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Bearded surgeons: Friend or foe in the fight against surgical site infections? An updated and comprehensive literature review

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ABSTRACT

One of the significant complications occurring after various surgical procedures, including orthopedics and traumatology, is surgical site infection (SSI), which poses an incidence of up to 3% and might lead to an increase in hospital stays, with a further increase in the economic burden on the healthcare system. Factors contributing to the SSI occurrence could be divided broadly into factors related to the patient (endogenous) or those associated with the surgical procedure (exogenous), which include, in part, the behavior and attitude of healthcare personnel and operative theater staff members, including surgeons. Facial hair and its correlation with increased bacterial contamination and colonization have been an issue of investigation. Furthermore, the relationship between healthcare personnel's facial hair (mainly beards) and the incidence of SSI was also evaluated. In this comprehensive narrative review, we aim to discuss the literature evidence related to facial hair and its correlation with SSIs. Studies showed conflicting results regarding the increase in bacterial contamination related to keeping facial hair compared with being clean-shaven. However, the correlation between having facial hair and increased SSI incidence was disputed. Healthcare personnel are encouraged to stick to covering their heads and facial hair while participating in patient care activities, especially inside the operative theaters, as this has been shown to decrease the rates of bacterial shedding from those having facial hair, even with long beards. Furthermore, surgeons should not be asked to shave their beards for the sake of protecting their patients from a possible increased SSI risk; instead, they should be encouraged to cover their beards and practice proper face hygiene.

Keywords: Bacterial contamination, Beards, Facial hair, Surgeons, Surgical site infection

INTRODUCTION

Surgical site infection (SSI) is "an infection that occurs in the part of the body where surgery took place," which is the simplified definition provided by the Centers for Disease Control and Prevention.[1] This common drawback complicates various surgical procedures, leading to increased patient morbidity and mortality incidences and creating a subsequent economic burden on healthcare systems.[2-4]

On the other hand, infections related to orthopedic and traumatology surgical procedures could be summarized into two major categories, both involving the insertion of implants or hardware. First are those occurring after joint replacement surgeries (such as total hip and total

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knee arthroplasties), which are called periprosthetic joint infections (PJI),[3,5] and second are those occurring after fracture fixation using various internal or external fixation hardware, which are called fracture-related infections.[2,6]

Regardless of the surgical subspecialties or procedures performed, SSI incidence is estimated to reach up to 3%, with an expected hospital stay lengthening by 11 days.[7,8] Hence, all efforts and attempts for decades have focused on preventing, diagnosing, and treating SSIs.[7,9] One major area of investigation and improvement is operative environment optimization, which mainly involves patient-related (intrinsic) and procedure-related (extrinsic) factors, including surgical team behavior and attitude issues.[9-12] Factors related to the surgeons and their attitude in the operative theater have been reported in the literature, such as sterilization techniques, surgical attire, limiting the operative theater traffic, and meticulous surgical techniques.[9,12] It has been shown that wearing proper surgical attire and head coverings is a way to decrease the number of microorganisms shed from the surgical team's skin and hair.[13-15]

On the other hand, various aspects and factors have been evaluated, which could be considered by some healthcare professionals as nonessential, such as the operative theater personnel's mobile phones possible contamination,[16,17] the role of opening the operative theater doors,[18,19] the way surgeons put the gloves on,[20,21] and one of these variables was related to the surgeon's facial hair, more specifically their beards.[22-27]

Preoperatively, hair removal from the surgical site has been assessed in the literature as a contributing factor to decreasing the SSI incidence, entailing mainly when it should be performed and how (i.e., using a razor or clipper).[28,29] According to the meta-analysis by Tanner and Melen, which analyzed 19 randomized controlled trials and six quasi-randomized trials, if hair removal is necessary (meaning that it could impede the surgical procedure), it should be performed in the pre-operative waiting area and not inside the operative room, furthermore, not shaving at all led to lower SSI compared to shaving with razor.[28]

Interestingly, one rarely studied factor related to hair removal or keeping is the effect of healthcare personnel, including surgeons, facial hair (mainly the beard) on SSI incidence, and whether it should be shaved or not. Hence, the current narrative review aimed to evaluate the literature on the correlation between SSI and whether healthcare personnel (including surgeons) grow facial hair (in particular, beards).

LITERATURE SEARCH FOR POSSIBLE STUDIES TO FORMULATE THE CURRENT REVIEW

To obtain the most relevant studies for formulating the current review, PubMed and Scopus databases were searched using the following search terms: ([Facial hair (Title/Abstract)] OR [beard (Title/Abstract)] AND [SSI (Title/Abstract)]) OR (periprosthetic infection* [Title/Abstract]), which revealed initial 914 articles. The results were downloaded to the EndNote program, and the titles and abstracts were examined for eligibility. Furthermore, a crude search using the Google search engine using generic questions such as "effect of surgeons' beard on infection" and "what is the correlation between beard and SSI?" and possible results were evaluated. The references of the included articles were assessed to find further eligible studies, and for studies indexed in PubMed, the Similar Articles tab was used to determine possible eligible studies.

This resulted in eight eligible articles; however, only six original research studies were included.[22-27] The excluded two articles: One was the results of a consensus meeting,[30] and the other was published as an abstract.[31] The results of the included articles were divided into A, those that reported on the issue of bacterial colonization and its relation to facial hair (beard), and B, articles in which the authors evaluated the correlation between bearded healthcare personnel and the incidence of SSIs. Furthermore, the articles were presented chronologically (from the oldest to the newest).

Studies evaluated the correlation between facial hair and bacterial colonization or shedding

A study published in 2000 by McLure *et al.* evaluated the effect of sex and the presence of facial hair on the amount of microorganism dispersal when the face mask worn during the surgical procedures was wiggled.[22] They compared ten male surgeons with shaved beards, ten with beards, and ten females. The authors reported that in the presence of a beard, the bacterial shedding was significantly higher if the mask was wiggled or not compared to clean-shaven males; *P*-values were 0.03 and 0.01, respectively. The authors recommended that to decrease bacterial contamination risk, the face mask should not be wiggled, and they suggested that bearded males should consider shaving their beards; however, the authors did not investigate if having a beard is correlated with a possible increase in infection risk or not, and their recommendations were based on speculations and theories.

A study by Wakeam *et al*. published in 2014 evaluated the bacterial ecology of healthcare workers with facial hair; they included 408 personnel, 199 (48.8%) with facial hair (either full beard, Goatee, or Mustache) and 209 (51.2%) without (clean-shaven).[23] All participants were involved in activities necessitating interaction with patients. They reported no difference ($P > 0.05$) between both groups regarding face washing protocols, time spent in the hospital, and their hospital roles (to be noted that 41% of the participants were residents or attending physicians). They collected samples in two ways: The first was by

obtaining two dry swabs from the face skin, and the second was by allowing the person to scratch or rub his cheek over a Petri dish 30 cm below the face (replicating the bacterial shedding occurring when the healthcare personnel touch their faces during patients care).

Wakeam *et al*.'s results showed the following: Healthcare personnel without facial hair had higher *Staphylococcus aureus* colonization on their lips and cheeks compared to those with facial hair (45.0% vs. 34.2%, $P = 0.03$; and 52.6% vs. 41.2%, $P = 0.02$, respectively). The same significant difference was noted for methicillin-resistant coagulase-negative staphylococci cultures (4.8% vs. 1.5%, $P = 0.06$; and 7.2% vs. 2.0%, $P = 0.01$, respectively).[23] However, healthcare personnel with facial hair shed more coagulase-negative staphylococci than those without (50.8% vs. 33.5%; $P < 0.001$), and no difference in shedding rates was reported for any other microorganisms. The authors carried out a sub-analysis comparing 103 personnel with full beards to 209 without (clean-shaven); they reported a significant difference regarding the *S. aureus* colonization on the cheek, where personnel with full beards showed less colonization (35.9% vs. 52.6%, $P = 0.005$). Although the authors concluded that facial hair did not increase the overall bacterial colonization risk, they emphasized the role of face coverings in decreasing the amount of bacterial shedding.

In a study by Parry *et al*. published in 2016, the authors evaluated bacterial shedding by 10 bearded compared to 10 clean-shaven surgeons.[24] All participants were tested under three circumstances: without a face mask, when masked, and after adding a non-sterile surgical hood. The authors reported no difference between bearded participants and clean-shaven regarding bacterial shedding if unmasked (9.5 vs. 3.3 colony-forming units [CFUs], $P = 0.1$), masked (1.6 vs. 1.2 CFUs, $P = 0.9$), or after adding a surgical hood (0.9 vs. 1.3 CFUs, $P = 0.6$). Furthermore, there was no difference between the two groups in the three different situations regarding aerobic or anaerobic bacterial CFUs. The authors reported that participants with a beard length ≥20 mm shed more bacteria than clean-shaven participants (18 vs. 3.3 CFUs, $P = 0.03$); however, this difference disappeared when participants were masked ($P = 0.4$) or wearing a surgical hood ($P = 0.3$).

It is worth noting that the overall bacterial shedding by all the participants was significantly higher when unmasked (a mean of 6.5 CFUs of aerobic and anaerobic bacteria) compared to when a mask was used (1.4 CFUs, $P = 0.02$) and after adding a surgical hood (1.1 CFUs, $P = 0.01$).[24]

The El Edelbi *et al*. study, published in 2022, aimed to evaluate the facial bacterial load in bearded versus non-bearded men attending the operative theatres in a tertiary Middle East hospital and to further identify the bacterial strains and their antimicrobial resistance profile.[25] They included 80 participants (61 bearded and 19 non-bearded men); the authors obtained four samples for each participant, where sample A was collected from the lower and upper lips, B: From the cheek skin, C and D were collected into a Petri plate 20 and 40 cm away after beard rubbing (to test for bacterial shedding). Furthermore, they tested microorganisms obtained from samples A and B against various concentrations of meropenem. Randomly selected samples from the four groups were tested on lysogeny broth (LB) agar plates supplemented with 4% chlorhexidine. Bacterial growth of <30 CFUs was considered low growth.

There were no differences between the two groups regarding the use of soap for daily face washing, smoking, working hours, and working departments. Heavy bacterial growth was significantly higher in the non-bearded compared to bearded participants for both samples A and B (78.9% vs. 50.8% ($P = 0.03$) and 89.5% vs. 65.6% ($P = 0.04$), respectively). However, for samples C and D, the isolates from the bearded group were associated with a higher positive bacterial growth compared to non-bearded, 77% versus 56% ($P = 0.04$) and 27.9% versus 21.1% ($P = 0.5$), respectively. It should be noted that the difference in sample D was not significant. Meropenem-resistant isolates were reported in 18 out of 65 tested isolates (27.6%); all isolates were defined as *S. aureus*, 14 were from bearded participants, and four were non-bearded. The authors reported no difference between the two groups regarding the minimal inhibitory concentration of >4 μg/mL against meropenem-resistant bacterial isolates among samples A and B (*P*-value was 0.96 and 0.84, respectively). Furthermore, the 160 randomly selected isolates from all sample groups, which were tested using LB agar plates supplemented with 4% chlorhexidine for 48 h, showed no bacterial growth.[25]

Studies evaluated the correlation between healthcare personnel having facial hair and the incidence of SSIs

A study published in 2023 by McEntee *et al*. aimed to assess the infection incidence in outpatients' orthopedic surgeries performed by bearded surgeons; two fellowship-trained surgeons operated on 471 patients when they were clean-shaved during the first 6 months of the study in the following 6 months that they grow their beards and operated on 469 patients, in all surgeries, the surgeons ware a standard face mask.[26] The SSI was divided into either minor or major (those requiring hospital readmission and secondary intervention). The overall SSI incidence was 0.31% and 6.05% for major and minor infections, respectively. While the surgeons' beards were clean-shaven, the minor and major infections were 6.62% and 0.42%, respectively. When they grow their beards, the minor and major infections are 5.75% and 0.21%, respectively. The authors reported no significant difference in the minor or major infections between both groups; *P*-values were 0.80 and 1.00, respectively. The authors

concluded that the infection incidence was not affected by whether the surgeons had a beard or not.

In a study published in 2023 by Brodt *et al*., the authors retrospectively evaluated the association between facial hair (beards) and PJI incidence.[27] They investigated the incidence of SSI in 20,394 primary total joint replacement surgeries (hips and knees) over 1 year, performed by 81 surgeons. They correlated the findings to the surgeons' status of facial hair (clean-shaven vs. facial hair wearer [mustache, chin beard, round beard, or full beard]), to be noted that their institution protocol necessitates surgeons to wear surgical hoods and surgical face masks (during the study, no helmet system or special masks for bearded surgeons were used). Of the included surgeons, 12 wore facial hair. The overall SSI incidence was 0.75%, and the authors reported that the incidence showed no significant association in the presence of any facial hair ($P = 0.774$) or according to specific beard types ($P = 0.298$); furthermore, the results remained non-significant even after adjusting for surgeon volume and the year and calendar month of the surgery. The authors stated that, according to their results, recommended special devices (such as a helmet system) for bearded surgeons are not mandatory. However, they recommended wearing an under-mask beard cover or two mouth and nose masks for surgeons with long beards.

DISCUSSION

Keeping or shaving healthcare personnel's facial hair (beards) seems controversial, with a dogmatic tendency to favor removing facial hair for better cleanliness and less bacterial contamination. Apparently, the published literature failed to support such a tendency, as only one study (McLure *et al*.) reported more bacterial shedding if the mask was wiggled in bearded healthcare personnel compared to clean-shaven, but could not demonstrate an increased incidence of SSI.[22] In contrast, the remaining studies supported the fact that having a beard is not associated with increased bacterial contamination, and studies reported on the correlation between having facial hair and SSI incidence showed no difference in whether the healthcare personnel were bearded or not.

So, why are there concerns related to healthcare personnel being bearded?

Noble, in 1975, reported that the desquamated skin (approximately 10%) harbors pathogenic microorganisms (bacteria), including *S. aureus* and streptococci. These microorganisms are disseminated in the air in variable amounts, relying mainly on the person's sex and body area; furthermore, 7% of the studied cohort dispersed microorganisms >3 colonies/plate.[32] This process has been linked to operative environment contamination with airborne bacteria.[13,33,34]

To evaluate the microorganisms in the hair and their drawbacks, Huijsmans-Evers examined 3,039 operative theaters and hospital personnel to assess *S. aureus* dispersion and its correlation to SSI incidence over 4 years. Among the 122 staff members identified as *S. aureus* dispersers, testing revealed the presence of microorganisms in the scalp hair of 21.5% of 2,688 personnel (whose scalp hair was screened). In addition, 15.5% of the 84 personnel whose facial hair was tested (beards and mustaches) were positive. The author noted that nine of these individuals, who tested positive as microorganism dispersers, were responsible for 19 SSI incidents.[35]

Lidwell *et al*. studied air samples from 15 hospitals during joint replacement surgeries, and they reported between 51 and 539 bacteria-carrying particles per cubic meter; furthermore, they found a strong correlation between PJI and air contamination levels.[36] Furthermore, in a study by Edmiston *et al*., the air samples obtained from within 0.5 to 1 m of the surgical incisions contained 51% coagulase-negative staphylococci, and 39% contained *S. aureus*, which was matched to the DNA of the staff members present during the operative procedures.[37]

As part of the questions asked during the 2018 International Consensus on Orthopedic Infections was whether facial hair (beard and mustache) worn by operative theatre personnel, including surgeons, affects the incidence of SSI or PJI, Baldini *et al*. reported that 89% of the delegates who participated in the voting agreed on the statement.[30] However, the authors could not report robust recommendations without solid data.

What is the role of covering the head and facial hair in preventing bacterial shedding and protecting against increased SSI risks?

Although covering hair as part of the surgical attire protocol is the standard protocol for most surgical procedures, it is interesting that the evidence to support hair covering during surgical procedures is controversial.[13,38,39] Furthermore, the debate extends to the efficiency of wearing surgical masks in decreasing the SSI incidence.[40,41] However, the current Occupational Safety and Health Administration regulations dictate that during surgical procedures, all scrubbed personnel should wear a face mask as part of the personal protective equipment, which was agreed on by the updates on SSI Guidelines by the American College of Surgeons and Surgical Infection Society.[42,43]

Interestingly, Tunevall prospectively randomized 3088 patients who underwent general surgery procedures into two groups, wherein the healthcare personnel were masked in one group and not in the other; the author reported no significant difference between both groups regarding the SSI incidence (4.7% vs. 3.5%; $P > 0.5$). Furthermore, the two groups did not differ in the bacterial species isolated from the surgical wounds.[44]

Parry *et al*.'s results emphasized the importance of wearing a surgical mask; furthermore, the authors reported that they noticed that shedding was the least when participants with the longest beards wore a mask, which they hypothesized that the longer hair might create a less abrasive articulation with the face covering materials, with subsequent lower shedding.[24]

In a study by Farach *et al*. (presented as an abstract in 2018), they evaluated the SSI incidence changes before (3,077 patients) and after (3,340 patients) implementing strict protocols for covering ears and all facial hair as part of the surgical attire (data were obtained from American College of Surgeons National Surgical Quality Improvement Program).[31] The authors reported that these restrictions did not decrease the SSI incidence (odds ratio 1.2, Confidence interval 0.70–1.96, $P = 0.56$).

Before advising surgeons to remove or keep their beards, one crucial question to be answered is why some surgeons grow their beards

Answering this question will help understand why some surgeons refuse to shave their beards and are willing to adopt any possible precaution to protect themselves and their patients from contamination or harm their beards might cause.

Regarding the general population adopting beards growing, a survey conducted in 2017 showed that about one-third of US adult males kept their beards; furthermore, 27% of the respondents confirmed keeping their beards sporadically.[45] In a British survey conducted in 2016, 61% of males between 18 and 39 years old reported having a form of facial hair, and 37% of all males confirmed having a beard.[46]

Furthermore, apart from being a free will for a person to grow facial hair, some consider a beard a symbol of masculinity and maturity, which further increases their attractiveness.[47] However, for others, it is not only for better appearance; it is a religious obligation and part of their religious rituals, such as for Muslims, Jews, and Sikhs.[48] Hence, understanding why surgeons are letting their beards grow could control whether they should be asked to shave them for patients and their safety against possible infection hazards.

What are the possible solutions for surgeons wanting to keep their beards?

Apart from the classic well-documented protocols and dress code for the operative theaters, covering the head and necessary facial parts are well described in the literature.[31,49] Regarding the facial hair covering and its impeding effect when it comes to face mask usage, surgical hoods and space suits (such as those being used during joint replacement surgeries) could be a solution. However, these are not available for every surgical team, especially those with restricted economic resources.[50-52]

Masud and Andrew described a simplified technique that used a usual theater hat and a standard surgical mask to cover and protect the surgeon's beard efficiently.[50] Furthermore, Singh *et al*. proposed what they called the "*Singh Thattha* technique," which entails using an under-mask beard cover.[53] Their methods achieved a qualitative pass rate of 25/27 (92.6%) and a quantitative fit test of 5/5 (100%) when used by full-bearded personnel. The previous two examples are simple and economical solutions that could be applied using materials in every operating theater without needing expensive and specific protective equipment. The same technique was proposed, and it showed efficacy in a study by Bhatia *et al*.[54]

Furthermore, wearing a surgical hood (even if it is non-sterile) with the usual face masks proved superior to wearing a face mask alone. It showed efficiency equal to that of the sterile ventilated hoods, decreasing the bacteria CFUs in the surgical wounds by about 99%.[55] Moreover, Parry *et al*.'s study proved the same previous conclusion.[24]

Finally, the results presented in the current review and the conclusions drawn should be interpreted cautiously due to some limitations. First, although the current narrative review was based on a literature database search, it was not a formal systematic review, and some of the major databases were not searched, which might lead to missing some crucial studies related to the subject being discussed. Second, the number of included studies is relatively small, with further differences between them regarding the study design, population being tested, and experiment preparation, leading to variability in the drawn results.

CONCLUSION

There is no doubt that healthcare personnel with facial hair (particularly beards) harbor certain bacterial species that might be shed while taking care of patients, with the possible risk of developing a nosocomial infection or SSI. However, the literature did not support such high-risk claims; even more, some studies showed a protective effect of having a beard, resulting in less bacterial shedding when the personnel are masked. Eventually, it is undeniable that covering facial hair with face masks will decrease bacterial shedding; furthermore, if a surgical hood is possible, it will improve the protection, even if it is non-sterile. Surgeons should not be asked to shave their beards for the sake of protecting their patients from a possible increased SSI risk; instead, they should be encouraged to cover their beards and practice proper face hygiene. Finally, conducting a systematic review and meta-analysis, including more studies, will provide more substantial evidence.

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