Bacterial Contamination of Surgical Scrubs

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Abstract

To our knowledge, no study has examined the bacterial profile of residents' scrubs. The goal of this investigation was to determine the bacterial profile of worn and unworn resident scrubs.

Thirty pairs of scrubs were swabbed in 10 predetermined locations both prior to and after being worn continuously by the on-call resident. All swabs were screened for aerobic gram-positive and gram-negative bacteria. Bacteria underwent antimicrobial resistance testing and genetic relatedness by pulsed-field gel electrophoresis.

Forty-one percent (123) of unworn scrub samples yielded bacteria, compared with 89% (268) of post-call scrub samples. On unworn scrubs, the most common organisms were coagulase-negative staphylococcus (CNS; 94), gram positive rods (GPR; 34) and *Streptococcus viridians* (8). On post-call scrubs, the most common bacteria were CNS (271), micrococcus (51), *Staphylococcus aureus* (33), and GPR (28). All *S aureus* were methicillin susceptible. There were different species, pulsed-field types and antibiotic resistance profiles found amongst the CNS identified. No scrubs were found to harbor multidrug-resistant (MDR) organisms.

This study found that unworn scrubs harbored normal skin flora and scrubs worn for at least 24 hours have a higher burden of bacteria than unworn scrubs but not an increased incidence of contamination with MDR organisms.

It is widely accepted that contamination of scrubs with bacteria, including multidrug-resistant (MDR) organisms, is unavoidable during health care administration.[1,2] Research has shown that the bacterial loads on clean and dirty-looking scrubs are similar.[3] Regardless of their appearance, scrubs should be changed daily.[4] However, several studies have shown that healthcare workers do not adhere to this recommendation and that nonadherence may lead to increased risk for nosocomial infections.[5]

Certain bacteria can survive in the hospital environment despite use of infection control protocols[6] and surgical attire (scrubs).[5] The perineum, thighs, and feet shed more bacteria than other parts of the body,[7] and shed bacteria often end up in the operating room air.[4,8] It is estimated that staff in the operating room release about 10,000 skin cells per minute, of which approximately 10% carry bacterial clusters.[9] These particles commonly come into contact with the operative field.[10] Reports suggest that more than 50% of all surgical site infections are caused by normal skin flora shed by the patient or the healthcare workers in the operating room.[11] In addition, pulsed-field gel electrophoresis (PFGE) has demonstrated clonal linkage of surgical wound bacteria and skin flora of operating room team members.[11] Bacterial shedding and contamination in the operating room may, in part, account for postoperative infections continuing to occur (rate, 0.5-11%) after implementation of many infection control practices in hospitals and surgery centers.[12]

It was recently shown that surgeons and high-risk patient populations have similar rates of methicillin-resistant *Staphylococcus aureus* (MRSA) nasal colonization.[13] Furthermore, the rate of methicillin-sensitive *S aureus* (MSSA) nasal colonization was significantly higher in surgeons (59% of orthopedic residents) than in patients.[13] These findings are worrisome, as many studies have identified colonization with *S aureus* as an important risk factor, if not the most important one, for developing a surgical site infection.[14]

To our knowledge, speciation of bacteria on postcall residents' scrubs has not been examined. The goal of the present study was to evaluate the bacterial profile of unworn (precall) and worn (postcall) scrubs in an effort to better understand the colonization of residents' scrubs. We hypothesized that scrubs would be colonized with MDR organisms and normal skin flora.

Materials and Methods

We conducted an observational study of the scrubs worn by orthopedic surgery residents at the Brooke Army Medical Center.

Isolate Collection

This study was conducted under a protocol reviewed and approved by the director of research and commander of the US Army Institute of Surgical Research

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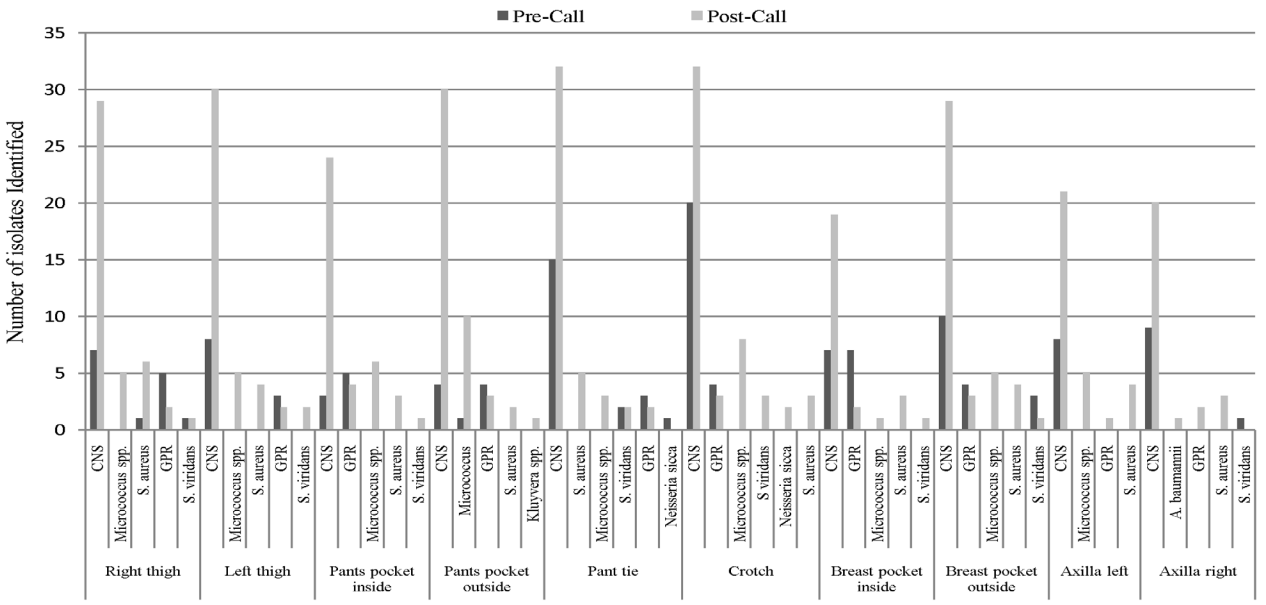

Figure 1. Isolates by scrub location. Abbreviations: CNS, coagulase-negative Staphylococcus; GPR, gram-positive rods.

and in accordance with the approved protocol. Brooke Army Medical Center is a 224-bed level I trauma center with infection control policies that include contact isolation for patients with vancomycin-resistant enterococci, MRSA, and other MDR organisms. The hospital contracts out the laundering of its scrubs to a local, private company (Division Laundry & Cleaners, San Antonio, Texas). The scrubs are laundered at that facility, packaged in cellophane wrap, and transported to the hospital for storage and use.

This study involved the scrubs worn by 3 men in the postgraduate year 2 (PGY-2) class of the orthopedic surgery residency. Scrubs were obtained from the main storage bin within the operating room. Unworn scrubs were cultured and delivered to on-call residents to wear. Residents changed into the scrubs at the start of their call and wore the scrubs continuously. When scrubs became grossly contaminated during call, the resident changed, and those scrubs were excluded from the final data set. Undershirts were not worn under scrub shirts. On completing call, the resident placed the scrubs into a sterile bag and the worn scrubs were then cultured in the same manner as the unworn scrubs. Results from 30 pairs of scrubs were analyzed.

Scrub Culturing

Swabbing was done in the orthopedic surgery department, where the residents have their desks. Microbiological samples from the scrubs were obtained using CultureSwab EZ (BD Diagnostics, Franklin Lakes, New Jersey). Designated areas were swabbed for 20 seconds in a rolling fashion. After being obtained from the main storage area (precall) or the sterile bag (postcall), scrubs were swabbed. The samples were plated on Trypticase soy agar with 5% sheep blood (BD Diagnostics) and MacConkey agar before being incubated for 48 hours with observation every 24 hours at 35°C to 37°C.

Ten areas were swabbed: on the shirt, a 5×10-cm area directly above both breast pockets and a 10×10-cm area centered in the mid-axilla; on the pants, a 10×10-cm area at the apex of the inseams, a 10×10-cm area directly below where the pants are tied, a 5×10-cm area directly above both pockets, and a 10×10-cm area on the anterolateral thigh of both legs. All swabs were sent to the microbiology laboratory for identification of aerobic gram-positive and gram-negative bacteria.

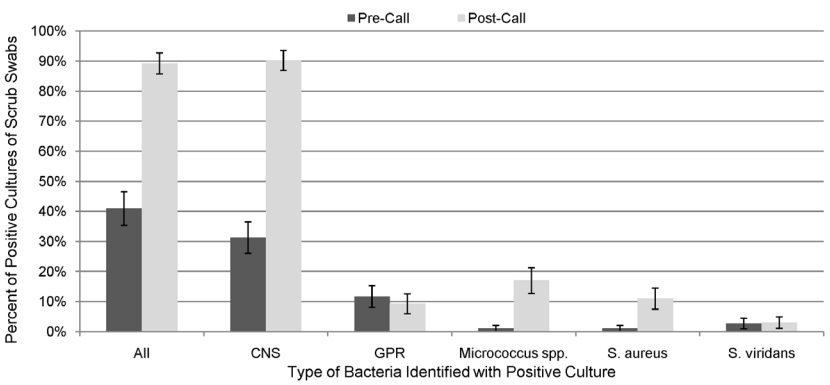

Figure 2. Percentage of positive cultures on precall and postcall scrubs, with 95% confidence intervals. The precall and postcall groups differed significantly with respect to all, coagulase-negative *staphylococcus, micrococcus*, and *Staphylococcus aureus,* but not gram-positive rods and *Streptococcus viridans*. Some scrub samples produced multiple isolates, and the percentages depicted in the bacterial groups represent the percentage in relationship to the total number of isolates, not the total number of culture samples.

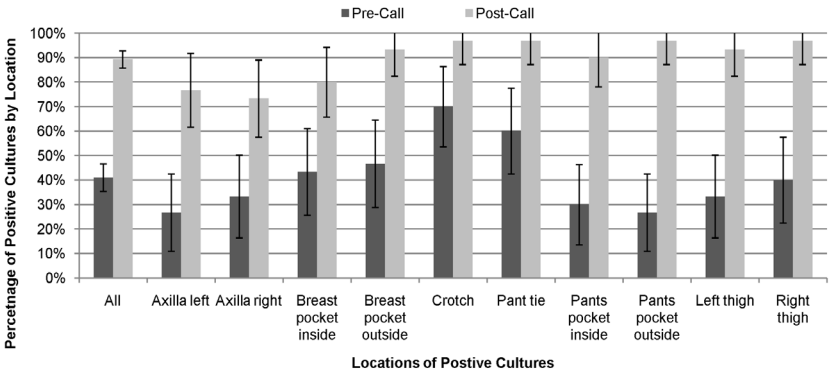

Figure 3. Percentage of positive cultures by location, with 95% confidence intervals. The precall and postcall groups differed significantly with respect to all, axilla left, axilla right, breast pocket inside, breast pocket outside, pant tie, pant pocket inside, pant pocket outside, thigh left, and thigh right, but not of the apex of the inseam.

Pathogen Identification

Gram-negative colonies were identified using the Microscan Walkaway (Siemens, Munich, Germany) gram-negative ID panel type 2, composed of carbohydrate fermentation reactions, biochemical reactions, and antimicrobial susceptibility. Gram-positive isolates were gram-stained and separated according to catalase reaction. Catalase-positive isolates were tested for coagulase to identify *S aureus;* coagulase-negative isolates were further tested with microdase to differentiate between *micrococcus* and coagulase-negative *staphylococcus* (CNS). Catalase-negative isolates were presumed to be streptococci and were identified by standard schema using optochin and bacitracin susceptibility, growth/reaction on bile esculin agar and salt media, and the CAMP (Christie, Atkins, Munch-Petersen) test. PFGE was performed on positive cultures of *S aureus* and CNS to determine the specific strain of each bacteria identified. All specimens were handled and disposed of in accordance with federal regulations. PFGE patterns were interpreted and grouped into pulsed-field types (PFTs) using established criteria.[15,16]

Antimicrobial Susceptibility Testing

Isolates were cultured from frozen storage (-80°C) by 2 overnight passages on blood agar plates (Remel, Lenexa, Kansas). Antibiotic susceptibility testing was performed by the BD Phoenix automated microbiology system (Becton Dickinson, Sparks, Maryland) according to the manufacturer's guidelines. Results were accessed through the EpiCenter Database (Becton Dickinson) connected to the BD Phoenix system.

Statistical Analysis

As this was an observational study, comparison of 95% confidence intervals (CIs) between groups was used to determine statistical significance. When 95% CIs did not overlap between 2 like groups, a statistically significant difference existed.[17]

Results

Scrub Isolate Species

Of the 300 samples obtained from precall scrubs, 123 (41%) yielded at least 1 bacterial species. CNS was the most common organism identified (94 isolates), followed by gram-positive rods (GPR, 34) and *Streptococcus viridans* (8). Of the 300 postcall samples, 268 (89%) were contaminated. CNS was the most common organism (271 isolates), then *Micrococcus* (51), *S aureus* (33), and GPR (34) (Figure 1). The precall-postcall difference in contamination was statistically significant for CNS, *Micrococcus,* and *S aureus* in particular (Figure 2).

Location of Isolates

The most common locations of isolates on the precall scrubs were the apex of the pant inseam (70%), the pant tie area (60%), outside the breast pocket (46.7%), and inside the breast pocket (43.3%). The most contaminated areas on the postcall scrubs were the pant tie area (96.7%), the apex of the inseam of the pants (96.7%), outside the pant pocket (96.7%), and the right thigh (96.7%). There was a statistically significant difference in the percentage of scrubs contaminated in a particular area between the precall and postcall groups for all areas except the crotch (Figure 3).

Results of Pulsed-Field Gel Electrophoresis

There were 4 different PFTs of *S aureus,* all MSSA. There were 29 MSSA isolates among the postcall scrubs and 2

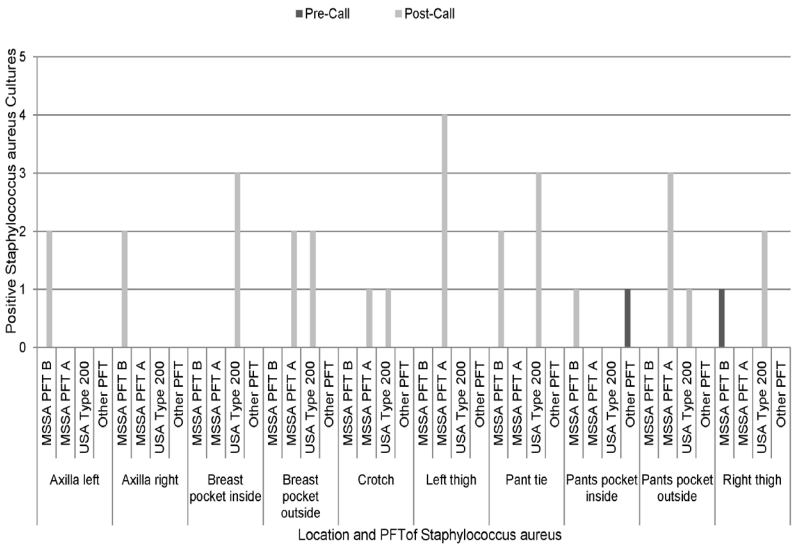

Figure 4. Location and pulsed-field type of *Staphylococcus aureus* by location. Abbreviations: MSSA, methicillin-sensitive *S aureus*; PFT, pulsed-field type.

Table. Results of Scrub Set 29

Location	Isolate 1	Isolate 2	Isolate 3	Phoenix Identification (PFGE Type)
Axilla right				
Precall	No growth	—	—	—
Postcall	CNS	*Micrococcus* spp	—	*Staphylococcus capitis* CNS, PFT-A)
Axilla left				
Precall	No growth	—	—	—
Postcall	CNS	CNS	*Micrococcus* spp	*Staphylococcus epidermidis* (other PFT)
Breast pocket outside				
Precall	CNS	—	—	*S capitis* (CNS, PFT-A)
Postcall	CNS	*S aureus*	*Micrococcus* spp	MSSA (PFT-A), *S epidermidis* (CNS, PFT-D)
Breast pocket inside				
Precall	No growth	—	—	—
Postcall	No growth	—	—	—
Pant pocket outside				
Precall	*Micrococcus* spp	—	—	—
Postcall	*S aureus*	CNS	*Micrococcus* spp	MSSA (PFT-A)
Pant pocket inside				
Precall	No growth	—	—	—
Postcall	CNS	*Streptococcus pneumoniae*	*Micrococcus* spp	*S capitis* (other PFT)
Right thigh				
Precall	*S aureus*	—	—	MSSA (PFT-B)
Postcall	CNS	GPR	*Micrococcus* spp	*S capitis* (CNS, PFT-A)
Left thigh				
Precall	CNS	—	—	*S capitis* (CNS, PFT-A)
Postcall	*S aureus*	CNS	*Streptococcus viridans* group	MSSA (PFT-A)
Pant tie				
Precall	CNS	—	—	*S capitis* (CNS, PFT-A)
Postcall	CNS	—	—	*S capitis* (CNS, PFT-A)
Crotch				
Precall	CNS	—	—	*S epidermidis* (other PFT)
Postcall	CNS	—	—	*Staphylococcus hominis* (CNS, PFT-F)

Abbreviations: CNS, coagulase-negative *Staphylococcus;* GPR, gram-positive rods; MSSA, methicillin-sensitive *Staphylococcus aureus;* PFGE, pulsed-field gel electrophoresis; PFT, pulsed-field type; spp, species (plural).

among the precall scrubs. There was no significant difference between any locations on the postcall scrubs and the number of MSSA isolates found in those locations (Figure 4).

Results of Antimicrobial Susceptibility Testing

Different antibiotic-resistance patterns were found among the *S aureus* and CNS species recovered. Of the 69 CNS samples tested for resistance against various antibiotics, 39 were resistant to ampicillin (57%), 12 to cefazolin (17%), 29 to clindamycin (42%), 28 to erythromycin (41%), and 42 to penicillin G (61%). Of the 31 *S aureus* samples tested for resistance, 23 were resistant to ampicillin (74%), 10 to erythromycin (32%), and 23 to penicillin G (74%). All CNS and *S aureus* isolates were susceptible to daptomycin, gentamycin, levofloxacin, linezolid, moxifloxacin, nitrofurantoin, quinupristin-dalfopristin, rifampin, and vancomycin. No MDR organisms were identified. The results of an individual scrub set are presented in the Table.

Discussion

In this study, we examined the bacterial profile of orthopedic residents' precall and postcall scrubs. We found a significant difference in the number of areas contaminated with bacteria on the unworn (precall) and worn (postcall) scrubs. Most of the bacteria found on these scrubs were common skin flora. While the direct impact these flora may have on postsurgical infections is not well understood, most of these organisms can adhere to hardware used in many surgical procedures, possibly increasing the infection risk. It has also been shown that the bacterial burden of scrubs in the operating room influences the contamination of wounds intraoperatively and the risk for postoperative infection of those wounds and that unworn, precall scrubs have a significantly lower bioburden than worn, postcall scrubs do.[18] Therefore, donning unworn scrubs before entering the surgical suite may help decrease intraoperative contamination of surgical wounds.

Unworn scrubs, however, are also prone to contamination. This study found that 41% of the precall scrub samples grew bacteria.[18] All of the bacteria identified

on the unworn scrubs in this study were of low virulence and common skin flora. These findings differed dramatically from the MDR bacteria found on the uniforms of intensive care unit nurses at the start of their shift in another study.[1] Still, despite being commonly found on skin and of low virulence, the common skin flora identified in the current should not be thought of as benign. There is a reason for using surgical scrubs to clean patients and surgeons' hands and for maintaining a "sterile field," even common, low-virulent organisms can cause postoperative infections.

These data show that scrub pants, particularly at the apex of the inseam, at the thighs, and at the tie area, were more contaminated than scrub tops at both precall and postcall. This supports previous findings that the perineum, thighs, and feet harbor more bacteria than other body parts do.[7] Of the physician's body parts, the waist is closest to the patient when the patient is lying in bed or on the operating room table. The proximity of this contaminated area to patients may account for the increased bacterial load in these areas, as each patient-physician interaction may involve the transfer of bacteria from patient to physician or vice versa.

As expected, most of the contamination on both precall and postcall scrubs was from CNS, and some of these CNS species were found to have antibiotic resistance. We found that 17% of the CNS samples tested were resistant to cefazolin, 42% were resistant to clindamycin, and 40% were resistant to erythromycin. Although resistance to these antibiotics is not uncommon within these species, these findings may be worrisome, as cefazolin and clindamycin are 2 of the most commonly used perioperative antibiotics. If surgical wounds were to harbor these resistant bacteria, these antibiotics may not be as effective in preventing infection.

That no MDR organisms were identified was surprising. The orthopedic surgery residents in this study were caring for multiple patients with MRSA and other MDR bacteria. However, no scrubs were found to be contaminated with these organisms. In addition, only 29 postcall samples grew *S aureus.* That number is surprisingly low, given how prevalent *S aureus* is in hospitals.[19] These findings seem to indicate that, in the majority of cases, patients were not contaminating physicians with bacteria; if they were, residents would have been expected to have MDR organisms at the end of call.

This study had several limitations. Although the number of sets of scrubs (30) was based on the number needed for statistical significance, those scrubs were worn by only 3 orthopedic residents. In addition, the procedures and activities completed by the residents during their shifts were not documented. That information could have yielded correlations between certain activities or procedures and bacterial contamination. Furthermore, it would have been interesting to know the bacterial profile of the patients with whom the residents interacted. Such data could have provided insight as to whether the bacteria found on the residents' scrubs were transmitted during patient interactions or from the surrounding hospital environment. Last, this study was conducted at a 224-bed military level I trauma center, so results may not be applicable to all hospitals.

Given the results of this study, our hypothesis was rejected, as postcall residents' scrubs were not colonized with MDR organisms. However, because of the significant increase in common skin flora on postcall residents' scrubs, we believe it would be prudent for postcall personnel to be required to change into fresh scrubs before surgical cases. Strong recommendations about duration of scrub wear await further study and it will be important to continue to investigate how the contamination of surgical scrubs may contribute to nosocomial infections.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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