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Short report

Bacterial ecology of hospital workers' facial hair: a cross-sectional study

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SUMMARY

It is unknown whether healthcare workers' facial hair harbours nosocomial pathogens. We compared facial bacterial colonization rates among 408 male healthcare workers with and without facial hair. Workers with facial hair were less likely to be colonized with *Staphylococcus aureus* (41.2% vs 52.6%, $P = 0.02$) and methicillin-resistant coagulase-negative staphylococci (2.0% vs 7.0%, $P = 0.01$). Colonization rates with Gram-negative organisms were low for all healthcare workers, and Gram-negative colonization rates did not differ by facial hair type. Overall, colonization is similar in male healthcare workers with and without facial hair; however, certain bacterial species were more prevalent in workers without facial hair.

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Introduction

Hospital-acquired infections (HAIs) are a major source of preventable morbidity and mortality. These infections have often been the target of quality improvement and safety initiatives, and many are now publicly reported by Medicare on its reporting outlet, *Hospital Compare*.¹ Although the precise route of infection is often unclear, the hands, clothing, and equipment of healthcare workers (HCWs) may play a role in facilitating patient-to-patient transmission.^{2–4} For example, reports suggest that 25–50% of physicians' white coats may harbour *Staphylococcus aureus*.^{2,3}

Facial hair may be another potential reservoir for the microorganisms implicated in HAIs. All human beings, including HCWs,

routinely touch their faces. If facial hair harbours different or more abundant pathogens than facial skin alone, then HCWs' facial hair may impact HAI risk and act as a reservoir for bacteria of potential nosocomial significance. No studies to date have evaluated colonization of HCWs' facial hair with HAI-associated bacteria. Better understanding of the bacterial ecology of facial hair may have implications for hospital policies regarding covering facial hair during invasive procedures.

We therefore sought to characterize the bacterial ecology of HCWs' facial hair, whether facial organisms differ in bearded and unbearded male HCWs and the propensity for facial self-contact to release bacteria.

Methods

Study population and sample size estimates

We performed cross-sectional sampling of the prevalence of bacterial species in HCWs with and without facial hair in two

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teaching hospitals during July and August of 2013. All participants were required to have routine direct patient contact, defined as daily interaction with patients in a clinical setting. Subjects entered the study anonymously. Each subject gave verbal consent prior to participating. This study was reviewed and approved by the Partners Healthcare Institutional Review Board.

We calculated our target sample sizes assuming a 30% rate of baseline colonization with *S. aureus* based on prior literature.^{5,6} For 80% power to see a 10% difference in colonization rates between workers with and without facial hair, assuming an alpha of 0.05, we calculated that 199 subjects were required for each group.

Study procedures

Subjects answered basic questions regarding their demographics, role in the hospital, department, and time of last face wash with soap and water. Subjects were asked to self-classify their facial hair style (no facial hair, full beard, moustache, goatee, other). We then took two dry swabs from the skin of the face, the first from the centre of the cheek and the second from the skin of the upper lip below the nares. We then carried out a test for shedding. Each subject was asked to scratch or rub their cheek using a sterile swab while a Petri dish was held 30 cm below the face. This test was designed to replicate potential bacterial shedding into a sterile field or surface that could occur if HCWs were to touch their face during patient care. To minimize misattribution of environmental bacteria to HCWs' faces, a shedding test was only considered positive if the same species of bacteria grew in the shedding test as from the HCWs' face swabs.

Microbiology

Swab samples were plated using standard techniques. Swabs from subjects' faces were placed in 1 mL sterile phosphate-buffered saline, vortexed for 30 s, and 100 μ L plated to Mannitol Salt Agar (MSA; Remel, Lenexa, KS, USA) for selection of *Staphylococci*, MRSA CHROMagar (Biomérieux, Durham, NC, USA) for detection of methicillin-resistant *S. aureus*, and MacConkey agar for detection of Gram-negative species (Remel, Lenexa, KS, USA). Shedding samples were directly collected on 10% Sheep's Blood Agar with Columbia agar base. MSA plates were incubated at 37 °C in a humidified incubator with ambient air; all other media were incubated at 37 °C in 5% CO₂ atmosphere. Plates were read at 24 h of incubation. On MSA plates, yellow colonies were identified as *S. aureus* and pink as coagulase-negative staphylococci. Blue colonies on CHROMagar were confirmed as methicillin-resistant *S. aureus* per Gram stain with Gram-positive cocci, and positive catalase and coagulase reactions. Lactose-positive colonies on MacConkey agar were typed by API-20E. Lactose-negative colonies were first tested by oxidase reaction. Oxidase-negative isolates were typed biochemically by API-20E and oxidase-positive by Biomérieux's non-fermenter panel or 16S rRNA sequencing.

Statistical analysis

Subject demographics and colonization rates were summarized with descriptive statistics. Categorical variables were analysed using χ^2 -tests and Fisher's exact test where appropriate. Continuous variables were analysed using *t*-tests and

Table 1
Demographic characteristics of the study population

	HCWs with facial hair	HCWs without facial hair	P-value
<i>n</i>	199	209	
Age	36.3 (14.5)	37.8 (13.8)	0.18
Facial hair			
Clean shaven	NA	209	
Full beard	103	NA	
Goatee	52	NA	
Moustache	25	NA	
Other	19	NA	
Role in hospital			
Attending physician	16.4%	24.9%	
Resident/fellow physician	18.0%	22.9%	
Nursing	5.6%	8.3%	
Ancillary and other	58.5%	43.9%	0.06
Date when face last washed			
Today	86.6%	87.0%	
Yesterday	11.2%	12.0%	
Within 1 week	2.2%	0.5%	
>1 week	0	0.5%	0.38
Mean (SD) no. of hours in the hospital	5.2 (6.5)	6.0 (6.9)	0.18
Department			
Surgery (incl. subspecialty)	26.1%	22.0%	
Medicine (incl. subspecialty)	21.6%	35.4%	
Anaesthetics	5.5%	7.9%	
Obstetrics & gynaecology	1.5%	1.9%	
Psychiatry	2.0%	1.9%	
Primary care	0.5%	0.5%	
Emergency department	0.5%	1.4%	
Radiology	11.1%	5.7%	
Ancillary	10.6%	4.8%	
Other	20.1%	16.8%	
Missing	0.5%	2.4%	0.03

NA, not applicable.

Wilcoxon tests. We planned several analyses *a priori*, including stratified analyses by hospital department and facial hair type. *P* < 0.05 was considered significant. All statistics were performed using SAS version 9.3 (SAS, Cary, NC, USA).

Results

Demographics

We enrolled 408 subjects. Subjects' demographic characteristics are summarized in Table 1. Resident or attending physicians accounted for 167/408 (41%) of subjects. No significant differences were observed between workers with facial hair and those without in terms of their hospital roles, face washing habits, or mean number of hours spent in hospital that day. There were slightly more clean-shaven men than men with facial hair from the Department of Medicine and more workers

with facial hair than without facial hair from the Radiology Department.

Culture results

Culture results are shown in Table II. HCWs without facial hair had higher rates of colonization with *S. aureus* for both lip and cheek swab compared to workers with facial hair (45.0% vs 34.2%, $P = 0.03$ for lip; 52.6% vs 41.2%, $P = 0.02$ cheek). A similar trend was observed for methicillin-resistant coagulase-negative staphylococci cultures (4.8% vs 1.5%, $P = 0.06$ for lip; 7.2% vs 2.0%, $P = 0.01$ for cheek) but no difference was seen in the prevalence of methicillin-susceptible coagulase-negative staphylococci. Overall prevalence of Gram-negative organisms was low for workers with and without facial hair (ranging from 1.0% to 3.8%). For those bacterial groups most closely associated with hospital-acquired infection (including *Klebsiella* spp., *Pseudomonas* spp., *Enterobacter* spp. and *Acinetobacter* spp.), prevalence was low and <2% for each group, respectively. Workers with facial hair were more likely to shed coagulase-negative staphylococci on to the agar plate (50.8% vs 33.5%; $P < 0.001$) but there was no difference in shedding rates for other organisms. Stratified analyses, shown in Appendices 1–3, did not reveal any differences in colonization rates by hospital department or facial hair type.

Discussion

Herein we report a cross-sectional study to test the hypothesis that the facial hair of HCWs could harbour bacteria of potential nosocomial significance. More generally, our study also presents data on the bacterial ecology of facial hair in HCWs. Our results suggest that male hospital workers with facial hair do not harbour more potentially concerning bacteria than clean-shaven workers, and that in some instances, clean-shaven individuals are significantly more likely to be colonized with potential nosocomial pathogens.

Several studies to date have demonstrated that physician white coats and neck ties can act as significant sources of

nosocomial bacteria.^{2,3} Our study suggests that facial hair does not increase the overall risk of bacterial colonization compared to clean-shaven control subjects. Indeed, clean-shaven control subjects exhibited higher rates of colonization with certain bacterial species. This finding may be explained by micro-trauma to the skin during shaving resulting in abrasions, which may support bacterial colonization and proliferation. This may be akin to the enhanced risk of surgical site infections in patients shaved with razors prior to surgery.^{7,8} Further, our results are consistent with prior evidence pertaining to bacterial colonization on the hands and nares of HCWs.^{5,6,9,10}

We also investigated differences in facial bacterial shedding between workers with and without facial hair. Workers with facial hair were more likely to shed bacteria after rubbing their faces with a swab; however, both subjects and controls shed bacteria at high rates, 42% overall, re-emphasizing the importance of HCWs fully covering their faces during sterile procedures. This result is consistent with prior literature suggesting that facial manipulation leads to bacterial shedding in both male and female HCWs, and that facial hair can increase bacterial shedding in male HCWs.¹¹ Airborne contamination and bacterial shedding are known to contribute to surgical infections.^{12–14} Our results therefore support current infection control practices, which include complete coverage of the face during the performance of invasive procedures under sterile conditions.

Our study has several limitations. Firstly the study was cross-sectional, not randomized, and therefore may have been influenced by unmeasured confounders. We only assessed for HCW colonization and shedding, we did not assess patient outcomes or transmission to patients. We were unable to quantify density of facial hair which could play a role in bacterial colonization. We did not collect details about shaving habits and therefore cannot comment on whether different shaving mechanisms are associated with different colonization rates. Further, it is possible that bacteria residing on hair may be more resistant to sampling by swab, and hence we may have underestimated rates of colonization in HCWs with facial hair. Finally, our study was based in two institutions alone and

Table II

Culture results for lip, cheek and shedding test in bearded and non-bearded subjects

	HCWs with facial hair	HCWs without facial hair	P-value
<i>n</i>	199	209	
Lip			
Methicillin-sensitive coagulase-negative staphylococcus	84.4%	87.6%	0.36
<i>Staphylococcus aureus</i>	34.2%	45.0%	0.03
Methicillin-resistant <i>Staphylococcus aureus</i>	0	0.3%	0.33
Methicillin-resistant coagulase-negative staphylococcus	1.5%	4.8%	0.06
Gram-negatives ^a	1.0%	2.4%	0.28
Cheek			
Methicillin-sensitive coagulase-negative staphylococcus	83.4%	82.3%	0.76
<i>Staphylococcus aureus</i>	41.2%	52.6%	0.02
Methicillin-resistant <i>Staphylococcus aureus</i>	0.5%	0	0.31
Methicillin-resistant coagulase-negative staphylococcus	2.0%	7.2%	0.01
Gram-negatives ^a	1.5%	3.8%	0.14
Shedding			
Methicillin-sensitive coagulase-negative staphylococcus	50.8%	33.5%	0.0004
<i>Staphylococcus aureus</i>	0	1.0%	0.17
Gram-negatives ^a	0	0.3%	1

^a Gram-negatives include *Enterobacter* spp., *Klebsiella* spp., *Acinetobacter* spp., *Burkholderia* spp., *Pantoea* spp., and *Pseudomonas* spp.

therefore the bacterial profile we observed may not be representative of other institutions.

Overall colonization rates are similar in male HCWs with and without facial hair. Clean-shaven workers, however, are significantly more likely to be colonized with *S. aureus* and methicillin-resistant coagulase-negative staphylococci. Both groups shed bacteria at high rates. Our results support standard infection control practices to prevent contamination during the performance of sterile procedures.

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Conflict of interest statement

None declared.

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Appendix 1. Sub-analysis of culture results by facial hair type

	Full beard	Goatee	Moustache	Other	P-value
<i>n</i>	103	52	25	19	
Lip					
Methicillin-sensitive coagulase-negative staphylococcus	80.6%	88.5%	88.0%	89.5%	0.49
<i>Staphylococcus aureus</i>	34.0%	30.8%	36.0%	42.1%	0.84
Methicillin-resistant <i>Staphylococcus aureus</i>	0	0	0	0	NA
Methicillin-resistant coagulase-negative staphylococcus	1.9%	0	4.0%	0	0.52
Gram-negatives ^a	1.9%	0	4.0%	0	0.52
Cheek					
Methicillin-sensitive coagulase-negative staphylococcus	78.6%	92.3%	92.0%	73.7%	0.06
<i>Staphylococcus aureus</i>	35.9%	48.1%	44.0%	47.4%	0.46
Methicillin-resistant <i>Staphylococcus aureus</i>	1.0%	0	0	0	0.82
Methicillin-resistant coagulase-negative staphylococcus	1.9%	0	8.0%	0	0.11
Gram-negatives ^a	1.9%	0	0	5.3%	0.37
Shedding ^b					
Coagulase-negative staphylococcus	56.3%	48.1%	40.0%	42.1%	0.37

NA, not applicable.

^a Gram-negatives include *Enterobacter* spp., *Klebsiella* spp., *Acinetobacter* spp., *Burkholderia* spp., *Pantoea* spp., and *Pseudomonas* spp.

^b No shedding observed for other bacterial species.

Appendix 2. Sub-analysis of culture results by hospital department

	Surgery	Medicine	Anaesthesia	Radiology	P-value
<i>n</i>	98	117	26	34	
Lip					
Methicillin-sensitive coagulase-negative staphylococcus	88.8%	87.2%	80.8%	85.3%	0.74
<i>Staphylococcus aureus</i>	35.7%	40.2%	42.3%	32.4%	0.78
Methicillin-resistant coagulase-negative staphylococcus	3.1%	4.3%	11.5%	0	0.14
Methicillin-resistant <i>Staphylococcus aureus</i>	0	0.9%	0	0	0.71
Gram-negatives ^a	2.0%	2.6%	0	0	0.68
Cheek					
Methicillin-sensitive coagulase-negative staphylococcus	83.7%	80.3%	80.8%	85.3%	0.87
<i>Staphylococcus aureus</i>	49.0%	47.9%	46.0%	47.1%	0.99
Methicillin-resistant coagulase-negative staphylococcus	4.1%	5.1%	3.9%	0	0.61
Methicillin-resistant <i>Staphylococcus aureus</i>	0	0	0	0	NA
Gram-negatives ^a	2.0%	4.3%	0	0	0.38
Shedding ^b					
Methicillin-sensitive coagulase-negative staphylococcus	39.8%	49.6%	26.9%	52.9%	0.1
<i>Staphylococcus aureus</i>	1.0%	0.9%	0	0	0.9

NA, not applicable.

^a Gram-negatives include *Enterobacter* spp., *Klebsiella* spp., *Acinetobacter* spp., *Burkholderia* spp., *Pantoea* spp., and *Pseudomonas* spp.

^b No shedding observed for other bacterial species.

Appendix 3. Direct comparison of culture results for healthcare workers (HCWs) with full beards versus those without facial hair

	Fully bearded HCWs	HCWs without facial hair	P-value
<i>n</i>	103	209	
Lip			
Meticillin-sensitive coagulase-negative staphylococcus	80.6%	87.6%	0.10
<i>Staphylococcus aureus</i>	34.0%	45.0%	0.06
Meticillin-resistant <i>Staphylococcus aureus</i>	0	0.3%	0.48
Meticillin-resistant coagulase-negative staphylococcus	1.9%	4.8%	0.22
Gram-negatives ^a	1.0%	2.4%	0.39
Cheek			
Meticillin-sensitive coagulase-negative staphylococcus	78.6%	82.3%	0.44
<i>Staphylococcus aureus</i>	35.9%	52.6%	0.005
Meticillin-resistant <i>Staphylococcus aureus</i>	1.0%	0	0.14
Meticillin-resistant coagulase-negative staphylococcus	1.9%	7.2%	0.06
Gram-negatives ^a	1.9%	3.8%	0.37
Shedding			
Coagulase-negative staphylococcus	56.3%	33.5%	0.0001
<i>Staphylococcus aureus</i>	0	1.0%	0.31
Gram-negatives ^a	0	0.5%	0.48

^a Gram-negatives include *Enterobacter* spp., *Klebsiella* spp., *Acinetobacter* spp., *Burkholderia* spp., *Pantoea* spp., and *Pseudomonas* spp.

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