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# Patient compliance and satisfaction with topical benzoyl peroxide gel prior to shoulder surgery

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**Background:** *Cutibacterium acnes* is a common pathogen leading to postoperative shoulder infections. Many centers are utilizing 5% topical benzoyl peroxide (BPO) gel to decrease cutibacterium acnes bioburden prior to surgery. The purpose of this study was to evaluate patient compliance, tolerance, and side effects of applying BPO to the shoulder prior to surgery. Our hypothesis was that BPO would be well tolerated with few, minor side effects, and patients would comply with a regimen of 5 treatments spanning 48 hours prior to surgery.

**Methods:** All patients undergoing operative intervention, either open or arthroscopic, about the shoulder from August 7, 2020, through July 15, 2021, by a single surgeon were instructed to apply BPO to the shoulder after showering, on dry skin, in the morning and evening, starting 48 hours before their surgical date. Patients were instructed to apply a half-dollar-sized quantity for each treatment. There were a total of 5 topical applications. On the day of surgery, patients were given a 6-question survey regarding side effects experienced, BPO treatments missed, ease of treatment, and a scenario question. Demographic information was collected, and a satisfaction survey was administered upon study completion.

**Results:** A total of 183 patients out of a possible 284 eligible patients (64.4%) completed the survey. The median (interquartile range) age at surgery was 59.9 years. Sixty-four participants (35%) in the study cohort were female. One-hundred thirteen (61.7%) had an arthroscopic surgical approach, whereas 70 (38.3%) underwent open shoulder surgery. Most patients (N = 152, 83.5%) experienced no side effects from the topical 5% BPO gel treatments. Twenty-two (12.0%) patients missed 1 treatment, 10 (5.5%) missed 2 treatments, 1 (0.5%) missed 3 treatments, 3 (1.6%) missed 4 treatments, and 4 (2.2%) missed all 5 treatments. The majority of patients, 143 (78.1%), completed all 5 treatments. When prompted to choose between serial skin preparation treatments at home leading up to surgery or a single light-based decolonization procedure in the preoperative holding area on the day of surgery, 111 (60.7%) preferred to undergo antimicrobial treatment at home and arrive for surgery as otherwise scheduled.

**Conclusion:** Serial preoperative applications of topical 5% BPO gel are well tolerated by the majority of patients. Over 20% of patients missed at least one application of BPO. Most patients prefer home-based antimicrobial treatments compared with arriving earlier on the day of surgery for a single light-based antimicrobial treatment.



*Cutibacterium acnes* (*C. acnes*) is a leading cause of infection following shoulder surgery.[2,13,18,19] This is a commensal organism that resides in the sebaceous glands of the dermal layer of the skin.[1,17] In recent years, topical skin preparations including 5% topical benzoyl peroxide (BPO) gel, povidone-iodine, hydrogen peroxide, and chlorhexidine have been investigated for their ability to diminish the bioburden of *C. acnes* at the epidermis prior to surgical intervention.[11,15,19,21–24] Blue light therapy (BLT), a modality utilized in dermatology for treatment of inflammatory acne, has also been investigated for this same purpose.[3,5,7,8] Many shoulder centers, including the study institution, utilize a regimen of topical 5% BPO gel prior to shoulder surgery. BPO is lipophilic, and it has been reported to enter the pilosebaceous glands where it leads to the production of reactive oxygen species capable of oxidizing proteins in bacterial cell membranes.[20] A typical preoperative regimen consists of 5 serial applications spanning 48 hours leading up to the day of surgery.[19] It is not uncommon for patients

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**Table I**
Baseline demographics and surgical data for the study population.

| | |
|---|---|
| Demographics | |
| Number of patients | 183 |
| Age at surgery (yr) | 59.9 (50.7-67.8) |
| Race (%) | |
| African American | 3 (1.6) |
| Asian | 1 (0.5) |
| Caucasian | 179 (97.8) |
| Female gender (%) | 64 (35.0) |
| Body mass index (kg/m$^2$) | 30.6 (27.1-34.0) |
| Surgical data | |
| Surgical approach (%) | |
| Arthroscopic | 113 (61.7) |
| Open | 70 (38.3) |
| Surgery performed (%)* | |
| Rotator cuff repair | 54 (29.5) |
| Anatomic TSA | 13 (7.1) |
| Reverse TSA | 51 (27.9) |
| Biceps tenodesis | 57 (31.1) |
| Clavicle ORIF | 1 (0.5) |
| Other | 35 (19.1) |

*TSA*, total shoulder arthroplasty; *ORIF*, open reduction and internal fixation.
Data presented as median (interquartile range) unless otherwise specified. One patient (0.5%) had a local skin reaction to benzoyl peroxide (BPO).
*Percentages do not add up to 100, as patients with more than 1 surgery performed were included.

to report missing one or more doses, as well as report frustration with known side effects of BPO application, including dry skin, itching, erythema, and bleaching of clothing and towels.[10,25] To date, no investigation has evaluated patient compliance and tolerance of 5% topical BPO gel regimen prior to shoulder surgery. Preoperative skin preparations that have reliably been shown to have beneficial antimicrobial effects are only useful if patients are compliant with the treatment protocol. Differences in compliance between various preoperative skin preparation regimens may have a clinical impact on regimen efficacy.

The purpose of this study was to (1) evaluate patient compliance with 5 preoperative applications, (2) determine the incidence of side effects from the topical BPO gel, and (3) report satisfaction with treatment. It was hypothesized that most patients would not miss a single BPO treatment, minor side effects would be common, and patients may be interested in alternative options.

## Methods

This study was approved by the institutional review baord. All patients undergoing operative intervention, either open or arthroscopic, about the shoulder from August 7, 2020, through July 15, 2021, by a single surgeon were prospectively administered a short survey in the preoperative holding area on the day of surgery.

### *Study participants*

Patients were included if they were scheduled to undergo open or arthroscopic surgery from the acromioclavicular joint to the proximal humerus. This included shoulder arthroplasty cases, both primary and revision, any arthroscopic shoulder procedure, any procedure on the acromioclavicular joint, and proximal humerus fracture open reduction internal fixation. Patients were excluded if they had an allergy to BPO. Prior to surgery, patients completed a short, 6-question survey regarding treatment compliance, side effects, and ease of treatment (Appendix 1). The survey was created by the investigators to be concise and objective with regard to side effects experienced, number of treatment doses missed, and whether or not patients would rather complete the 5-treatment regimen of BPO or prefer a single light-based treatment on the day of surgery in the preoperative holding area.

### *Treatment description*

Patients were instructed to apply a half-dollar sized amount of 5% BPO to the front, back, and armpit of the operative shoulder after showering, on dry skin, twice daily and once on the morning of surgery, for a total of 5 applications. The treatment regimen was 3 days in duration (2 days prior to surgery, 1 day prior to surgery, and the morning of surgery). The handout with instructions given to patients can be found in Appendix 2.

### *Statistical analysis*

Descriptive statistics were performed for demographic information of study volunteers and results of the satisfaction survey. Due to abnormal distribution of the data, median and interquartile ranges were reported for continuous variables. Bar graphs were created to depict the results of select survey questions. All statistical analyses were performed using RStudio software version 4.0.4 (R Foundation for Statistical Computing, Vienna, Austria).

## Results

A total of 183 patients out of a possible 284 eligible patients (64.4%) completed the survey and were included in the study cohort. The median (interquartile range) age at surgery and body mass index were 59.9 years and 30.6 kg/m$^2$, respectively. Sixty-four participants (35%) in the study cohort were female. One-hundred thirteen (61.7%) had an arthroscopic surgical approach, whereas 70 (38.3%) underwent open shoulder surgery. A complete description of subject demographics can be found in Table I.

Regarding the survey questions, most patients (N = 152, 83.5%) experienced no side effects from the topical 5% BPO gel treatments (Fig. 1). Twenty-two (12.0%) patients missed 1 treatment, 10 (5.5%) missed 2 treatments, 1 (0.5%) missed 3 treatments, 3 (1.6%) missed 4 treatments, and 4 (2.2%) missed all 5 treatments. The majority, 143 (78.1%), of patients completed all 5 recommended treatments. Most patients reported that complying with the preoperative treatment regimen was either easy (N = 42, 23.0%) or very easy (N = 114, 62.3%) (Fig. 2). The median level of satisfaction with topical BPO treatment was 10 (interquartile range: 8 – 10, range: 0 – 10). When prompted to choose between serial skin preparation treatments at home leading up to surgery or a single light-based decolonization procedure in the preoperative holding area on the day of surgery, 111 (60.7%) preferred to undergo antimicrobial treatment at home rather than arrive for surgery 30 minutes earlier than scheduled to undergo one light-based antimicrobial treatment.

## Discussion

The main findings of this study demonstrate that the preoperative treatment regimen of 5% topical BPO gel was well tolerated with adequate overall compliance and few side effects. Most patients (N = 152, 83.5%) experienced no side effects to the treatment. Of those patients who did report side effects, bleaching of clothes (3.8%), itching or burning (3.3%), and multiple side effects (4.9%) were most commonly reported. Forty (N = 21.9%) patients failed to complete at least one of the required 5 doses of BPO prior to surgery. The majority of patients (N = 111, 60.7%) responded that they would prefer to undergo microbial treatment at home rather than undergo a one-time antimicrobial treatment consisting of light-based treatment in the preoperative area.

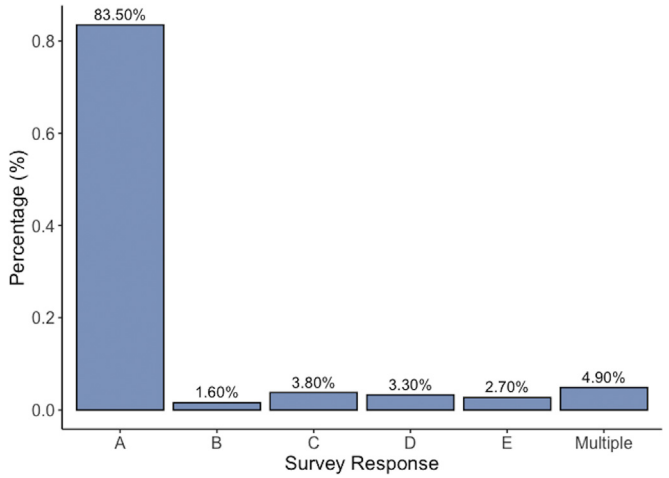


**Figure 1** Bar graph demonstrating responses to question 1, "Did you experience any side effects of 5% topical benzoyl peroxide (circle all that apply)?". A = none, B = skin dryness, peeling, or flaking, C = bleaching of clothing, D = itching or burning, E = redness. One patient responded other with free text: "skin lighter on affected shoulder after doses".

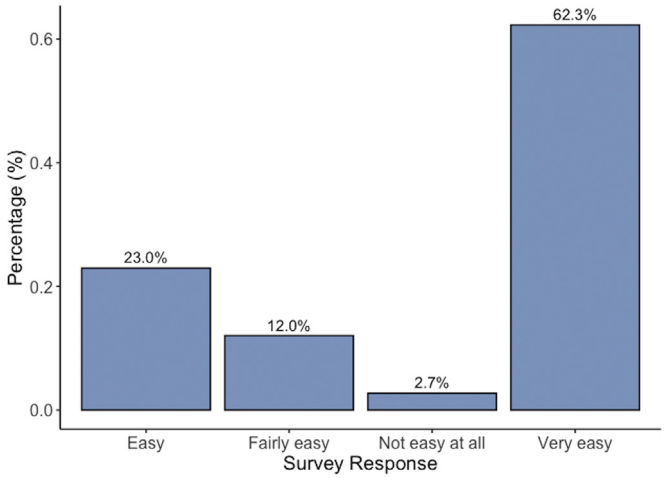


**Figure 2** Bar graph demonstrating responses to question 3, "How easy was it to comply with the treatment regimen?".

In this study, the application of BPO was well tolerated and had a high rate of satisfaction; however, greater than 20% of patients reported missing at least 1 of the 5 required doses prior to surgery. Various studies have demonstrated the efficacy of BPO treatment prior to shoulder surgery.[10,15,22] Scheer et al randomized 40 patients to topical at home treatment with either 5% BPO or chlorhexidine soap on the operative shoulder.[22] The authors found that the application of topical BPO significantly reduced the presence of *C. acnes* on the skin at the time of surgery and at 2 hours after surgical preparation compared with chlorhexidine soap. Kolakowski et al similarly demonstrated that treating with 5% BPO for 3 days prior to surgery led to fewer positive cultures relative to chlorhexidine and contralateral shoulder negative control.[15] In contrast, Hsu et al found that neither a 10% BPO soap nor a 4% chlorhexidine solution was effective at decreasing *C. acnes* burden from the skin surface or dermal edge of the incision.[14] Notably, patients in the study by Hsu et al were instructed to only apply treatment to the surgical shoulder twice (once the night prior and once the morning of surgery) rather than 5 applications.[14] Due to variability in current BPO treatment protocols in the literature, it is unclear whether treatment compliance may have an impact on the bioburden of *C. acnes* and the subsequent risk of periprosthetic joint infection. The protocol of 5 serial treatments described by Sabetta et al was used in the current study.[19] However, asking patients to complete more treatments may lead to a subset of patients missing one or more treatment, which was corroborated by the findings of the present study. The clinical implication of missing at least one treatment remains unknown, but the data put forth by Hsu et al do raise concern that fewer applications may lead to inferior antimicrobial effect.[14] Further work is needed to elucidate the optimal preoperative regimen of BPO application to maximize antimicrobial effects and compliance.

Drawbacks to topical BPO treatment prior to shoulder surgery have previously been described. These include side effects (bleaching of clothes, contact dermatitis), serial treatment applications leading to poor compliance, and failure of BPO to penetrate deep enough into the superficial dermis where sebaceous glands are located.[10,12,16,25] The concerns regarding the depth of penetration of topical preparations such as BPO are important, as *C. acnes* resides predominantly in the pilosebaceous gland in the dermis of the skin. Accordingly, recent efforts have focused on identifying viable alternative treatments that offer similar efficacy and potentially deeper penetration into the dermal layer of skin to BPO with fewer drawbacks. One such alternative that has been extensively investigated in the dermatology literature for the treatment of mild-to-moderate acne caused by high *C. acnes* burden is photodynamic therapy or BLT.[3,5,7,8] BLT has demonstrated effective antimicrobial action against *C. acnes* as well as other common bacteria,[5,9] penetrates into the dermal and subdermal layers where the sebaceous glands reside,[4,6] and may reduce susceptibility to bacterial resistance relative to antibiotic topicals and oral agents.[7] In the present study, approximately 40% of patients responded that they would prefer to undergo one-time BLT on the day of surgery rather than serial treatments with BPO prior to surgery. However, light-based treatments are in the early experimental stages within orthopedics, and it remains to be seen if these treatments will be useful as part of skin preparation prior to shoulder surgery.

### *Limitations*

This study is not without limitations. Consecutive patients managed by a single surgeon at our institution were approached in the preoperative holding area for completion of the survey, and approximately 35% of patients failed to complete the survey. These results are from a single center in a single region of the country. It is unknown if other centers in other locations would have similar compliance from their patient population in completing BPO treatments. Finally, compliance with BPO treatment was determined based on patient self-reported surveys, which may have resulted in underestimation or overestimation of the true compliance rate.

## Conclusion

Serial preoperative applications of topical 5% BPO gel are well tolerated by the majority of patients. Over 20% of patients missed at least one application of BPO. Most patients prefer home-based antimicrobial treatments over arriving earlier on the day of surgery for a single light-based antimicrobial treatment.

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Conflicts of interest: Dr. Grogan reports board or committee membership for the American Shoulder and Elbows Surgeons. The other authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

## Supplementary Data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jseint.2022.02.009.

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