

Bugs on cuffs and pockets: A cross-sectional Study of the contamination of healthcare personnel attire at salmanyia medical complex

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Abstract

Background: Hospital acquired infections increase the morbidity and mortality of the inpatient population. Pathogens like *Staphylococcus aureus*, *Enterococcus* species, as well as multi-drug resistant microorganisms like Vancomycin-Resistant *Enterococcus* (VRE), *Staphylococcus aureus* Methicillin –Resistant (MRSA) and *Pseudomonas aeruginosa* have been found on healthcare providers cloths and can be transmitted by healthcare personnel's attires. This is a cross-sectional study aimed to explore the prevalence of contamination of the attires of healthcare personnel working at Salmaniya Medical Complex.

Methods and Findings: We randomly selected 100 doctors and nurses working in different departments and swabbed their attire's sleeves and pockets. We then stored both swabs in their accompanying syringe that contains a bacterial transportation media, and sent them to the laboratory for culture. Percentages and frequencies were computed for different categorical variables, and a cross-tabulation was computed between each two categorical variables. Chi-Squared test was used to determine whether there were significant relationships between each two categorical variables. Our primary outcome measure was the percentage of contamination of the attires and pockets, and identification of the bacteria. The secondary outcome measure of the study is to compare the percentage of contamination between participants. Out of the total samples, 44 pockets and 45 cuff samples were contaminated with coagulase-negative staphylococci (CoNS). Thirty eight participants were found to have contamination of both the cuffs and pockets. Nurses had slightly higher prevalence of cuff contamination than doctors ($P=0.032$). Amongst doctors,

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surgeons had the highest prevalence of contamination ($P=0.006$). A major potential limitation include the sample technique as it did not include direct contact between the blood agar and personnel attires.

Discussion: Our data did not reveal contamination of hospital personal cuffs and pockets with significant pathogens such as *Staphylococcus aureus* or both MRSA and VRE. Nevertheless, contamination with CoNS was found and could be either from autoinoculation or contamination from the hospital environment and could correlate to level of hygiene. Frequent washing of attire doesn't reduce the level of contamination. Further studies should be done, with larger samples and by performing antibiotic susceptibility test as well as using the method of direct contact between the blood agar and white coats.

Introduction

Hospital acquired infections increase the morbidity and mortality of the inpatient population [1]. Bacteria known to cause hospital acquired infections can be transmitted by direct contact or by fomites. One potential fomite is the healthcare personnel attire. Several studies have demonstrated contamination of healthcare personnel attires with wide spectrum of bacteria [1-4]. Multidrug resistant bacteria like VRE, MRSA and *Pseudomonas spp.* have been found on healthcare providers cloths and devices [1]. Other than cloths, items found to be contaminated are stethoscope, pens, and ties [1].

No research about the rate of contamination of healthcare personnel has been done in the region. The aim of our research study is to explore the prevalence of contamination among healthcare personnel attire working in Salmaniya Medical Complex. This study will also assess the profile of microbial contamination, and will compare the attires worn by the physicians and nurses working in the different departments of this large hospital in Bahrain.

Methods

Study Population

Our study is a cross-sectional study targeting healthcare personnel. We randomly selected 100 doctors and nurses working in medical, surgical, and pediatric department at Salmaniya medical complex. This Medical

Keywords

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Complex is the largest tertiary hospital in Bahrain with a capacity of 1,200 beds. We obtained the lists of doctors and nurses from the three different departments. We then chose every third or every fourth doctor or nurse (depending on the department faculty size) from the list. For example, there were 111 junior and senior doctors in the medical department at the time of taking the swabs, after excluding those doctors who were at the time in their annual leave. We selected every fourth doctor from the list, and we ended up with 28 medical doctors. Similarly, we have chosen doctors from the surgical and pediatric departments' but for those departments we have chosen every third doctor as the departments sizes are smaller. There were 10 surgical and 6 pediatric doctors. For nurses, there were 7 medical wards in our hospital, 4 pediatric wards and 5 surgical wards. We obtained the nurses lists from each ward's head nurse and then selected every fourth nurse, and after excluding those who were not available or were in their annual leave, we selected every fourth nurse. There were a total of 29 medical, 9 surgical and 6 pediatric nurses. Twelve of the samples were randomly obtained from other departments, which consisted of 6 doctors and 6 nurses. The study included departments like orthopedics, Neurology, and Obstetrics and Gynecology, and then each two doctors and two nurses were selected randomly from the lists. The involvement of the participants was only in collecting samples after signing a consent to take part in this study. There were no drop outs from the study. All samples were collected in August and September of 2017 and analyzed as one group.

Data Collection

After obtaining the consent of participants, we swabbed the sleeves and the pockets of their attires. For each participant, we prepared two swabs that were moisturized with normal saline. One swab was used for the inner and outer surfaces

of both pockets, while the other swab for the inner and outer surfaces of the cuffs. The pockets are the two lower pockets of the lab coat's front side, while the cuffs are the tip of the rounded long-sleeved lab coats sleeves. All swabs were stored with their accompanying syringe that contains a bacterial transportation media. All participants have filled a questionnaire about their demographic information and hygiene practices. Unfortunately we didn't have any previous data about the hygiene practices of our doctors such as their hand hygiene practices.

Laboratory analysis

All specimens collected from the cuffs and pockets were sent to the microbiology laboratory for culturing. A selected group of Chromogenic culture plates were used for the primary inoculation to ensure the growth of any commonly/uncommonly encountered organisms. Plates were incubated in CO₂ incubator at 37 degree Celsius, and then were checked for any growth every morning for two days. Final reports were released after 48 hours. The first CHROMagar *Staphylococcus aureus* is used for detection of *S. aureus* as colonies appear pink to mauve after 24 h of incubation, whereas the other coagulase-negative staphylococci (CoNS) grew as blue, white, or beige colonies [5]. The second CHROMagar MRSA is used for identification Methicillin -Resistant *Staphylococcus aureus* (MRSA) where the typical MRSA appears rose to mauve. Methicillin-susceptible *Staphylococcus aureus* (MSSA) appears inhibited, and other bacteria of the group appear blue, colorless, or inhibited [6]. The third CHROMagar is used for detection VRE (Vancomycin-Resistant Enterococcus) of both Van A/Van B VRE (VRE faecalis and VRE faecium); VRE faecalis and VRE faecium colonies appear pink to mauve, *E. gallinarum*/ *E. casseliflavus* colonies appear blue or inhibited, whereas the other types colonies will be inhibited [7].

Statistical Analysis

SPSS 23 was used for data entry and analysis. After that, percentages and frequencies were computed for different categorical variables, and a cross-tabulation was computed between each two categorical variables. Finally, Chi-Squared test was used to determine whether there were significant relationships between each two categorical variables. A P-value of less than 0.05 was considered statistically significant.

Results

A total of 100 participants were included in our study. Half of them were physicians and the other half were nurses. Sixty nine participants were females while males were 31. More than half of our participants belonged to the specialty of internal medicine while the remaining was distributed between surgery, pediatrics and others.

Our cultures' results were split mainly to two categories; namely, negative and positive for coagulase-negative staphylococci (CoNS) contamination. Of the total samples from pockets of the participants, 44 samples were contaminated with CoNS. Similarly, 45 samples of the cuffs were contaminated with CoNS. Thirty eight participants were found to have contamination of both the cuff and pocket with CoNS. On the other hand, 42 participants had completely negative cultures. One sample had polymicrobial contamination with CoNS, Micrococcus, Bacillus, alpha-Strep and another sample had CoNS and Bacillus. Both of these samples were counted in the total number of samples to make it hundred but were excluded in the comparison between negative and positive with CoNS.

Outcome Measures

In our study, the primary outcome measures of the study were the percentage of contamination of the attires and identification of the bacteria. The secondary outcome measure of the study was to

compare the percentage of contamination between participants.

The relationship between the demographical data of the participants and the pocket samples' cultures

When we compared the demographical data to the pocket culture results we found that gender, age, staff position (nurse vs resident), and work location results were all non-significant. When comparing the seniors to the juniors, we found that 36.6% (15/41) of senior residents had CoNS contamination, while 66.7% (6/7) junior residents of had CoNS contamination ($p= 0.015$). Another

Table 1. Relationship between Demographical data and Pocket.

	Pocket				Chi-Square
	Negative culture		CoNS		P-value
	n	%	n	%	
Gender					
Female	31	44.9	38	55.1	0.354
Male	16	51.6	13	41.9	
Age in years					
<35	22	39.3	32	57.1	0.113
35+	25	56.8	19	43.2	
Staff Position					
Senior Resident	26	63.4	15	36.6	0.015
Junior Resident	1	11.1	6	66.7	
Staff Position					
Resident	27	54.0	21	42.0	0.107
Nurse	20	40.0	30	60.0	
Specialty					
Medicine	30	52.6	26	45.6	0.006
Surgery	9	47.4	10	52.6	
Pediatrics	0	0.0	11	91.7	
Others	8	66.7	4	33.3	
Work location					
Inpatient	24	40.7	35	59.3	0.121
Inpatient & Outpatient	14	60.9	7	30.4	
Inpatient & Outpatient & OT	9	50.0	9	50.0	

significant comparison was noticed when comparing the culture results from participant in the different specialties. We found that 45.6% (26/56) of participants in internal medicine, 52.6% (10/19) of participants in surgery, 91.7% (11/11) (one sample was excluded in comparison as mentioned above) of participants in pediatrics and 33.3% (4/12) of the participants in other departments were contaminated with CoNS (P = 0.006). This means that in pockets samples, senior doctors and participants from the medical/surgical departments generally had more negative cultures as compared to junior doctors and participants from pediatrics departments, and this was demonstrated by the significant p-value (**Table 1**)

The relationship between the demographical data of the participants and the cuffs samples' cultures

When looking at the cultures obtained from cuffs, we found a significant difference between residents (doctors) and nurses. Thirty two percent (16/49) resident had *Staphylococcus species* contamination in their attires' cuffs compared to 54% (27/50) of nurses' attires cuffs were contaminated (p=0.032). This significance means that doctors generally had more sterile cuffs compared to nurses (**Table 2**).

The relationship between the Hygiene practices of the participants and pockets sample's cultures

While comparing the responses of the participants in the questionnaire to the pocket culture results, we noticed that attires claimed to be washed within less than a day were surprisingly more contaminated with CoNS (61.2%) (41/67) compared to those which were last washed in 1-3 days (28%) (7/17) or more than three days (37.5%) (3/7) (p=0.023). Moreover, when we examined how frequently the participants wash their attire per week, we noticed a CoNS contamination rate of 33.3% (6/17) in those who wash their attires less than twice a week,

Table 2. Relationship between Demographical data and Cuff.

	Cuff				Chi-Square
	Negative culture		CoNS		P-value
	n	%	n	%	
Gender					
Female	37	53.6	32	46.4	0.370
Male	19	61.3	11	35.5	
Age in years					
<35	28	50.0	27	48.2	0.204
35+	28	63.6	16	36.4	
Staff Position					
Senior Resident	29	70.7	12	29.3	0.253
Junior Resident	4	44.4	4	44.4	
Staff Position					
Resident	33	66.0	16	32.0	0.032
Nurse	23	46.0	27	54.0	
Specialty					
Medicine	35	61.4	21	36.8	0.204
Surgery	9	47.4	10	52.6	
Pediatrics	4	33.3	8	66.7	
Others	8	66.7	4	33.3	
Work location					
Inpatient	28	47.5	31	52.5	0.021
Inpatient & Outpatient	18	78.3	4	17.4	
Inpatient & Outpatient & OT	10	55.6%	8	44.4	

36.7% (11/29) in those who wash twice/thrice a week, and 65.4% (34/52) in those who wash their attire daily (p=0.019). Those who own less than 4 attires have more pocket contamination (64.9%) (24/35) than those who have four attires (41.7%) (10/24) or more than four attires (43.6%) (22/39) (p=0.05). Therefore this significance illustrates that those attires washed very close to the time of the study as well as those attires washed more frequently demonstrated more contamination of their pockets with CoNS in comparison to attires that were washed at a further time or less frequently (**Table 3**).

Table 3. Relationship between Hygienic data and Pocket.

	Pocket				Chi-Square
	Culture negative		CoNS		P-value
	n	%	n	%	
Last time washed your attire					
<1 day	26	38.8	41	61.2	0.023
<3 days	17	68.0	7	28.0	
<7 or <10 days	4	50.0	3	37.5	
Frequency of washing your attire per week					
<Twice	11	61.1	6	33.3	0.019
Twice/Thrice	18	60.0	11	36.7	
Daily	18	34.6	34	65.4	
Frequency of wearing your attire					
All the time	40	43.0	51	54.8	0.004
Only when seeing patients	7	100.0	0	0.0	
Number of white coats/professional attire you own					
<Four	11	29.7	24	64.9	0.050
Four	14	58.3	10	41.7	
>Four	22	56.4	17	43.6	
Cleanliness of your current attire					
Clean	16	42.1	22	57.9	0.417
Moderately clean	29	51.8	25	44.6	
Dirty	2	33.3	4	66.7	

The relationship between the Hygiene practices of the participants and cuffs samples' cultures

A similar pattern to the pocket's results was noticed in the cuffs' results when looking at the last time the attires were washed and the frequency of their washing. In regard to the last time the attires were washed, we found that the contamination rate with CoNS was 55.2% (37/67) in those who washed their attire within the last 24 hours, 20% (5/25) in those who washed their attire within 1-3 days, and 12.5% (1/7) in those who washed their attire in more than three days ($p=0.003$). Furthermore, we noticed that those who wash their attire less than a twice a week had a contamination rate of 22.2% (4/17), those who wash their attire twice/thrice a

week had 26.7% (8/20) contamination rate with CoNS, while those who was their attire daily had 59.6% (31/52) contamination rate ($p=0.003$). In here, the significant p -value demonstrated a positive correlation between cuffs contamination with CoNS and how close the attires were washed to the time of the study as well as the frequency of washing them (**Table 4**).

Table 4. Relationship between Hygienic data and Cuff.

	Cuff				Chi-Square
	Culture negative		CoNS		P-value
	n	%	n	%	
Last time washed your attire					
<1 day	30	44.8	37	55.2	0.003
<3 days	20	80.0	5	20.0	
<7 or <10 days	6	75.0	1	12.5	
Frequency of washing your attire per week					
<Twice	13	72.2	4	22.2	0.003
Twice/Thrice	22	73.3	8	26.7	
Daily	21	40.4	31	59.6	
Frequency of wearing your attire					
All the time	51	54.8	41	44.1	0.411
Only when seeing patients	5	71.4	2	28.6	
Number of white coats/professional attire you own					
<Four	18	48.6	18	48.6	0.590
Four	14	58.3	10	41.7	
>Four	24	61.5	15	38.5	
Cleanliness of your current attire					
Clean	18	47.4	20	52.6	0.282
Moderately clean	35	62.5	20	35.7	
Dirty	3	50.0	3	50.0	

Discussion

In regards to our primary outcome measure, which is to know the percentage of contamination of personnel attires as well as organism detection. Our study data suggests that healthcare workers personal attires are frequently contaminated with bacteria, mostly with coagulase-negative staphylococci

(CoNS) which are a type of staphylococci that commonly live on a human's skin. Physicians typically consider CoNS as harmless bacteria when it remains not invasive. Almost half of the total samples showed growth of CoNS, whereas approximately the other half were culturally negative. Compared to the data available in the literature, which showed a lot of significantly contaminated white coats, our data did not reveal contamination with significant pathogens such as *S. aureus* or MRSA. Significant pathogenic contaminations were detected in the majority of other studies [1-3]. According to systematic review done by Cambridge University, contamination of physicians' apparel with *S. aureus* ranged from 5% to 29% [2]. In another study, they found that 23% of white coats were contaminated with *S. aureus* and 18% were MRSA [3]. A systematic review titled "Healthcare personnel attire and devices as fomites" showed that MRSA contamination of white coats ranges from 0 to 16% and Gram-negative rods (GNR) contamination ranges from 0 to 42% [1]. In Tanzania, a study showed that the percentage of white coat contamination is 73.3% among doctors and medical students, and the most isolated pathogen in their study was *S. aureus* (46.20%) [4]. Another study that examined white coat contamination in dental operatory found other organisms; although 50% were gram positive cocci, it also revealed gram-negative cocci (24%), gram-positive bacilli (15%), and gram-negative bacilli (11%) [8]. Other micro-organisms have also been identified; Despite non-resistant forms of *Staphylococcus spp.* being the predominant isolate (27.98%), it founded MRSA (7.3%), *E. coli* (9.17%), *Acinetobacter spp.* (4.58%), *P. aeruginosa* (3.6%), and *Klebsiella spp.* (2.06%) [9]. Another study showed that the locations that had highest contamination were the sleeves (especially the cuffs) and the pockets [10].

Regarding the practices of washing the white coats, data showed that contamination was high irrespective of the gap of time since last wash [11]. A randomized clinical trial showed that after an 8

hours workday, newly cleaned physician uniforms had similar rates of bacterial contamination as infrequently washed white coats [12]. On the other hand, a research showed that the rate of contamination with resistant pathogens was higher in attires changed every 2 days compared with that changed every day [13].

We did not find similar studies that did not reveal contamination with significant microorganisms. However, some of those studies that had positive results, a minority of those results had significant microorganism, while the majority were similar to what we found in a large proportion of our samples, namely, skin flora contamination (*Staphylococcus species*). For example, less than one quarter of the samples of one study had contamination with significant organism, while more than three fourths had only skin flora [8]. Although many studies showed that there was a significant percentage of contamination of white coats, but none has found the relationship between white coats and contamination and clinical infection except for one case reported in which an infection with *Gordonia bronchialis* among three patients were linked to a nurse anesthetist that had the pathogen isolated from her scrubs, axilla, hands and purses [14].

Contamination with coagulase-negative staphylococci could be an autoinoculation from the healthcare personnel himself or from hospital environment. Thus, its existence might not be a true reflection due to contamination with pathogens.

In regards to our secondary outcome measure which basically was to compare the percentages of contamination between participants, our results showed that junior doctors have more CoNS contamination than senior doctors and so do nurses when compared to physicians. This could be explained by the fact that nurses have more patient contact than doctors as do juniors compared to seniors. The fact that CoNS is directly related to the degree of patient contact might reflect that it's actually from environmental contamination rather than just autoinoculation. On the other hand, we found that people who

claimed that they wash their attire more frequently was found to have more contamination with staphylococcus epidermis. This could be because they might overestimate the frequency of washing their attire or that attire gets contaminated quickly in a span of a single working day.

One of the limitations of our study is our sampling technique which did not involve direct contact between the white coats and the blood agars; but rather, the sample were collected by a moisturized swab, taken to the laboratory in a transportation media and were inoculated into the blood agars. However, even with a methodology similar to ours, different studies actually proved the existence of significant contamination. For example, a study proved the contamination of 28% of white coats with significant organism although their sampling technique was similar to ours [9].

Conclusion

This study did not provide evidence of significant contamination of the white coats in contrast to previous studies. Therefore, we can't provide strong evidence against wearing them in hospitals. We suggest that further studies should be done in our hospital, firstly with a bigger sample size, and secondly using the method of direct contact between the blood agar and white coats.

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