). There was a significant reduction in total bacterial load and *P. acnes* load for both axillae after surgical preparation ( $P < .001$  for all).

**Conclusions:** Removal of axillary hair has no effect on the burden of *P. acnes* in the axilla. Clipped axillae had a higher total bacterial burden. A 2% chlorhexidine gluconate surgical preparation is effective at removal of all bacteria and specifically *P. acnes* from the axilla.

**Level of evidence:** Basic Science, Microbiology.

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**Keywords:** Shoulder; axilla; infection; *Propionibacterium acnes*; surgical preparation

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Infection after shoulder surgery can have devastating consequences. Fortunately, this complication is uncommon, with reported rates from 0.43% to 4.0% for procedures including arthroscopy, arthroplasty, and fracture treatment.<sup>17</sup> Patients who suffer postoperative shoulder infection have worse outcomes than those who do not.<sup>4,17,21</sup> Multiple surgeries and a protracted clinical course are common in the treatment of postoperative shoulder infection.<sup>17</sup>

Recent literature has highlighted that *Propionibacterium acnes* is not a skin contaminant and is in actuality responsible for a large percentage of postoperative infections after shoulder surgery.<sup>5,6,8-10,12,18,19,21,22,25</sup> *P. acnes* is a gram-positive anaerobic bacillus implicated in the pathogenesis of facial acne and other more serious infections. The bacterium is associated with hair follicles and is more common in men than in women.<sup>14,15</sup> *P. acnes* is found preferentially around the shoulder compared with the hip or knee.<sup>14</sup>

Draping the axilla out of the surgical field and removal of axillary hair have been proposed as methods to decrease infection risk<sup>1,6</sup>; however, few data exist regarding the effectiveness of these measures. In one study of preoperative surgical preparation solutions, a small cohort of patients had shaved their axillary hair before surgery with no difference in infection rates.<sup>18</sup> We sought to better define the effect of axillary hair removal on the bacterial burden around the shoulder.

## Materials and methods

Eighty-five healthy male volunteers were enrolled in the study. Eligible volunteers were men aged 18 to 80 years; only men were enrolled as *P. acnes* infection is more common in men than in women.<sup>14,15</sup> Enrollment was precluded if volunteers had active infections or antibiotic use in the previous 2 weeks or a history of dermatologic conditions in the axillae. The median age of participants was 27 years (range, 21-53 years).

We clipped one randomly selected axilla in each volunteer with commercially available surgical clippers (CareFusion, Vernon Hills, IL, USA) (Fig. 1). Randomization was performed by random number generator ([random.org](http://random.org)), with even or odd numbers designating the right or left axilla to be clipped, respectively. Aerobic and anaerobic culture specimens were taken from the clipped and unclipped axillae. Each shoulder was then prepared with 2% chlorhexidine gluconate and 70% isopropyl alcohol (ChlorPrep; CareFusion, San Diego, CA, USA) according to the manufacturer's specifications. Once the surgical preparation was complete, additional culture specimens were then taken from each axilla.

All culture specimens were obtained by 1 of 3 authors (G.S.M., B.M.W., E.B.F.) by standardized technique. Cultures were obtained with a single standard cotton-tipped culture swab per axilla. Each culture swab was rolled over the entire axilla for 1 to 2 seconds and transported in an aerobic or anaerobic transport tube (anaerobic transport medium; Anaerobe Systems, Morgan Hill, CA, USA). All cultures were held for 14 days as *P. acnes* may have a prolonged incubation time.<sup>9,14</sup> Culture results were recorded with a semiquantitative system (Table I).



**Figure 1** Surgical clippers used for axillary hair removal.

**Table I** Scoring system for growth of bacteria

Finding	Score
No growth	0
1-5 colonies	1
Growth in 1 quadrant	2
Growth in 2 quadrants	3
Growth in 3 quadrants	4

Culture broth was applied to 3 of 4 quadrants on each agar. The fourth quadrant was left sterile as control.

Participants were asked to fill out a short questionnaire. The survey consisted of 9 questions about their dermatologic history, antibiotic use, immune status, and smoking history (Appendix 1). Participants were also characterized with respect to their axillary environment as described previously by Patel et al.<sup>14</sup> Specifically, subjects were rated on the presence of axillary hair, rash, comedones, pimples, and perspiration.

Bacterial levels were compared with the Wilcoxon signed rank test. Questionnaire responses were analyzed for associations with antibiotic burden by Pearson correlation coefficients (for continuous demographics) or Wilcoxon rank sum tests (for binary demographics). Statistics were analyzed with SAS v9.2 (SAS Institute, Cary, NC, USA). Results from the first 25 subjects were preliminarily reviewed to perform a power analysis. On the basis of a standard deviation of 2 of the difference of 2 conditions (e.g., shaved or unshaved),  $\alpha = .05$ , a sample size of 58 pairs had 80% power to detect a difference of 0.75 in total bacterial burden by a Wilcoxon signed rank test.

## Results

The right axilla was clipped in 42 participants; the left was clipped in 43. Only 3 subjects had no axillary hair before clipping; 14 had perspiration, and 4 had acne. Only 1 subject reported tobacco use. A summary of baseline characteristics is found in Table II.

All subjects had positive cultures from the clipped axilla, whereas 7 subjects had negative cultures from the unclipped axilla. The most commonly isolated organism was coagulase-negative staphylococcus (124 of 170; 72.9%), followed by *P. acnes* (123 of 170; 72.4%) and

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