

# Bacteria on the Soles of Patient-Issued Nonskid Slipper Socks An Overlooked Pathogen Spread Threat?

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**BACKGROUND:** This is the first study to determine whether nonskid slipper socks in contact with the hospital floor and worn into bed contaminate bed linen.

**PURPOSE:** The main purpose of the study was to determine whether contamination of hospital linen occurred with bacteria transferred from the soles of nonskid slipper socks that have touched the floor.

**METHODS:** This study mimicked real patients walking on a hospital floor wearing slipper socks and getting back into bed with the slipper socks on. Swab samples were collected from the surfaces of the hospital floor, nonskid slipper sock bottoms, and bed linen in 2 Midwestern hospitals. From the samples, bacterial isolates were identified and tested for antibiotic resistance.

**RESULTS:** Isolates obtained from the samples were identified on all 3 surfaces at both hospitals, indicating spread of the bacteria from floor to the bed linen via the nonskid slipper socks. Antibiotic sensitivity test revealed that a significant number of isolates collected were resistant to at least 2 antibiotics tested.

**CONCLUSION:** This study demonstrates cross-contamination of bed linen with potentially pathogenic bacteria present on the hospital floor via contact with patient-worn nonskid slipper socks. A simple practice change regarding the wearing of slipper socks could play an important role in preventing pathogen transfer to the bed linen. Awareness of the likelihood of hand contamination after touching the sock bottoms that have come in contact with the hospital floor should also be considered.

## Introduction

### HEALTHCARE-ASSOCIATED INFECTIONS AND THE ROLE OF THE ENVIRONMENT

Healthcare-associated infections (HCAIs) are infections that originate in a hospital or healthcare setting and are usually caused by pathogens that can tolerate a wide range of antimicrobials. Weiner et al. (2016) conveyed that of the more than 365,000 cases of HCAIs reported in the United States from 2011 to 2014 were caused by a broad range of antimicrobial resistant pathogens. The

role of the healthcare environment in the emergence and spread of HCAIs has been debated for decades (Palmore & Henderson, 2015; Roques et al., 2015). In addition, the role of the environment has not received the same level of attention from infectious disease specialists as other sources (Chemaly et al., 2014). It is now widely accepted that contaminated surfaces within the patient's environment can contribute to the acquisition of HCAIs and there are critical gaps in knowledge about the source and the solution (Esteves et al., 2016; Otter, Yezli, Salkeld, & French, 2013; Roques et al., 2015; Weber & Rutala, 2013). Wille et al. (2018) found high levels of microbial contamination within the hospital patient care environment and raised concern about the potential for the environment as a reservoir for resistant species.

### THE HOSPITAL FLOOR

The hospital floor is an overlooked and underappreciated environmental reservoir of pathogens and a source of possible pathogen transfer. Deshpande et al. (2017) tested pathogen transfer from the floor to environmental objects and contamination of hands after touching objects that fell to the floor. They found that objects that touched the floors frequently resulted in acquisition of pathogens from the floors and showed that any object that falls to the floor can transfer pathogens to the hands when picked up or handled.

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With the floor as a source of healthcare-associated pathogens, cleaning methods have been addressed to control pathogen load. Debate over methods, material, and measurement exists and hospital environment surface cleaning has never been considered an evidenced-based science (Dancer, 2014). The Centers of Disease Control and Prevention (2008) recommends that hospital floors should be cleaned with detergent alone and not disinfected. The rationale underlying the recommendation for using detergent alone is that hospital floor surfaces become quickly contaminated after disinfection (Ayliffe, Collins, Lowbury, Babb, & Lilly, 1967; Rashid, Vonville, Hasan, & Garey, 2017). Rashid et al. (2017) surmised in a systematic review that staff shoes contaminate floor surfaces and also aerosolize pathogens. Wheels of equipment rolled in and out of patient rooms are overlooked and are not optimally cleaned as revealed by Gardner et al. (2014). If floors are not cleaned, pathogens present can survive for months and can be a continuous source of transmission (Esteves et al., 2016; Kramer, Schwebke & Kampf, 2006; Otter & French, 2009; Yazgi et al., 2009; Zarpellon et al., 2015).

### **NONSKID SLIPPER SOCKS**

During a typical hospital stay, a patient is issued one pair of nonskid slipper socks. It is advised that as a universal precaution to prevent patient falls, nurses should maintain nonslip, comfortable, and well-fitting footwear on the patient (United States Department of Health & Human Services, Agency for Healthcare Research and Quality, 2013). It is important to get patients out of bed during their hospital stay, as mobilization improves patient outcomes and reduces length of stay (Alder & Malone, 2012; Connolly, O'Neill, Salisbury, & Blackword, 2016). After mobilization, patients often wear the nonskid slipper socks that have touched the floor back into their beds. The problem, therefore, is that the socks could potentially contaminate the bed linen with bacteria from the floor. In a recent study, Mahida and Boswell (2016) discovered pathogenic bacteria on the socks touching the hospital floor. However, they did not examine the transfer of pathogens from the floor to the bed linen via the socks.

### **HOSPITAL LINEN**

The association between hospital bed linens and the occurrence of HCAs is often overlooked because of lack of interventional studies (Fijan & Turk, 2012). Hygienically clean hospital bed linen has not been shown to pose a risk of pathogen transfer. However, there is no microbial benchmark to define hygienically clean linen as testing has not been supported by epidemiological data (Sehulster, 2015).

## **Purpose of the Study**

The main purpose of this study was to examine the contamination of hospital bed linen with bacteria transferred from the soles of nonskid slipper socks that had touched the floor. In addition, this study aimed to test the antibiotic susceptibility of the bacteria isolated from the floor. Three types of surfaces within the hospital

environment were tested: the floor, the soles of nonskid slipper socks, and the bed linen.

## **Methods**

### **SAMPLE SELECTION**

Two chief investigators, three undergraduate biology students, and three undergraduate nursing student volunteers participated in sample collection from two Midwestern hospital orthopaedic units. Internal review board permission was granted by both hospitals to collect the samples. The researchers gathered samples from the rooms and adjacent hallway areas at each of the two hospitals. Samples were obtained from a total of two uncleaned, previously occupied patient rooms within an hour of the patient's discharge. No information about the identity or diagnosis of the patient was obtained other than acknowledgment from the nursing staff that the patient had no known infection on admission or discharge.

### **SAMPLE COLLECTION**

At each hospital, a total of 132 samples were collected through swabbing of the floor, bottoms of the nonskid socks, and bed linen. Each sampling surface was swabbed vertically, horizontally, and diagonally 10 times with sterile E-Swab (COPAN Diagnostics, Murietta, CA). The swabs were immediately placed into sterile transport tubes and transported to the microbiology laboratory. Floor samples were obtained in triplicate from six selected floor areas immediately prior to being walked on with the slipper socks; nonskid slipper sock samples were obtained before contact with the floor as the control and in duplicate after contact with the floor; and bed linen samples were obtained before contact with the rubbed slipper socks as the control and in duplicate from six designated areas on the sheet after contact with the socks.

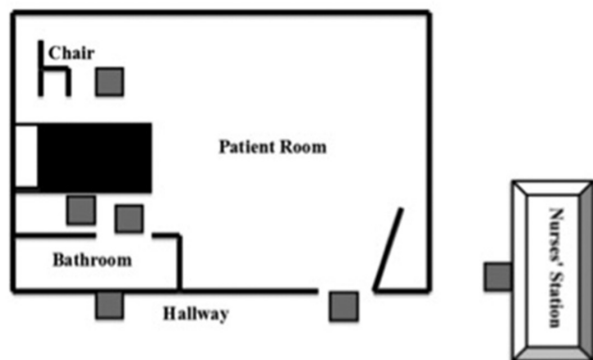
### **Floor Samples**

Six floor sample areas inside and outside a patient room were selected on the basis of observation of normal hospital care unit foot traffic flow. The locations of the sample areas within the patient room were at the bathroom entry, at the side of the bed, and in front of the chair. Likewise, three areas outside and adjacent to the patient room were selected in the hallway (at the patient room door entry, 10 ft. to the right of the doorway and along the wall railing, and in front of the nearest nurses' station) and were also marked (see Figure 1). Sampling areas were marked with paper tape measuring 2 × 2 sq ft.

### **Linen Samples and Slipper Sock Samples**

Six areas on the surface of a fitted bottom bed linen were sampled in duplicates before and after exposure to the rubbing of worn slipper socks. The linen chosen to sample was obtained from the care unit's linen cart to simulate normal patient care hospital conditions. A banquet style hard plastic table, carefully disinfected with a hospital grade disinfectant wipe and allowed to

### Hospital Floor Sample Areas



**FIGURE 1.** Floor sample areas. Dark gray squares indicate 2 × 2 sq ft. areas on the floor of the orthopaedic unit. Three areas were within the patient room in front of the chair, adjacent to the bed, entry to the bathroom. Three areas were within the hallway: the entry to the room, 10 ft. to the right of the door, in front of the nurses' station.

dry completely, was used to serve as a platform for placement of the linen for testing. After stretching the linen on the table, the linen was marked and labeled with paper tape to designate six 1 sq ft. areas, each correlating with a specific, marked floor sampling area. Before any contact with the floor-exposed slipper socks to the linen, each of the six areas of the linen was sampled in duplicate as the control.

Nonskid slipper socks are distributed to almost all patients on admission as a fall prevention measure. It is a common practice that patients wearing nonskid slipper socks get in and out of bed. Three nursing student volunteers simulated real patients walking within the designated floor sampling areas and within the room and adjacent hallway wearing nonskid slipper socks obtained from a medical product vendor (Dynarex Corporation, Orangeburg, NY). The socks were individually packaged in sealed plastic sleeves.

Volunteers carefully prepared to don the socks by cleaning of hands and feet with an alcohol-based wipe, wearing clean examination gloves and sliding on a pair of clean white cotton liner socks by touching the cuff only. The slipper socks were also donned carefully over the liner socks with no touch exposure to the sock bottom surface. After the slipper sock donning by the volunteers, the slipper sock sole bottoms were swabbed before any contact with the floor as the control sample. The volunteers then walked on the marked, designated areas on the floor, around the room in general and adjacent hallway areas to simulate normal patient walking patterns. After floor exposure, swab samples were collected in duplicate from the exposed bottoms of the socks.

To sample for pathogen transference from the bottoms of the floor-exposed slipper socks, the biology students while wearing sterile gloves carefully doffed each floor-exposed sock from each volunteer and placed the sock in a disinfected container with the sock bottom facing up. The biology student then aseptically removed the floor-exposed sock from the container and rubbed the sock bottoms onto the surface on each specific bed

linen area that corresponded with marked floor area. Immediately following the sock to linen rubbing, swab samples were collected in duplicates from each sock-rubbed bed linen area.

### BACTERIAL ISOLATION AND IDENTIFICATION

Transport tubes containing the swab samples were incubated at 37°C for 24 hours. Following incubation, each swab sample was inoculated in Tryptic Soy Agar, Blood Agar, Mannitol Salt Agar, and MacConkey Agar plates and incubated at 37°C for 48 hours. The most prevalent bacterial colonies growing on the media plates were selected for further testing for identification by Gram staining and biochemical tests. Cultures displaying fungal growth only were recorded and discarded. Gram-negative bacteria were identified using IMVIC (Indole, Methyl Red, Voges-Proskauer, and Citrate Utilization), Catalase, Oxidase, and Triple Sugar Iron tests. All gram-positive isolates were identified using the Mannitol-fermentation, DNase, Coagulase, and Catalase tests.

### ANTIBIOTIC SUSCEPTIBILITY TESTING

All isolates identified were subjected to antibiotic susceptibility testing by the Kirby-Bauer Disk Diffusion method following the guidelines provided by the Clinical and Laboratory Standards Institute (2014). Overnight cultures of the bacterial isolates were adjusted to an optical density equivalent to McFarland turbidity standard 0.5 and then plated on sterile Mueller Hinton Agar plates. Disks of selected antibiotics were placed on the plated cultures and incubated at 35°C for 20 hours. Gram-positive isolates were tested with six antibiotics: vancomycin (5 µg and 30 µg), oxacillin (1 µg), ciprofloxacin (5 µg), chloramphenicol (30 µg), penicillin (10 µg), and tetracycline (30 µg). Gram-negative isolates were also tested with six antibiotics, with imipenem (10 µg) and ceftriaxone (30 µg) substituted for vancomycin and penicillin. Following incubation, the size of the zone of inhibition formed around each disk was measured and the levels of susceptibility of the isolates were determined using the zone-size interpretive chart provided by the antibiotic disk manufacturer. The antibiotic susceptibility test was repeated to verify the results.

## Results

### BACTERIAL ISOLATES IDENTIFIED ON SURFACE SAMPLES

From the 132 surface samples collected in the two hospitals (hospital 1 and hospital 2), a total of 122 bacterial isolates were obtained and subjected to identification tests. These included 54 isolates from the floor (26 from hospital 1 and 28 from hospital 2); 34 from the floor-exposed slipper socks (15 from hospital 1 and 19 from hospital 2); and 34 from the bed linen exposed to slipper socks (22 from hospital 1 and 12 from hospital 2). Overall, 63 bacterial isolates were obtained from hospital 1 and 59 isolates were obtained from hospital 2. No bacterial growth was obtained from the control samples collected in either hospital.

Samples from both hospitals yielded higher numbers of gram-positive bacteria than gram-negative bacteria. Of the 59 isolates obtained from hospital 1, 39 (61.9%) were gram-positive and 24 (38.0%) were gram-negative (see Table 1). Likewise, of the bacterial isolates obtained from hospital 2, 42 (71.1%) were gram-positive and 17 (29.0%) were gram-negative. All gram-positive isolates from hospital 1 were identified as *Staphylococcus* species and included 32 (51.0%) coagulase-negative staphylococci (CoNS) and 3 (4.8%) *Staphylococcus aureus* isolates (see Table 1). Of the gram-positive isolates identified from hospital 2, 30 (71.4%) were CoNS, three (7.1%) were *Micrococcus*, and three (7.1%) were *Bacillus* isolates (see Table 2). Overall, CoNS were the most prevalent gram-positive species in both hospitals, constituting about 51% of all bacterial isolates examined in this study.

The gram-negative bacteria isolated from hospital 1 included 9 (37.5%) *Citrobacter*, 7 (29.1%) *Pseudomonas*, 2 (8.3%) *Proteus*, and 1 (4.1%) *Salmonella* isolates (see Table 1). Of the gram-negative isolates obtained from hospital 2, 5 (29.4%) were *Klebsiella*, 3 (17.6%) were *Pseudomonas*, and 1 was *Proteus* (see Table 2). In contrast to hospital 2, no *Citrobacter* species was isolated from hospital 1. Four gram-positive and five gram-negative isolates from hospital 1, and four gram-positive

**TABLE 1. BACTERIAL PREVALENCE IN THE ORTHOPAEDIC UNIT OF HOSPITAL 1**

	Number of Isolates (%) <sup>a</sup>		
	Floor Samples	Slipper Socks	Bed
Linen			
Test samples	18	12	12
Control samples <sup>b</sup>	–	6	12
Gram-positive	39 (61.9)		
Coagulase-negative staphylococci	15	8	9
<i>Staphylococcus aureus</i>	1	–	2
Other (unidentified)	–	2	2
Gram-negative	24 (38.1)		
<i>Citrobacter</i>	3	–	6
<i>Pseudomonas</i>	2	4	1
<i>Klebsiella</i>	–	–	–
<i>Proteus</i>	2	–	–
<i>Salmonella</i>	1	–	–
Other (unidentified)	2	1	2

<sup>a</sup>Numbers within parentheses connote percentages of isolates out of the total isolates obtained from hospital 1 (*n* = 63). Test samples were collected in triplicates from each floor area, in duplicates from each slipper sock, and bed linen surfaces.

<sup>b</sup>Control samples were collected from clean, previously unexposed slipper sock (singly from each slipper sock prior to contact with the floor) and bed linen surfaces (in duplicates from each area prior to contact with the floor-exposed slipper sock). No bacterial growth was obtained from the control samples.

**TABLE 2. BACTERIAL PREVALENCE IN THE ORTHOPAEDIC UNIT OF HOSPITAL 2**

	Number of Isolates (%) <sup>a</sup>		
	Floor Samples	Slipper Socks	Bed
Linen			
Test samples	18	12	12
Control samples <sup>b</sup>	–	6	12
Gram-positive	42 (71.1)		
Coagulase-negative staphylococci	13	10	7
<i>Staphylococcus aureus</i>	–	–	–
<i>Micrococcus</i>	2	–	1
<i>Bacillus</i>	2	–	1
<i>Streptococcus</i>	–	–	1
<i>Corynebacterium</i>	–	1	–
Unidentified gram-positive bacteria	2	1	1
Gram-negative	17 (28.8)		
<i>Citrobacter</i>	–	–	–
<i>Pseudomonas</i>	2	1	–
<i>Klebsiella</i>	2	2	1
<i>Proteus</i>	1	–	–
<i>Salmonella</i>	–	–	–
Unidentified gram-negative bacteria	4	4	–

<sup>a</sup>Numbers within parentheses connote percentages of isolates out of the total isolates obtained from hospital 1 (*n* = 63). Test samples were collected in triplicates from each floor area, in duplicates from each slipper sock, and bed linen surfaces.

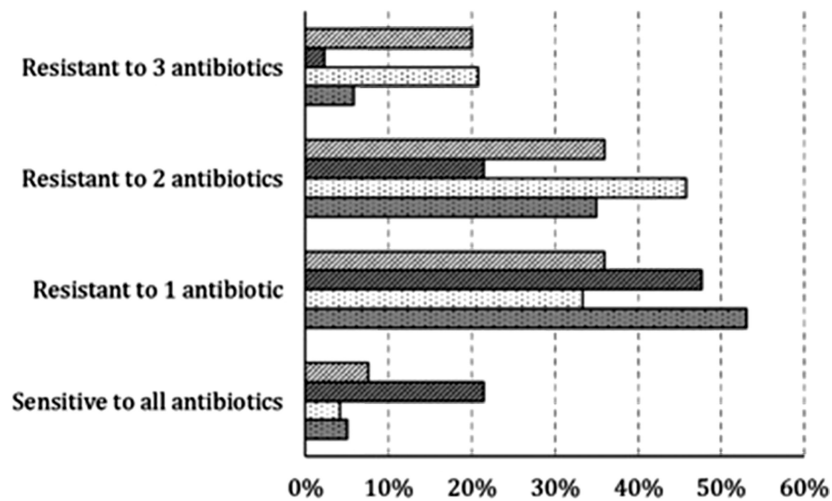
<sup>b</sup>Control samples were collected from clean, previously unexposed slipper sock (singly from each slipper sock prior to contact with the floor) and bed linen surfaces (in duplicates from each area prior to contact with the floor-exposed slipper sock). No bacterial growth was obtained from the control samples.

and eight gram-negative isolates from hospital 2 could not be identified by the identification tests used in this study and were therefore labeled as other (unidentified) bacteria. Overall, *Staphylococcus*, *Citrobacter*, and *Pseudomonas* species were found to be prevalent on the hospital surfaces tested in this study. Pathogenic species *Staphylococcus aureus*, *Salmonella*, *Proteus*, and *Klebsiella* were isolated in lower numbers. These results are consistent with the results of previous studies (Gaynes & Edwards, 2005; Samonis et al., 2009; Thapa & Tribuddharat, 2012).

### ANTIBIOTIC SUSCEPTIBILITY PATTERNS

Of the bacterial isolates obtained from hospital 1, 35.8% (14) gram-positive isolates were resistant to two antibiotics and 20.5% (eight) were resistant to more than two antibiotics tested (see Figure 2). Of the gram-negative isolates, 45.8% (11) isolates were resistant to

### Antibiotic Susceptibility Patterns of the Isolates



**FIGURE 2.** Comparison of gram-negative and gram-positive bacterial isolates displaying resistance to varying numbers of antibiotics tested in the study. Striped bars connote gram-positive isolates and dotted bars connote gram-negative isolates. Bars with white filling represent hospital 1 isolates and bars with gray filling represent hospital 2 isolates.

two antibiotics tested, and 20.8% (five) were resistant to three antibiotics. Of the isolates obtained from hospital 2, numbers of isolates resistant to more than two antibiotics were significantly lower (one gram-positive and one gram-negative isolates), but the isolates demonstrating resistance to two antibiotics were more or less similar in number—21.4% (nine) gram-positive and 35.3% (six) gram-negative isolates—as compared with those obtained from hospital 1 (see Figure 2). A low number of isolates displayed susceptibility to all antibiotics (three isolates from hospital 1 and nine isolates from hospital 2).

Of the three *S. aureus* isolates obtained from hospital 1, two were resistant to both penicillin and oxacillin, but sensitive to vancomycin, indicating that these isolates are likely methicillin-resistant *S. aureus*. *S. aureus* and *P. aeruginosa* are well known bacterial pathogens that are often associated with HCAs. *S. aureus* is the leading pathogen identified in orthopaedic surgical site infections (SSIs) and is ranked second in all HCAI-associated pathogens (Weiner et al., 2016). *P. aeruginosa* is ranked the sixth leading pathogen for all HCAI infections and the third leading cause of catheter-acquired urinary tract infections or CAUTIs (Weiner et al., 2016). *Citrobacter freundii* is an opportunistic pathogen and is responsible for most hospital-acquired cases of urinary tract infections and intra-abdominal infections.

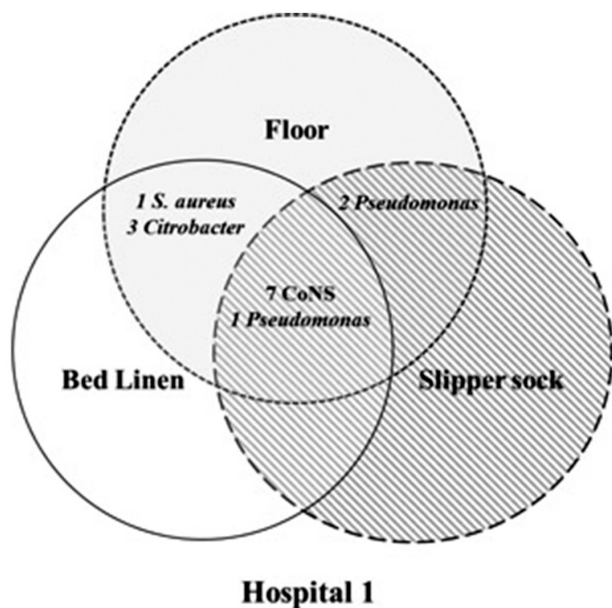
## Discussion

### CROSS-CONTAMINATION AND THE POSSIBLE ROLE OF NONSKID SLIPPER SOCKS

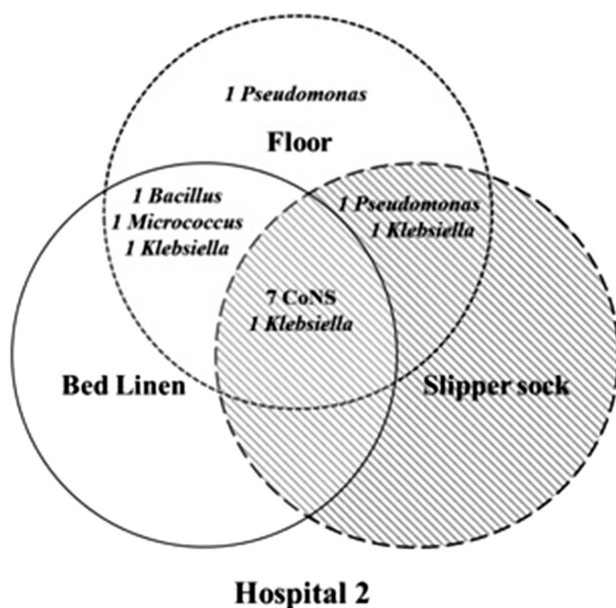
A high proportion of the isolates constituted CoNS at both hospitals (32 and 30 isolates from hospital 1 and hospital 2, respectively; see Tables 1 and 2). Coagulase-negative staphylococci are common bacteria of the normal microbiota of humans and are considered common

contaminants in hospital environments. However, it is also important to consider that these species are opportunistic pathogens of humans and can cause infections in immunocompromised hosts such as patients who are hospitalized or have surgical wounds (Weiner et al., 2016). In this study, relatively high numbers of CoNS were obtained from all three surfaces sampled at hospital 1 and hospital 2 (seven and eight isolates from hospital 1 and hospital 2, respectively; see Figures 3 and 4). This indicates a role of the slipper socks in the transfer of these bacteria from the floor to the bed linen. This is further supported by the finding that CoNS were absent in control samples obtained from the slipper sock and bed linen surfaces before bringing them in contact with the floor microbes (see Tables 1 and 2).

Besides CoNS, a *Pseudomonas* isolate and a *Klebsiella* isolate were obtained from all three surfaces sampled at hospital 1 and hospital 2, respectively. Additional isolates of *Pseudomonas* were also obtained from the floor and the floor-contacted slipper socks at both hospital 1 (2 isolates) and hospital 2 (one isolate; see Figures 3 and 4). Interestingly, in hospital 1, an isolate of *Staphylococcus aureus* and three isolates of *Citrobacter* were obtained from both the floor and the bed linen but these species were absent in the corresponding nonskid slipper sock samples. An explanation for this could be the failure of transfer of the bacteria from the nonskid slipper sock to the bed linen because of the nonelectrostatic attraction between the bacterium and textile surface of the slipper socks (Callewaert et al., 2014). It is possible that the swab may not have picked up the bacteria that were on the floor-contacted sock, but when the sock was rubbed onto the bed linen, the pressure of rubbing could have caused the bacteria to transfer onto the bed linen. Another explanation for the failure of transfer could be inadequate contact between the two surfaces during the transfer process.



**FIGURE 3.** Bacterial cross-contamination in hospital 1 as demonstrated by the isolation of identical bacterial species from the floor (shown within the solid circle), floor-exposed nonskid slipper socks (shown within the dotted circle), and nonskid slipper sock-exposed bed linen (shown within the dashed circle). The isolation of CoNS and *Pseudomonas aeruginosa* from all three surfaces signifies pathogen transfer by the nonskid slipper socks from the floor to the bed linen. CoNS = coagulase-negative staphylococci.



**FIGURE 4.** Bacterial cross-contamination in hospital 2, as demonstrated by the isolation of identical bacterial species from the floor (shown within the solid circle), floor-exposed nonskid slipper socks (shown within the dotted circle), and nonskid slipper sock-exposed bed linen (shown within the dashed circle). The isolation of CoNS and *Klebsiella* from all three surfaces signifies pathogen transfer by the slipper socks from the floor to the bed linen. CoNS = coagulase-negative staphylococci.

The results of this study underline the association between the use of nonskid slipper socks by patients and the cross-contamination of hospital surfaces, in particular, patient bed linens. This research verifies that the hospital floor is a potential source of transfer pathogens. This study also indicates that when exposed to the hospital floor, nonskid slipper socks could be an overlooked vehicle for the spread of healthcare-associated pathogens and an underappreciated potential source of HCAI.

### PRACTICE IMPLICATIONS

Healthcare workers and researchers need to heed the impact of the environment and mechanisms of pathogen transfer through examination and awareness of all possible high touch surfaces and possible ways of cross-transmission (Otter et al., 2013). From the results of this study, the bottoms of nonskid slipper socks should be considered as contaminated and capable of pathogen transfer not only to the bed linen but also to the hands of healthcare workers. Nonskid slipper socks are routinely touched and removed multiple times per day for various reasons such as to access neurovascular status of the lower extremity, for bathing, or for dressing changes. Because this study demonstrates that the socks are inoculated with floor pathogens, care staff must consider cleansing their hands after handling the socks. Studies indicate that hands of healthcare workers have high pathogen loads after touching contaminated objects in the environment (Allegranzi & Pittet, 2009; Cheng et al., 2015; Guerrero et al., 2012; Stiefel et al., 2011; Wille et al., 2018). As a strategy to reduce infection risk, care staff must recognize when their hands are contaminated (Steed et al., 2011).

Prevention of SSIs and CAUTIs is a key role for healthcare providers. Bed linen contaminated with floor pathogens could be a possible risk for SSIs, especially lower limb incisions/wounds and CAUTIs as pathogens could transfer from the bed linen to the surgical incision/wound and to the tubing of the catheter that is lying on the bed linen.

There are two simple practice change solutions to avoid bed linen contamination from the nonskid socks. One solution would be to issue two different colors of socks on patient admission as one to be designated for the floor and the other to wear while in bed. The socks are inexpensive usually costing the hospital less than \$1 a pair. Another solution would be for staff to remove the floor-exposed socks before the patient returns back to bed.

For future research, a study to test the impact of bed linen contamination on SSI and CAUTI rates could explore whether SSIs or CAUTIs are reduced through the practice change of not allowing nonskid slipper socks that have been exposed to the floor to touch the bed linen. Another line of research would be to test the impact on HCAI rates with the practice change of point of care hand hygiene after handling nonskid slipper socks that have been exposed to the floor.

### STUDY LIMITATIONS

Sampling was limited to a specific nursing care unit at both hospitals so that results may be different in care

units with different patient care populations. Sampling was obtained from specific areas of the floor. Some pathogens could have been missed or been overrepresented from areas not tested. All attempts were made to simulate a normal patient and staff movement foot pathway experience as areas tested were deemed to be high foot traffic areas.

Hygienically clean bed linen was collected from the nursing care unit's linen cart to simulate normal conditions of the patient care unit. The linen obtained for this study was not sterile. All precautions were taken to ensure that transference of pathogens from handling the linen did not occur before testing. The bed linen obtained for this study was tested before contact with the nonskid slipper socks as a control measure. Packaged, medical, nonskid socks were used to simulate natural circumstances and were not sterile. The packaged nonskid slipper socks were tested before contact with the floor as a control measure. All precautions were taken to ensure that no transference of pathogens from the hands or feet of the investigators occurred during sampling. Fungal isolates were excluded from this study and specific species level isolation was not performed on any of the isolates obtained.

## Conclusion

This is the first study to examine pathogen transfer from the floor to the bed via the use of nonskid slipper socks in healthcare settings. The finding that the majority of the gram-positive and gram-negative isolates identified showed resistance to two or more antibiotics is of concern. Healthcare workers must be aware of the potential pathogens within the environment and methods to prevent the spread of those pathogens.

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