5-2014

"Nursing Contamination: Wearing Scrubs in Public"

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NURSING CONTAMINATION: WEARING SCRUBS IN PUBLIC

Thesis Submitted In Partial Fulfillment of Requirements
for the Midway Honors Scholars and Honors-in-Nursing Programs

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April 17, 2014

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ABSTRACT

Nurses are frequently seen in public in their "scrubs," which could mean that contaminated clothing is being brought into the community, thereby posing an infection risk. The purpose of this study is to investigate if and which contaminants are present on the fabrics and the actions nurses are taking to eliminate contamination risks.

Eleven scrub tops were worn on hospital units over one twelve-hour shift. The contaminated scrubs and three control tops were then swabbed and used to inoculate agar plates. After incubation, colonies were counted, streaked onto nutrient and Mannitol-salt agar for isolation, and incubated. Using API Staph strips and Gram staining, the bacteria were identified. The nurses also completed a short survey on laundering and scrub care.

All scrub tops, except the controls, were contaminated with multiple species of bacteria including *Staphylococcus* species. Responses to the survey showed that no two nurses washed their scrubs in the same manner and many wear them in public. The results determined that bacteria can survive on clothing and pose the possibility of transmission throughout the hospital and public venues. The survey results indicate a need for employer laundering policies, public awareness of the risk for transmission of disease from contaminated clothing, and stricter regulations about employees wearing scrubs outside of health care facilities.

Key words: scrubs, contamination, nurses, community, public, hospital, infection

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INTRODUCTION

When patients are admitted to hospitals, they believe they will receive the best possible treatment. Yet, health care personnel are often trying to protect their patients from nosocomial infections before the original ailment can be addressed. Hospital employees have been battling germs for centuries, though today the battle is more difficult due to antibiotic resistance. In September of 2013, the Centers for Disease Control and Prevention (CDC) announced that at least two million Americans develop infections from antibiotic-resistant bacteria every year and at least 23,000 of those individuals die from those infections. The report identified seventeen different drug-resistant bacteria and one fungus that attributed to these infections and fatalities (Tavernise, 2013). Between 2001 and 2010 the number of *Clostridium difficile* (C-Diff) infections in the United States nearly doubled with no indication of future decline; more patients are also dying from C-diff as a secondary infection (Brunk, 2013). With these new threats, the prevention of these infections in the hospital and *community* is essential. The CDC (2013) has reported that invasive hospital- acquired methicillin-resistant *Staphylococcus aureus* (MRSA) incidence has decreased but community-acquired MRSA infections has shown no decline. In fact, for the first time in history, the incidence of community-acquired MRSA infections actually surpassed the incidence of nosocomial MRSA infections (Tavernise, 2013).

Nurses and assistive personnel experience the closest proximity to these patients while spending much of their time trying to reduce the risk of infection. So why would those who work so hard to prevent nosocomial infections pose a community health risk? Hospital personnel are frequently seen in public in their “scrubs,” the accepted “uniform” for clinical settings. They lean over produce while grocery shopping, eat in restaurants, visit non-clinical areas of the hospital, carry their children to and from daycare centers and schools, and even eat lunch off campus and then return to the hospital (Belkin, 2001). During these activities, the public, including children and the elderly, are exposed to contaminated clothing that poses an infection risk. Even uniforms perceived as clean will inevitably become tainted by skin secretions and environmental microbial contaminants in a clinical setting (Loveday, Wilson, Hoffman, & Pratt, 2007).

Currently a world-wide effort is underway in the health care industry to increase hand hygiene for the benefits of both patients and hospital staff (Munoz-Price, Arheart, Lubarsky, & Birnbach, 2013). Yet, the possibility of re-contaminating health care workers' hands from the microbial contamination on uniforms has implied that hand hygiene practices may be insufficient (Munoz-Price et al., 2012). It is common human behavior to wipe the hands on clothing. Combine that practice with the added requirement for nurses to have pens, tape, Band-Aids, IV supplies and other valuable equipment in their pockets at all times, nurses are inevitably touching their uniforms with their hands. These practices could indicate that hand hygiene practices are insufficient if nurses are repeatedly contaminating their hands via their clothing and subsequently increasing the risk of nosocomial infections through direct hand to patient contact. This issue was first introduced by a British nursing researcher, Irene Callaghan, in 1998. (Callaghan, 1998)

Yet another issue is the way scrubs are laundered by employees at home. Surgical and obstetrical scrubs have historically been laundered at the hospital. In the past few decades, it is common for hospital staff on other units to launder their own uniforms at home. The availability of laundry facilities at the worksite have decreased as hospitals have eliminated this service in order to save money (Harrison, 2006). It is also rare for health care facilities to provide changing areas, laundering services, or hospital-issued uniforms for staff members (Wilson, Loveday, Hoffman, & Pratt, 2007). Hospital laundry services are rarely offered to nursing staff even though an in house laundry could reduce the accidental spread of infectious agents, guarantee compliance with hygiene standards, and save staff the cost of washing their attire at home (Justice, Jeffs, Tanton, & Tantam, 2010). Similar to changing facilities, these practices have fallen out of favor because of the cost and space required in hospitals (Nye, Leggett, & Watterson, 2005). Although hospitals save money when nurses launder their uniforms at home, they may be spreading infections through the community resulting in more admissions.

Another risk is the contamination of the home environment. If contaminated scrubs are laundered at home with other clothing, lower-than required temperatures and a complete lack of decontamination instructions may lead to contamination of the entire load of clothing (Parish, 2005; Belkin, 2001). In addition, thousands of domestic washers running separate loads of contaminated scrubs every week is expensive and not environmentally responsible (Justice et al., 2010).

This study will examine scrubs worn by nursing personnel in a hospital setting to determine if they are contaminated with potentially pathogenic bacteria by the end of a single shift. Scrub attire is generally worn more often in today's hospitals because past research has shown that they remain cleaner for longer periods of time, are more likely to be changed, and are less expensive than the traditional white cotton uniforms (Waters, 2005).

The purpose of this study is to investigate if and which contaminants are present on the fabrics, why they are worn in public, and how this practice could be prevented. If scrubs contaminated with pathogenic bacteria are worn by nurses in public, is it possible to infect community residents?

LITERATURE REVIEW

The Nurses Uniform

In the United States, little research has been reported on nursing uniform contamination in health care facilities. The few studies that have been conducted have focused on physicians' lab coats and laundering practices (Munoz-Price et al., 2012; Nordstrom, Reynolds, & Gerba, 2012). Although those findings are valuable, the largest group of health care providers in hospitals are nurses who experience the closest contact with patients throughout their shifts. Due to these close interactions with sick patients, there is an increased risk of contamination by pathogenic microorganisms that are especially virulent due to antibiotic resistance. Most of the published literature originates from studies conducted by the National Health Service (NHS) of the United Kingdom (U.K.). Some of these studies examined the reasons for health care professionals to wear well-defined uniforms. One study discussed the value of patients and their families being able to easily identify nurses and other health care professionals and the illusion of cleanliness as reasons for nursing dress codes (Pearson, Baker, Walsh, & Fitzgerald, 2001). However, another study in the *British Journal of Infection Control* claimed that uniforms provide an unnecessary sense of prestige to health professionals that could create a social barrier between them and their patients.

Uniforms can cause a superior-inferior complex that may lead patients to docilely trust health care professionals to care for them instead of taking a role in their own treatment (Loveday et al., 2010). This powerful notion of influence over others may be a reason some nurses purposely wear their uniforms in public. Nurses may enjoy the idea of achieving respect or admiration for their professional status from those in the public they actually *risk* infecting. The overwhelming conclusion from these studies came from *Nursing Standard* which published results of studies that emphasized that there is a need for uniform identification; scrubs also met the need for cleanliness because they are easy to launder. Scrubs were found to grow fewer bacteria due to their polyester blends and to be easier to wash than white cotton uniforms. Therefore, they have a higher likelihood of being changed frequently (Waters, 2005).

Previous Contamination Studies

Contamination is defined by one of the few American studies as the presence of pathogenic organisms on or in an inanimate vector, such as clothing (Belkin, 2001). A study that surveyed nurses' personal perceptions found that the actual cleanliness of their uniforms did not correlate with how clean nurses reported them to be (Wiener-Well et al., 2011). A few studies conducted in Israel, Britain and France demonstrated contamination of nursing uniforms and scrubs. In the *Journal of Hospital Infection*, a study conducted by the National Health Service in the U.K. found 54% of uniforms sampled post-shift were positive for Methicillin-resistant *Staphylococcus aureus*, Vancomycin-resistant *enterococci, Clostridium difficile*, or any combination of the three (Perry, Marshall, & Jones, 2001). Another study from Jerusalem found that 63% of the sampled uniforms were positive for pathogenic organisms and 11% of those were antibiotic resistant. One study demonstrated that contamination of uniforms and white coats increased throughout the duration of clinical care before finally reaching a saturation point (Loveday et al., 2010).

Indirect contact with contaminated hospital staff clothing has already been identified as a source of cross-contamination when these items touch and potentially infect patients in clinical situations or cause the wearers' hands to become contaminated (Nordstrom et al., 2012). The contamination occurs on areas of uniforms that are most frequently touched by staff and patients like pockets and hemlines. Although it is clear that contamination of staff clothing is likely, little research has been conducted on the contamination of nursing scrubs in American hospitals.

One of the few studies on this phenomenon was conducted in 2012 by the University of Miami (FL) on health care workers' (HCWs) hands, white coats, and scrubs. Sixty-nine nurses' dominant hands were cultured along with ninety-seven scrubs. Pathogens such as *S. aureus, enterococci*, and *Acinetobacter* were found on workers' hands; almost twenty-nine percent of the scrubs cultured were positive for pathogenic bacteria (Munoz-Price et al., 2012). This study represented the first report of a positive correlation between contamination of health care workers hands and scrubs. The same researchers published another study in 2013 about the differences in white coat and scrub laundering practices. Ninety percent of 160 health care providers from different departments and specialties acknowledged that they were aware their uniforms were potentially contaminated with pathogenic bacteria (Munoz-Price et al., 2013). Yet, no education in the facility was provided on how to prevent or combat contamination specifically.

Importance of Proper Laundering

Much of the literature focused on ineffective laundering practices used by hospitals and nurses. However, the research findings about uniform laundering is very limited and the methods and study designs vary substantially, making positive correlations and definitive explanations difficult to confirm (Wilson et al., 2007). One analysis discussed a plethora of infectious outbreaks that have been traced to improper laundering of linens in the hospital (Perry et al., 2001). Although linens have more patient contact than workers' uniforms, the reality is that incorrect decontamination processes can have severe consequences for patients. The literature largely contradicts laundering guidelines, some stating that home-laundering of scrubs is adequate while others claim that it is completely ineffective. One study even questioned the ability of new “energy-saving” domestic washers to decontaminate clothing at all (Perry et al., 2001).

The Occupational Safety and Health Administration (OSHA) has stated that nursing uniforms become contaminated by perspiration, human secretions of oils, or items handled during a shift. The agency has also stated that “Under no circumstance should it [contaminated scrub attire] be taken home for decontamination if contaminated with blood or other potentially infectious materials” (Belkin, 2001). Yet, since this recommendation is rarely followed in modern healthcare facilities, OSHA also makes no actual recommendations for how to launder clothing properly in the home environment like most nurses have to do (Loveday et al., 2007). The lack of specific instructions or policies in the literature suggests that part of the contamination may be due to clothing arriving at the hospital already soiled. It has been documented that contamination will increase during extended use until saturation is reached, such as wearing scrubs repeatedly without washing (Wilson et al., 2007). Hospitals and other health organizations cannot monitor the home washing practices of all staff and therefore have no way to prevent this problem (Parish, 2005). Home laundering of scrubs and lab coats should be further investigated as a possible source of contamination.

The water temperature best for bacterial decontamination, whether scrubs should be washed with other clothing, and whether commercial washers at nurse’s homes are even capable of adequate sanitation are all unanswered research questions. Given that water temperature is the most effective aspect of potentially harmful bacteria decontamination, the confusion in the literature is especially concerning (Parish, 2005). The *Nursing Standard* published an article that suggests hospitals institute standardized policies for washing hospital uniforms; according to this article, current policies range from recommending scrubs be washed in water ranging from recommended temperatures of sixty degrees Fahrenheit to seventy-one degrees Fahrenheit and washing times ranging from ten to sixty-five minutes (Sprinks, 2011). The CDC recommends that hospital laundering facilities use a temperature of 71.1 degrees Celsius (approx. 160 degrees Fahrenheit) for a minimum of twenty-five minutes to adequately decontaminate hospital bed linens. Yet, no specific recommendations for home laundering water temperatures, times, or detergents have been adopted (Nordstrom et al., 2012). With the introduction of multi-colored uniforms in hospital nursing and technician positions, the issue of water temperature is especially serious because most colored clothes are washed in cold water. Low temperature domestic laundering practices have little effect on the microbes living on hospital attire (Munoz-Price et al., 2013).

Another article addressed the risk of bringing scrubs home, posing a possible health risk to individuals living in the household (Justice et al., 2010). Contamination of casual clothing in the washing machine by soiled scrubs has been cited as a potential source of contamination for other household residents, thereby exposing the community to contaminated clothing (Wilson et al., 2007). Overall, laundry inconsistencies may be responsible for the contamination of scrubs before and after hospital shifts while simultaneously contributing to microbial exposures for patients and the public.

METHODS

This descriptive study was undertaken at a southeastern community hospital. The university and community hospital institutional review boards approved the study.

Sample

Nine registered nurses (RN) and two licensed practical nurses (LPN) agreed to participate. Nurses from various units including cardiac, oncology, medical, surgical, neurology, and orthopedics were invited and agreed to participate in the study. The nurses were informed that participating or declining participation would not affect their employment with the health system in any way and participation was strictly voluntary with no known benefits. A signed consent document was obtained from those who chose to participate. The sample was not adjusted for age, race, experience level, or gender nor were the units adjusted for concordance. Only one participant was male. Three participants practiced on the oncology unit, three on the cardiac unit, two from neurology, one from orthopedics and two from a general medical/surgical unit. The medical/surgical and oncology departments were chosen because the patients on these units are at extremely high risk when exposed to contaminated environments and bacterial biofilms.

Population

Sixteen Cherokee unisex scrub tops were purchased in varying sizes according to the sizes requested on the informed consent documents. On the day of the study, eleven of the tops were distributed to the volunteers; the remaining three tops served as controls. The scrubs were given to the volunteers at the beginning of their shift in factory sealed packaging by the primary investigator so the participants could change at work. The volunteers were told not wear anything over their scrubs and to proceed normally during their shifts. They were not told the specific bacteria that would be tested for or what parts of the uniform tops would be tested so participants could not deliberately try to avoid contamination or at risk patients.

Data Collection

The uniforms were returned to the researcher at the end of the shifts and placed in individual, sealed bio-hazard material bags. No action was taken to differentiate the scrubs, maintaining unit and nurse anonymity. Neither did the researcher attempt to track the whereabouts or exposure levels of the nurses to minimize researcher bias. The study participants were asked to complete and return a short survey consisting of five questions:

1.) Are your scrubs laundered in hot or cold water?

2.) Are your scrubs laundered with casual clothes or without casual clothes?

3.) How long are your scrubs typically in the washing machine?

4.) How often are your scrubs laundered?

5.) How often are they worn in public venues after a work shift (daycare, restaurant, grocery store, etc.)?

The participants were told not to write their names on the survey and to return them to a blank envelope that had been placed in their corresponding break rooms to maintain complete anonymity. The principal investigator took the envelopes after collecting the tops. Ten surveys were completed.

After collecting the scrubs, they were taken to a university laboratory facility. An estimated hour and a half elapsed before the inoculations began due to transport time from the facility to the laboratory and preparation time. The bottom three inches of the front hems and inner lining of both pockets were swabbed for thirty seconds with sterile swabs wetted with sterile water. The swabs were then placed into three milliliters of sterile water in sterile test tubes and placed on a vortex for ten seconds in order to vibrate and mix the contents. Then, 0.15

milliliters of the solution was drawn into a pipette and dispensed directly onto nutrient agar in a media plate.

Forty-two plates were inoculated using this method, three for each scrub top, control and experimental. Each plate was labeled according to the sampling location (hem, right pocket, left pocket) and allotted scrub number. The agar plates were then incubated for forty-eight hours at thirty-seven degrees Celsius (98.6 degrees Farenheit, the same average internal temperature of the human body) at the facility. After removal from the incubator, the number of colonies visible upon each plate were counted and sampled. From every first generation plate (the original forty-two), three to eight samplings with isolation streaks were completed from colonies that represented the morphological and phenotypical differences present on each plate (Pictures 3-6). For example, if a plate had fifty colonies present, we sampled the most abundant phenotypes, such as one of the twenty small yellow ringed colonies and one of the thirty large white amorphous colonies. The chosen sample colonies were each streaked for isolation onto nutrient agar and Mannitol-Salt-Agar (MSA) plates and incubated for another forty-eight hours at 37 degrees Celsius. After incubation, each individual streak was Gram stained for identification purposes from the nutrient agar plates.

Data Analysis

MSA plates have high salt content (7.5% to 11%) so *Staphylococcus* species thrive and grow vigorously. Other microbes may also grow, but in less numbers. These plates also have Mannitol, a sugar, which can be fermented by *Staphylococcus* and a phenol red pH indicator which causes the surrounding agar to turn yellow when fermentation occurs. In most cases, *Staphylococcus* can ferment sugar, while non-pathogenic *Staphylococcus* typically cannot, thus the colonies that turned the Mannitol bright yellow were suspected to be pathogenic strains (Shields & Tsang, 2006) (Picture 8).

API Staph kits were used to identify the exact species of *Staphylococcus* present on the plate, and thereby the scrub. API microbiological testing is a well-established international database used to identify specific species of bacteria. By using bacteria-specific media to encourage the bacterial growth, the media samples are then deposited onto the API strips which contain different sugars for the bacteria to interact with. If the sugars change color (like the Mannitol) then they were fermented and a numerical value is attached to each sugar. The numbers are then inserted into the online database which calculates which species is present depending on which sugars they fermented and the numerical values attached to each strip. Antibiotic resistance was not tested. All of the results were calculated and tabled in the following section.

The results were posted in a spreadsheet comparing the presence of colony forming units on the exposed and control scrubs. The average number of colonies on the hem, right, and left pocket plates were calculated and compared to the average number of colonies on the control plates. SPSS Version 20 software was used to calculate and compare the results. The survey responses were examined manually and placed into answer categories for percentile ranking.

RESULTS

Of the thirty-three plates inoculated from the scrubs worn in the hospital, approximately 2,760 individual colonies grew. The control scrubs produced only one colony, which is attributed to laboratory cross-contamination. Of the 2,760 colonies, 120 were sampled based on their morphological representations in comparison to the total colonies on the individual plates. In Table 1, the representations of the average colonies per plate are listed, along with the minimum and maximum colonies produced from the hem, left, and right pocket plates. On average, each plate produced nearly 300 colonies, despite their original sampling location. The hem plates had the highest concentration of colonies; no significant difference between the average number of colonies of the right and left pocket plates was found. The comparisons between the control plates' colony averages and the hospital scrub plates' averages yielded the following p-values:

Right Pockets: 0.33 vs. 68.18, p=0.043 → 4.3% chance of error

Left Pockets: 0 vs. 62.82, p=0.027 → 2.7% chance of error

Hemlines: 0 vs. 111.6, p=0.002 → 0.2% chance of error

Of the 120 isolated samples, sixteen were positively identified as *Staphylococcus* species (*xylosus*, *aureus*, *hemolyticus*, *sciuri*, and *saprophyticus*) (Table 2) from the API Staph kits. Six of the *Staphylococcus* species came from the hems, five from the right pockets, and five from the left pockets. Through Gram staining, ten different staining morphologies were identified ranging from Gram positive coccid cluster to Gram negative bacilli (Table 3, Pictures 1 and 2). Two plates grew a single fungi matrix that overtook the entire surface of the media, thereby causing a statistical aberration of only one colony forming on those plates (Picture 7). Both were from the right pockets of experimental scrubs. No further testing was conducted on these samples because fungi were outside the scope of this study. This study did not differentiate between natural body flora and pathogenic bacteria.

The survey was answered by ten of the eleven participating nurses. According to their answers on question one, 30% washed their scrubs in hot water, 60% in cold water, and 10% in warm water (write-in answer). For question two, 50% of the nurses reported they wash their hospital scrubs with casual clothing; the other 50% wash their scrubs alone. The responses to question three showed that 10% of the participants wash their scrubs for about fifteen minutes, 10% wash for about thirty minutes, 60% wash for about forty-five minutes, and 20% for an hour or more. All the participants reported that they wash their scrubs after each shift. Answers to the final question revealed that 60% of participants occasionally wear their scrubs in public venues after a work shift; the remaining 40% answered that they never wear their scrubs in the community (Table 4).

DISCUSSION

The contamination of scrubs can come from many sources including patients, inanimate objects, nurses themselves, and even via poor laundering practices. The significance of the contamination lies in whether the microbes can cause illness and if so how the contamination can be decreased or controlled to prevent infections. The colony counts conducted in this study demonstrate that after a twelve-hour shift on a hospital unit, nurses' scrub tops are contaminated with microbes on the hems and in both the right and left pockets. When comparing the contamination averages to that of the control tops that were factory sealed and opened only at the moment of testing, the p-values show that the difference in contamination levels was unlikely to happen by chance. Thereby the purpose of this study was accomplished by providing physical and statistical support for significant contamination.

The single colony that grew on one of the nine control plates is attributed to cross-contamination; the occurrence was on the rim of the plate where condensation may gather. Because none of the other plates grew any type of visible colony, this aberration is attributed to investigator error. The fungi that formed on two of the plates, causing a colony count of only one per plate, can be attributed to the area of collection (northeast Tennessee mountainous region),the climate conditions at the time (August when humidity averages 77%), or a patient with a fungal infection (Nordstrom et al., 2012; Current Results, 2014).

The hems of the experimental scrubs produced the highest concentration of microbial contamination. Nurses are often leaning against mobile computer units, counters in nursing stations, and patients, therefore the hem concentration levels should be reasonably higher due to the high occurrence rate of surface contact. Also, nurses are often adjusting their clothing after donning personal protective equipment (PPE). Therefore, hand contamination at the hem is another route of microbial exposure. However, most of the plates averaged around 300 colonies, illustrating perhaps the maximum number of colonies the nutrient agar can grow during the forty-eight hour incubation time.

Sixteen of the 120 samples were positively identified as a *Staphylococcus* species. Of these species, five were *S. aureus*, six were *S. hemolyticus,* two were *S. sciuri*, one was *S. saprophyticus*, and one was *S. xylosus* (Table 2). As listed in Table 2, *S. aureus* are often the pathogens behind major nosocomial infections leading to septicemia, osteomyelitis, and pneumonia. *S. aureus* is also the only pathogen that has been shown to transfer from nurses' PPE to the gown of a patient and the bed linens (Wilson et al., 2007). Methicillin resistant *S. aureus*, vancomycin resistant *enterococci*, and multidrug resistant *Acinetobacter baumannii* have all been demonstrated to transfer between contaminated cloth and pigskin in a laboratory setting (Munoz-Price et al., 2012). No studies have demonstrated if direct transfer of microbes from contaminated uniforms to patients in a clinical setting is possible (Wilson et al., 2007).

S. saprophyticus is an opportunistic pathogen known to cause bladder and urinary tract infections; *S. hemolyticus* is the second most common pathogen to cause nosocomial infections

(Nordstrom et al., 2012; Oregon Health and Science University, n.d.). *S. sciuri* has been associated with serious infections such as peritonitis, endocarditis, urinary tract infections, and, most frequently, wound infections (Strepanovic et al., 2005). Finally, *S. xylosus* is usually found only in animal populations; very few cases of human primary infections cases have been reported (Gozalo et al., 2010). Therefore, this pathogen most likely originated from an animal source such as pet therapy dogs, the patient's dog (this specific hospital allowed patients' dogs to visit with proof of vaccinations and a bath within the past 24 hours), or an employee's pet. The bacteria could have been transferred to the scrub from direct contact with an animal or from an individual who had animal saliva or skin cells on them.

Overall, floor and unit nurses and nursing assistants have significantly more patient contact than any other staff members in hospitals (Nordstrom et al., 2012). Even though the sample size was small, the presence of various *Staphylococcus* species, known to be pathogenic, on a nurses clothes is very concerning considering their close proximity to patients' intravenous access, wounds, drains and mucus membranes.

This study did not differentiate the bacteria collected from what is naturally a part of natural human flora. On average, 32% of humans have *S. aureus* present on their skin or in their nostrils at any given time (Nordstrom et al., 2012). Also, most studies have found that 1/3 of the microbes recovered from hospital clothing originate from the wearer and a majority of clothing contamination may in fact arise from the wearer. However, when natural flora are combined with pathogens known to survive the harsh conditions of a hospital and the bacteria already present in infected patients in biofilms, these combinations could be potentially dangerous when inflicted upon an unsuspecting public (Wilson et al., 2007).

Although *Staphylococcus* species were colonized from the scrubs, many other possible genera of bacteria were also present. Other than Gram staining, no further identification efforts were made for the non-*Staphylococcus* species. However, by knowing the Gram stain and morphology of a sample, the possible genera has been listed in Table 3 and the subsequent known infections. For example, eighteen Gram negative samples were identified. These samples are particularly troubling since Gram negative enterococci are heat resistant and difficult to eliminate (Wilson et al., 2007). Also, many Gram negative species have been known to cause serious nosocomial infections such as pneumonia, meningitis, and septicemia (Nordstrom et al., 2012). The second most common stain and morphology identified was Gram positive bacilli, the known morphology for *Clostridium* species (Oregon Health and Science University, n.d.). With the aforementioned consequences of *C. diff* infections in hospitals, the presence of this morphology on nurses' clothing is particularly troubling. Gram staining the individual samples demonstrated that many different species of bacteria live on clothing long enough for a nurse to leave the hospital, enter a public forum (stores, restaurants, child care facilities), and return home (approximately an hour and a half).

The survey portion of this study was crucial to understanding nurses' perceptions of their scrub cleanliness and their actions regarding contamination of community and home environments. With less than 40% of the participants using warm-hot water to launder their scrubs, bacterial decontamination of their uniforms may not be fully accomplished. This particular facility had no color code for the RN's and patterned tops were the popular apparel choice. Thereby, most of the participants use cold water known to protect the colors in clothes. Yet, it has been shown in multiple studies that the number of surviving organisms on a uniform decrease as the water temperature increases. A laboratory study showed a reduction of 10^5 in *S.*

aureus bacteria on clothing swatches when exposed to fifty-five degrees Celsius (131 degrees Fahrenheit) water for five minutes. Complete elimination of this microbe occurred after exposure to sixty-one degrees Celsius (approximately 142 degrees Fahrenheit) for five minutes (Wilson et al., 2007).

Fifty percent of the survey respondents reported that they wash their clothes with casual wear. No definitive evidence has shown contamination of other items in washing machines, but evidence has demonstrated that it is common for washers to be used ineffectively (i.e. using cold water, not using bleach, using low water levels). Dilution of biofilms is a key element in the decontamination process (Wilson et al., 2007). Yet, 20% of the responses indicated that they are washing their clothing for less than thirty minutes, not enough time for a full cycle of dilution, especially if the load is large. Added to the lack of hot water, ineffective decontamination processes are being followed by nurses in their homes.

All of the survey responses indicated that nurses wash their scrubs after every shift. Because scrubs have been shown to have a higher contamination load after two days of wear than one, this response was very positive for the nurses at this facility (Munoz-Price et al., 2012). One study indicated that scrubs in a large hospital network are washed every 1.6 ± 0.1 days; physicians white coats averaged every 9.5 ± 0.9 days (Munoz-Price et al., 2013). Because nurses experience primary contact with patients, it is reassuring to know that the scrubs nurses are wearing are likely being washed before they were worn again. Whether they were washed correctly, however, is another matter.

Although no conclusive scientific evidence was found in the literature indicating that domestic washers are inferior to industrial decontamination processes, domestic washers must be used correctly to achieve the same results. Many studies have shown that scrubs are rarely washed with bleach, the recommended decontaminant for many hospital pathogens (Wilson et al., 2007) Also, with the advent of rayon and polyester scrub blends, fewer individuals iron their uniforms, a method for reducing up to 10^7 microbial load on a shirt (Wilson et al., 2007). When contaminated scrubs are not properly cleaned, the possibility of community, household, and patient contamination increases.

This study had a very small sample size. Eleven participants is not enough to gain a full picture of the attitudes and practices of nurses in this facility or in the health care industry in general. For the identification portion of the study, the sample size was also very small, with a 1:23 ratio of sampled versus colonies counted. Thus, the identification of these samples may not have demonstrated the full array of possible contaminants present on the scrubs. Gram staining was the final step in the identification process for some of the samples, and did not definitively identify the genus or species of that sample. This study concluded that bacteria are present on nursing uniforms after a twelve hour shift on a hospital unit. It also confirmed the presence of varying strains of *Staphylococcus* species and that no two nurses launder their scrubs in the same manner.

Sixty percent of participants admitted to occasionally wearing their scrubs in public. Although better than reporting frequent public wear, the behavior still poses a significant risk when over half of the nurses wear contaminated uniforms in public. Provided that the responses were honest and the nurses trusted the survey's anonymity, the issue remains that scrubs are now known to have potentially pathogenic bacteria such as *S. aureus* and *S. hemolyticus* present on the hems and pockets. The presence of these pathogens in the community puts individuals at risk and may be why the incidence of community-acquired *Staphylococcus* and antibiotic resistant infections is increasing.

Antibiotic resistance is a growing problem around the world. With MRSA and other hazardous drug-resistant infections on the rise, the importance of microbial containment is also rising. Hospitals are full of antibiotics and disinfectants so it is logical that only the most resistant bacterial strains will survive in this environment. Therefore, the risks posed by nurses who enter public forums after being contaminated by these "super bugs" is highly problematic.

RECOMMENDATIONS

Nursing Practice

Disinfecting practices in hospitals have improved over the years. Health care equipment is now disinfected between patient uses but it is impossible to disinfect patients' primary care giver, the nurse (Holmström, 2010). Despite frequent hand-washing, contamination of clothing still occurs mostly from nurses' hands because they are the principal tool a nurse uses when in contact with patients. The areas that are often tested for contamination should be the areas with maximum hand contact, the pockets and hems of the shirt (Nye et al., 2005). These are the areas nurses touch when tugging their shirts down and replacing contaminated items. This study found that these areas host bacteria and nurses are wearing grossly soiled shirts in the community. Whether they are fully aware of the danger or the degree to which their scrubs are contaminated was not examined.

One of the main reasons nurses wear scrubs in the community is the lack of changing facilities at the workplace (Harrison, 2006). If nurses have nowhere to change out of their uniforms, they have few options but to wear their scrubs home and on post-work errands. This research will hopefully stimulate policy change about nurses wearing their uniforms in the community. Other mechanisms of pathogenic control might be decontaminating phones, wearing protective plastic aprons, managing pocket contents, and even eliminating pockets (Gaspard et al., 2009).

Nursing Education

Nurses should be informed of the importance of ironing their uniforms as another way to eliminate bacteria (Parish, 2005). The reintroduction of commercial laundry services for nurses could solve many of these contamination problems and confusion associated with home laundering. These issues must be resolved; this research may serve as a small impetus to start the process. If this is shown to not be an option with most healthcare agencies, then all health care workers should be given specific instructions on effective washing techniques known to decontaminate clothing. The University of Miami studies concluded that laundering education is simply “not being done,” in hospitals (Munoz-Price et al., 2013).

Nursing Research

Further research is needed to assess the transmission of bacteria from clothing into the human body causing illness. It is possible that nurses could re-contaminate themselves from their scrubs and then transfer the bacteria to another individual through their hands, a known route for infection (Pearson et al., 2001). They may also leave bacteria on inanimate objects in the community through the contamination of their hands due to soiled scrubs. This study was conducted to investigate the ability of scrub uniforms to become contaminated during a twelve hour hospital shift. Further study is needed to determine if contaminated scrubs can actually affect the community’s health.

CONCLUSIONS

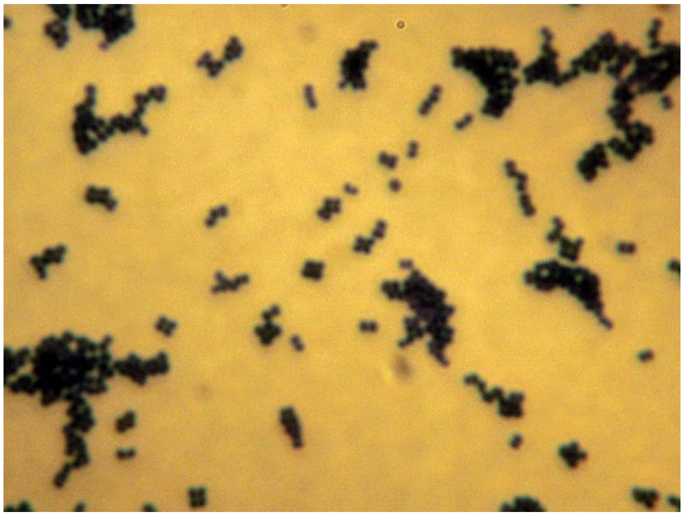
This study has concluded that after a twelve hour shift, staff nurses scrub tops become contaminated with a plethora of bacteria, including multiple species of *Staphylococcus*. The survey results positively identified that the majority of the participants do occasionally where their scrubs into public venues outside of the hospital. Although, the sample size was small, the sheer number of colonies grown upon the nutrient agar definitively proves that scrubs are able to become contaminated and maintain a sustainable environment for the bacteria for at least a few hours.

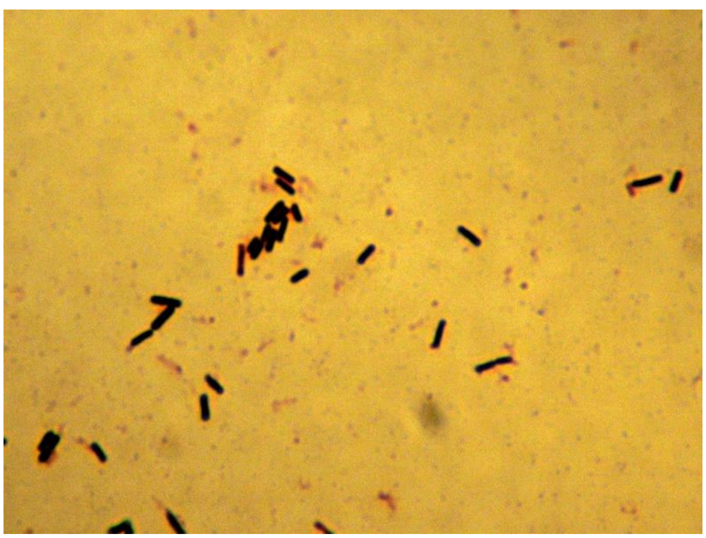
Though all of the participants stated that they only wear their scrubs after one shift, their individual laundering practices at home were not congruent. Many of the participants admitted to washing their clothing in cold water (hot is recommended) and half of them wash their scrubs with casual clothing. This practice presents the possibility of contaminating the nurses' home environment by ineffectively washing scrubs with street clothes, thereby spreading contamination throughout the wash and to other members of the household.

Finally, this study identified five different species of *Staphylococcus* upon the scrubs, four of which are proven to be pathogenic to humans. There were sixteen positively identified samples of staff from the small pool sampled (one out of every twenty-three colonies), thereby indicating that there could have been more *Staphylococcus* present on the experimental tops. The species identified are often linked to nosocomial infections known to cause severe sepsis, urinary tract infections, endocarditis and more. The *Staphylococcus aureus* samples also have the potential for antibiotic resistance, though testing for that was not conducted.

Overall, when these scrub tops are worn into the public, they are bringing contaminated clothing into contact with individuals who are unaware of the danger they present. Nurses may be leaning into the produce section at the grocery store, picking up their children at daycare, or sitting at tables in restaurants after work. All of these instances represent actual situations in which contaminated scrubs are being brought into the public, possibly contaminating open surfaces. Since community-acquired antibiotic resistant infections are on the rise, nurses need to be educated of the risks they pose in order to prevent contaminating their communities. Further research also needs to be conducted concerning whether or not clothing can be a direct source of contamination for human infection.

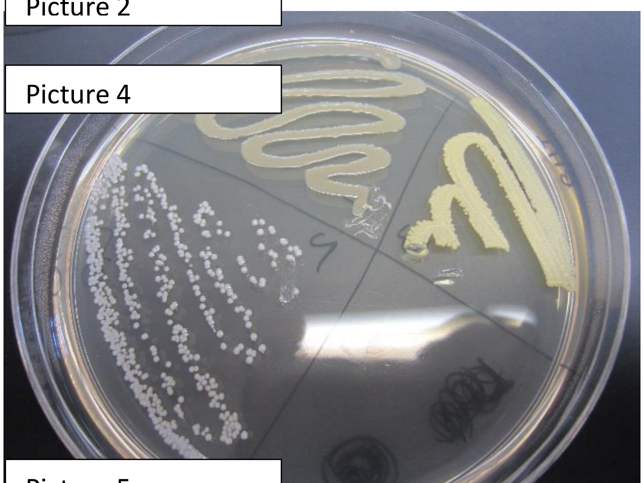
Pictures





Picture 2

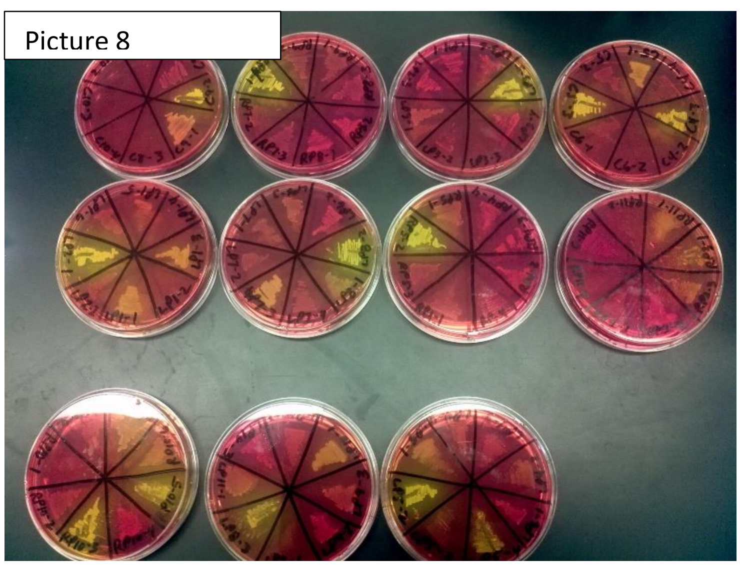
Picture 4



Picture 5

Picture 6

Picture 7



Picture 8

Tables

Table 1

		Hem	Left Pocket	Right Pocket
N	Valid	11	11	11
	Missing	0	0	0
Mean		111.64	62.82	68.18
Median		79.00	27.00	42.00
Std. Deviation		87.248	80.415	96.874
Minimum		15	8	1
Maximum		310	273	298

Table 2 (Oregon Health and Science University, n.d.)

Bacterial Identities	#	Possible Infection
Staphylococcus aureus	5	food poisoning, boils and other skin infections, osteomyelitis, post-operative infections, sepsis, endocarditis, toxic shock syndrome, scalded skin syndrome, and pneumoniae.
Staphylococcus hemolyticus	6	endocarditis, septicemia, peritonitis, urinary tract infections and wound, bone and joint infections.
Staphylococcus sciuri	2	endocarditis, peritonitis,septic shock, wound infections, and UTI
Staphylococcus saprophyticus	1	UTI
Staphylococcus xylosus	1	usually found in animals

Bacterial Identities	#	Possible Genus	Possible Infections
Gram + cocci clusters	42	Staphylococcus, Enterococci	skin infections, osteomyelitis, post-operative infections, sepsis, endocarditis, toxic shock syndrome, scalded skin syndrome, and pneumoniae, endocarditis, UTI, peritonitis, wound, bone and joint infections
Gram + cocci chains	2	Streptococcus, Enterococci	pharyngitis, scarlet fever, toxic shock, UTI, sepsis, endocarditis, necrotizing fascitis, skin infections, rheumatic fever, glomerular nephritis
Gram + bacilli w and w/o endospores	20	Clostridium, Bacillus	Gangrene, botulism, tetanus, pseudomembranous colitis, cutaneous, gastrointestinal or pulmonary anthrax, food poisoning.
Gram + diplococci	5	Streptococcus, Micrococcus, Enterococci	Pneumonia, meningitis, sinusitis, otitis media, mastoiditis, arthritis, peritonitis and conjunctivitis
Gram + cocci	7	Micrococcus	sepsis, peritonitis, endocarditis
Gram + cocci tetrads	5	Micrococcus, Staphylococcus	food poisoning, skin infections, osteomyelitis, post-operative infections, sepsis, endocarditis, toxic shock syndrome, scalded skin syndrome, and pneumoniae
Gram - bacillus chains	2	Escherichia	UTI, cystitis, pyelonephritis, sepsis, neonatal meningitis, and enteric diseases
Gram - diplococci	10	Nesseria, Moraxella	gonorrhea, arthritis, meningitis, otitis media, sinusitis, bronchitis, laryngitis, tracheitis and pneumoniae
Gram + bacillus chains	1	Lactobacilli	usually noninfectious (found in yogurt and Ensure)
Gram - bacilli	6	Proteus, Shigella, Enterobacter, Pseudomonas	UTI, kidney stones, would infection, septicemia and pneumonia, malignant otitis externa, GI infections

Table 3 (Oregon Health and Science University, n.d.)

Table 4

SURVEY RESPONSES								
1. Are your scrubs laundered in hot or cold water?			2. Are your scrubs laundered with casual clothes or without casual clothes?			3. How long are your scrubs typically in the washing machine?		
Answers	Responses	Percent	Answers	Responses	Percent	Answers	Responses	Percent
Hot	3	30%	With	5	50%	15 min	1	10%
Cold	6	60%	Without	5	50%	30 min	1	10%
Warm	1	10%				45 min	6	60%
						1 hr	2	20%
4. How often are your scrubs laundered?			5. How often are they worn in public venues after a work shift (daycare, restaurant, grocery store, etc.)?					
Choices	Responses	Percent	Answers	Responses	Percent			
after 1 shift	10	100%	Never	4	40%			
after 2 shifts	0	0%	Occaisionally	6	60%			
after 3 shifts	0	0%	Frequently	0	0%			

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