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Nurses' uniforms: How many bacteria do they carry after one shift?

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Abstract

This pilot study investigated the pathogens that nurses are potentially bringing into the public and their home when they wear work uniforms outside of the work environment. To achieve this, sterilized uniforms were distributed to 10 nurses at a local hospital in Washington State at the beginning of their shift. Worn uniforms were collected at the end of the shifts and sent to a laboratory for analysis. Four tests were conducted: 1) a heterotrophic growth plate count, 2) methicillin-resistant *Staphylococcus aureus* (MRSA) growth, 3) vancomycin-resistant *Enterococci* (VRE), and 4) identification of the heterotrophic plate counts. Each participant completed a questionnaire and a survey. The results showed that the average bacteria colony growth per square inch was 1,246 and 5,795 for day and night shift, respectively. After 48 h, MRSA positives were present on 4 of the day shift and 3 of the night shift uniforms. Additional bacteria identified include: *Bacillus* sp., Micrococcus luteus, Staphylococcus aureus, Staphylococcus epidermidis, and Micrococcus roseus. The significant presence of bacteria on the uniforms 48 h after the shift ended necessitates further study, discussions and policy consideration regarding wearing health care uniforms outside of the work environment.

Keywords

Scrubs; uniforms; infections; nurses; healthcare providers; pathogens

INTRODUCTION

The spread of pathogens breaching hospital walls and into communities is a major public health concern (Committee to Reduce Infection Deaths, 2008). Other countries such as the United Kingdom, Belgium, Australia, and Canada acknowledge and address this problem by prohibiting the wearing of hospital clothing outside the workplace. These countries also require health service providers to sterilize and provide clean uniforms to healthcare workers (Australian Government: Department of Health and Ageing, 2004; Conseil Superieur D'hygiene, 2005; Jacob, 2007; Nye et al., 2005; Treakle et al., 2009). However, the United States has lagged in fully addressing this issue. To date, studies have yet to investigate the frequency to which hospital uniforms are worn outside of the workplace. Hospitals in the

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United States do not regulate whether or not health care providers wear their uniforms to and from work. Therefore, their uniforms remain potential vectors for spreading pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA) (Rao, 2009).

The cost of care for infections due to pathogens such as MRSA is estimated to be over $20 billion annually in the US (Marler, 2009). Taking precautionary measures can decrease the financial and health burdens experienced by those who become infected due to exposure to vector infected hospital uniforms. This pilot study explored the presence and potential transmission of microorganism on uniforms worn during shifts in clinical settings that are subsequently worn in public.

Background of study

Several studies have confirmed the presence of pathogens on nurses' uniforms during their shift (Callaghan, 1998; Perry et al., 2001; Wiener-Well et al., 2011). These studies found a relationship between the presence of pathogens such as MRSA and vancomycin-resistant Enterococci (VRE) on health care providers' uniforms and the spread of nosocomial infections. However, in these studies the uniforms tested were worn prior to the commencement work in a clinical setting, thus not controlling for outside sources of contamination (Callaghan, 1998; Perry et al., 2001; Wiener-Well et al., 2011). Studies exploring the presence of bacteria on nurses' uniforms have not been conducted to control outside contamination. Hence, this study sought to investigate this aspect by answering the following research questions: If nurses begin work shifts with sterilized uniforms, to what degree, and with what organisms are these uniforms infected during their shifts? Do those bacteria continue to live on the uniforms hours after the shift ends long enough to potentially infect members of the public who may come into contact with the uniform?

The importance of understanding and addressing the risk for increased exposure to pathogens and the potential spreading infections from healthcare workers' uniforms in milieus beyond the walls of the workplace is acknowledged (Committee to Reduce Infection Deaths, 2008; Jacob, 2009; Loveday et al., 2007). It also remains a public health concern (Committee to Reduce Infection Deaths, 2008; Jacob, 2009; Loveday et al., 2007). This pilot study investigated the pathogens that nurses are potentially bringing into the public and into their home when they wear work uniforms outside of the work environment.

METHODOLOGY

Ten nurses working on a medical telemetry unit from a local hospital in Washington State were recruited for this study. Prior to conducting the study, hospital institutional review board (IRB) approval was obtained. All 10 participants worked 12-h shifts. Five of the nurses worked the day shift and the other five worked the night shift. Upon recruitment and receipt of informed consent, the participants provided their scrub top size. Eleven scrub tops were purchased and sterilized, individually packaged and then distributed to each of the 10 nurses at the beginning of their 12-h shift. The eleventh scrub top was also sterilized and was used as a control to ensure that the nurses started their shift with uniforms that were bacteria free. At the end of their shift, each of the nurses placed their worn scrub top in an individual paper bag and returned the bag to the principal investigator. The uniforms were

collected from the nurses within a 24-h period. All 11 scrub tops were then sent via express mail to a designated laboratory unaffiliated with the hospital for testing. The laboratory received the uniforms within 48 h. Each of the participants completed a demographic questionnaire and a brief survey about their shift. Questions in the survey included the number of patients cared for, the type of diagnoses, whether the patients were in isolation, and any other factors that the nurse believed might have increased their exposure to a contaminant. Each participant was randomly assigned a number between 1 and 10 to ensure confidentiality.

Upon receipt of the uniforms by the laboratory, a single 3 inch by 3 inch portion of each of the eleven uniforms was cut out with sterilized scissors from the front beltline/pocket area of each scrub. The front beltline/pocket areas and the sleeves (for long sleeves coats) are more likely to be contaminated (Nye et al., 2005). For this study, all the uniforms were short sleeves; thus the focus remained on the front beltline/pocket area of the participants' uniforms. Gloves were changed and the scissors flame sterilized between samples. After removing each sample, the fabric was cut into small pieces and placed in a sterile 100 ml container to which exactly 25 ml of sterile peptone water was added. The cloth in the peptone water was vigorously mixed to extract bacteria. After agitation, three volumes of each sample were placed on separate sterile Petri dishes (1 ml, 100 μL and 20 μL). Twelve to fifteen milliliters of tempered heterotrophic growth medium was added to each plate, swirled, and allowed to solidify. One milliliter of the peptone water extracted sample was also added to the top of a prepurchased chromogenic MRSA agar plate (Hardy Diagnostics G249) and one milliliter to a chromogenic VRE agar plate (Hardy Diagnostics G333). Prepared Petri dishes were sealed with parafilm and placed in an incubator at 35°C. After the designated growth interval was completed for each of the plates, the most prevalent bacteria were identified. There were three control measures for this study: 1) the 11th scrub top; 2) the media control of the peptone water; and 3) the HPC Agar Black media. There was no growth observed on any of the three controls, thereby ensuring that there was no contamination prior to sample collection and testing.

Sampling

Table 1 depicts the participants' characteristics. Seven of the participants cared for 4 patients while 3 of the participants cared for 5 patients. All the study participants reported frequently wearing a gown over their uniforms when going in the rooms for hands-on care.

RESULTS

Presence of pathogens

A total of 4 tests were conducted with the scrub tops: 1) a heterotrophic growth plate count, 2) methicillin-resistant *Staphylococcus aureus* (MRSA) growth, 3) vancomycin-resistant enterococci (VRE), and 4) identification of the heterotrophic plate counts. The heterotrophic plate counts reported significant bacteria colony growth for both day and night shift. The average colony growth per square inch was 1,246 for the day shift (minimum 175 and maximum 2,600). The average colony growth per square inch for the night shift was 5,795 (minimum 300 and maximum 24,900). One night shift nurse had a number of 24,900, which

influenced the age bacteria for the night shift. Without this one outlier, there were no major differences between the average of the day shift and that of the night shift. MRSA was present on 4 of the day shift and 3 of the night shift scrub tops. However, VRE was not present on any of the scrub tops.

Identification of the heterotrophic plate counts yielded the following: *Bacillus* species, *Micrococcus luteus, Staphylococcus aureus* (MRSA Negative), *Staphylococcus epidermidis, Micrococcus* species *and Micrococcus roseus*. Up to 4 bacteria were identified on each of the uniforms. For example, scrub number 5 of the day shift contained *M. luteus (35%), S. aureus* (MRSA negative) (20%) and *S. epidermidis* (25%). Scrub number 2 night shift contained bacillus species (60%), *M. luteus* (15%), *Micrococcus* (10%) and *S. epidermidis* (10%) (Table 2). Other factors that the participants thought might have influenced contamination of the uniforms include: going into the break room, sharing desks, sharing computer mouse and keyboards, touching the gowns with dirty gloves, sharing equipment with co-workers, and using the restrooms. There were no significance differences on the presence of microorganisms between those who reported other places for potential sources of contamination.

DISCUSSION

This pilot study mirrors previous study results on the presence of bacteria on health care providers' uniforms, thus increasing the risk for infection spread (Halliwell and Nayda, 2011; Wilson et al., 2007). The findings of this study are important for many reasons. First, unlike previous research, the provision of sterilized uniforms allowed the researchers to control for potential confounding factors that might have influenced the contamination of the uniforms. Secondly, this study is the first to illustrate the longevity of the vectors found, with live bacteria presence confirmed more than 48 h after the shifts ended. Previous studies have been limited to showing the presence of microorganisms during and immediately after shifts. This study addresses the growing concern of health care providers' uniforms as potential reservoirs for community infections.

According to this study, differences were found in the average of bacteria on the night shift compared to the day shift. This was because of the count of one night nurse whose count per square inch was 24,900. There were no particular indications on the demographic questionnaire or on the survey that would explain the high number of bacteria present on this participant's uniform. The participant had been an RN for over 10 years and had been working on the unit for over five years and for that shift cared for participants with the diagnosis of pneumonia, urinary tract infection (UTI), diabetic foot ulcer, and decubitus ulcer. The high number of bacteria on this particular nurse's uniform could have been due to mode of practice such as lack of proper hand hygiene, and laboratory discrepancies.

Study limitations

Several factors might have influenced the study findings. The first limitation relates to the Hawthorne effect. Participation in the study was voluntary; therefore, knowledge of participation might have influenced the participant's behavior while providing care during their shift. We recommend that a future study randomly recruit participants at the end of

their shifts. Moreover, all of the 38 patients that were cared for by the study participants were in isolation. Therefore, the nurses had to wear a gown on top of the uniforms provided for the study, thus minimizing the level of exposure. Despite the isolation gowns, these study findings showed substantial presence of bacteria on the uniforms. Bacterial presence could be an indication of the lack of effectiveness of those isolation gowns as personal protective equipment (PPE) (Lovitt et al., 1992). The presence of bacteria despite the isolation gowns could also be an indication that the nurses were not fully compliant and were not wearing their isolation gowns as necessary over their uniforms during patient care. Such issue of lack of compliance for donning isolation gowns has been addressed in previous studies (Manian and Ponzillo, 2007). Thus, an "observational study" is recommended for further study to observe how healthcare providers' implement infection control measures while taking care of their patients. Additionally, the laboratory was not able to detect organisms that were anaerobic. Every step of the testing, including incubation took place in the presence of oxygen as they focused on aerobic (isotonic peptone water) organisms. Bacteria that are susceptible to oxygen such as *Clostridium haemolyticum*, would have likely died before reaching the laboratory due to oxygen exposure.

Further studies are needed to compare presence of bacteria across hospital units and other types of healthcare workers. Studies also are needed to determine the presence of pathogens in open public spaces (e.g. surface of restaurant tables) where health providers wear their post-shift uniforms. Research is also needed to compare whether differences exist in infection rates of family members of nurses who wear soiled uniforms outside the clinical setting to those who do not. The increasing numbers of bacteria resistant to antibiotics makes a compelling case for limiting public exposure to such pathogens. This study makes clear that such bacteria are present and alive on hospital uniforms that nurses wear both inside and outside the hospital setting, increasing the potential both for nosocomial infections and for wider circulation of potentially dangerous microorganisms in communities. While creating policy to limit public exposure to hospital-based microorganisms benefit community health, there are economic consequences to consider. We therefore recommend that a cost-benefit analysis be conducted to compare the cost of providing laundered uniforms to the potential cost of community-acquired infections such as MRSA.

Conclusion

The scientific contribution of this study supports and builds on previous research that health care providers' uniforms can be vectors that spread infections not only within hospitals, but also potentially within communities. Therefore, further research and policy that address this topic is imperative to protecting patients, health care providers, and the health of the public.

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Table 1

Participants' characteristics.

ID	Shift	Age	Ethnicity	Years as RN (year)	Year on Unit (year)	No. of Patient	Diagnoses	Cover gown
1	Day	31 - 40	Caucasian/White	4 - 7	1 - 3	4	Fecal impaction, gull stones, bronchitis, ankle wound	Yes
2	Day	25 or under	Hispanic	1 - 3	1 - 3	4	Chronic renal failure, chronic obstructive pulmonary disease (COPD), septicemia, UTI, Rhabdo, AMS,	Yes
3	Day	25 or under	Asian/Pacific Islander	<1	<1	5	Nephrolithiasis, COPD, ESBL, Kidney Stones, Aspiration pneumonia, MRSA	Yes
4	Day	26 - 30	Caucasian/White	1 - 3	1 - 3	4	UTI, chest pain, abscess	Yes
5	Day	26 - 30	Caucasian/White	1 - 3	1 - 3	5	AMS, CP, S/P skin graft groin, severe anemia, PNA r/o TB	Yes
6	Night	31 - 40	Asian/Pacific Islander	8 - 15	4 - 7	4	Pneumonia, UTI, Diabetic foot ulcer, Decub. To Coccyx	yes
7	Night	31 - 40	Asian/Pacific Islander	16+	1 - 3	4	Sickle cell anemia crisis, COPD exacerbation, chest pain with hypertension, abscess foot	yes
8	Night	31 - 40	Asian/Pacific Islander	1 - 3	1 - 3	4	Dehydration, right knee infection, r/o MI, CHF	Yes
9	Night	51 - 60	Asian/Pacific Islander	16+	8 - 15	Charge nurse	All	Yes
10	Night	26 - 30	Caucasian-White	1 - 3	<1	4	Bowel obstruction, UTI, cellulitis, hypoglycemia	yes

Table 2

Identification of 3 most predominant organisms and presence/absence of MRSA and VRE.

Sample ID	Organism identification	MRSA Presence/absence (Primary isolation)	VRE Presence/absence (Primary isolation)
Day Shift Scrubs-1 (D-1)	Bacillus sp. (45%); *Micrococcus luteus* (35%)	Absent	Absent
Day Shift Scrubs-2 (D-2)	*Bacillus* sp. (50%); *Micrococcus luteus* (40%)	Present	Absent
Day Shift Scrubs-3 (D-3)	*Bacillus* sp. (25%); *Micrococcus luteus* (70%)	Present	Absent
Day Shift Scrubs-4 (D-4)	*Micrococcus luteus* (65%); *Staphylococcus aureus* (MRSA negative) (35%)	Present	Absent
Day Shift Scrubs-5 (D-5)	*Micrococcus luteus* (35%); *Staphylococcus aureus* (MRSA negative) (20%); *Staphylococcus epidermidis* (25%)	Present	Absent
Night Shift Scrubs-1 (N-1)	*Bacillus* sp. (75%); *Micrococcus luteus* (10); *Staphylococcus aureus* (MRSA negative) (10%)	Present	Absent
Night Shift Scrubs-2 (N-2)	*Bacillus* sp. (60%); *Micrococcus luteus* (15%) *Micrococcus* sp. (10%); *Staphylococcus epidermidis* (10%)	Present	Absent
Night Shift Scrubs-3 (N-3)	*Bacillus* sp. (35%); *Micrococcus luteus* (25%); *Staphylococcus aureus* (MRSA negative) (25%)	Present	Absent
Night Shift Scrubs-4 (N-4)	*Bacillus* sp. (20%); *Micrococcus luteus* (70%)	Absent	Absent
Night Shift Scrubs-5 (N-5)	*Bacillus* sp. (75%); *Micrococcus roseus* (15%)	Absent	Absent
Control 1 (C1)	No growth observed	N/A	N/A
Media Blank (MB-Peptone)	No growth observed	N/A	N/A
HPC Agar Blank	No growth observed	N/A	N/A