SHORT REPORT

Bacterial contamination of medical uniforms: a cross-sectional study from Suzhou city, China

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Abstract

Few studies have been conducted which evaluate the prevalence of contamination of medical uniforms in China. The present study was designed to explore the characteristics of uniform contamination and associated factors. A total of 120 participants were enrolled in the study and 122 uniforms were sampled. Each uniform was sampled at three different sites to determine the colonisation of microorganisms. A total of 366 swab samples were cultured; 294 (80.3%) samples yielded various microorganisms and 75(61.5%) uniforms were contaminated with bacteria. The uniforms of medical students had the highest prevalence of contamination. The cuffs of uniforms were the most easily infected with bacteria. Participants who wiped their hands at the back of uniforms had higher contamination rate in the hanging part of uniforms. Our study demonstrated that medical uniforms can harbour microorganisms. Proper handling of medical uniforms and adequate education to medical staffs are required to decrease healthcare-associated infections.

Keywords: Uniform, Equipment contamination, Healthcare associated infection.

Introduction

Healthcare-associated infection (HAI) is a growing global concern. It is widely believed that hands of medical practitioners are the most common vector for transmission of HAI.[1] In a resource-limited country such as Pakistan, the compliance of hand hygiene among the trainee physicians was found to be less than ideal in one study.[2] Medical uniforms serve many purposes including representation of professionalism, holding things, and cover personal clothing. Some investigations show that medical uniform's can harbour microorganisms and play a potential role in their transmission.[3,4] However, a recent evidence-based review from United Kingdom debated that the current literature did not support the notion that uniforms are vehicles for transmission of microorganisms.[5]

Few studies have been conducted in China to evaluate the contamination conditions of medical uniforms. The current study aims to assess the prevalence and associated factors contamination of medical uniforms.

Methods and Results

A cross-sectional study was performed at the Second Affiliated Hospital of Soochow University, China. Participants were interviewed and medical uniforms were collected from December 14th to December 21st 2014. The smallest sample size of 120 was estimated according to the calculating formula in EipCalc 2000 (α= 0.05; confidence level= 95; proportion= 60%; precision= 0.15×proportion; simple random sampling). A total of 122 uniforms from 120 participants were sampled (1.02 uniforms per participant). Each participant was asked to complete an anonymous questionnaire with regards to information including age, gender, position, professional rank (grade, junior title, intermediate title, or senior title), uniform washing frequency, service year, self-assessment of uniform hygiene, and method of drying hands. Students undergoing clinical training were also included as they had close contact with patients. Drying hands by wiping at the back of uniform was judged as "incorrect", while other methods such as use of paper towels, cloth towels, and warm air dryers were judged as "correct".

Work clothing of healthcare practitioners were defined as white overcoats in this study. Each participant's uniform was sampled using three swabs. The first swab was taken from the neckline, the second from the cuff, and the last one from the back of the uniform's hanging part parallel to the lower pocket. The swabs were collected by sampling the outer surface area of 5cm×5cm for 4 times. Each swab was soaked in 10 ml normal saline and sent to the clinical bacteriological laboratory of the institute's hospital within 1 hour. A 1.0 ml aliquot from each sample was spread on sheep blood agar plates with trypticase soy. The plates were incubated at 37°C for 24 hours and then examined for bacterial growth by BD phoenix™ 100

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Table-1: Demographic data and uniform contamination of the participants (n=120).

Characteristics	Uniform contamination No (%)	t/x^2	p
Gender		2.188	0.139
Male	40/43 (93.0)		
Female	66/77 (85.7)		
Occupation		6.701	0.035
Doctor	34/42 (81.0)		
Nurse	32/49 (65.3)		
Student	26/29 (89.7)		
Professional rank		4.963	0.175
Senior	6/7 (85.7)		
Intermediate	15/24 (62.5)		
Junior	50/64 (78.1)		
No grade	22/25 (88.0)		
Sample site		6.781	0.034
Neckline	86/120 (71.7)		
Cuff	91/120 (75.8)		
Back	73/120 (60.8)		
Self-assessment		2.347	0.504
Clean	6/10 (60)		
Moderately clean	50/64 (78.1)		
Moderately dirty	35/43 (81.4)		
Dirty	2/3 (66.7)		
Hand-drying method		17.379	0.001
Correct	48/94 (51.1%)		
Incorrect	25/26?96.2%?		

No = number; t/x^2=

Table-2: Comparison regarding self-assessment of cleanliness and hand-drying method among doctors, nurses and medical students.

Characteristics	Doctor N=42	Nurse N=49	Student N=29	t/x^2	p
Male (%)	71.4	0	44.8	51.280	0.032
Self-assessment				4.219	0.214
Clean	2	7	1		
Moderately clean	22	25	17		
Moderately dirty	17	16	10		
Dirty	1	1	1		
Hand-drying method				6.897	0.009
Correct	32	43	23		
Incorrect	10	6	6		

t/x^2=

automated microbiology system. Ten or more colony forming units were considered as significant. A uniform with one or more contaminant sites was judged as contaminated. Strain typing was done by biochemical methods including colony characteristics, Gram staining, and coagulase test. Methicillin resistance was determined according to the Clinical and Laboratory Standards Institute (CLSI) guidelines (M100-S23).[6]

Statistical analysis was performed using SAS 8.2 software. Distributions of bacteria were analysed by x2 test. Comparison among groups was performed by t-test. All tests were two-tailed. P< 0.05 was considered to be statistically significant.

All staff wore long-sleeved, knee-length white overcoats made of 65% cotton and 35% polyester blends. A total of 366 swab samples were cultured out of which 294 samples (80.3%) yielded various microorganisms. Among the 122 uniforms examined, 75 overcoats (61.5%) were contaminated with bacteria. Overall, 15 different species of bacteria were identified, including 3168 strains of gram-positive bacilli and 8130 strains of gram-negative bacilli. The top three bacterial species included Staphylococcus (21.4%), Escherichia coli (8.6%), and Klebsiella (7.8%).All the isolates from the necklines were Gram-positive. It was noteworthy that the same types of Gram-negative bacteria were detected on the white overcoats from 3 medical students, including 2 cases of Acinetobactercalcoaceticus subsp.lwoffii and 1 case of Moraxella osloensis.

The participants' demographic data are summarised in Table-1. There was no statistical difference in prevalence of contamination between different genders, professional rank, and self-assessment (all p-values >0.05), however a difference was noted with regards to occupation, sampling site, and hand-drying methods. The uniforms of medical students showed the highest contamination prevalence (prevalence= 89.7%; x^2= 6.701; p= 0.035) compared to doctors and nurses. The cuffs were the most easily contaminated. The uniforms of the participants who dried their hands at the back of uniforms showed a higher contamination prevalence (96.2% vs 51.1%; x^2= 17.379; p= 0.001).

Characteristics between genders were further compared. There was no difference between genders with regards to average age (30.5 years vs 29.5 years; t= 0.841; p= 0.438) and working years (5.7 years vs 7.4 years; t= 1.168; p= 0.245). The average laundry interval of the females was shorter than that of the males (5.1 days vs 9.3 days; t= 4.549; p= 0.001). The females were more likely to adopt correct hand-drying method (85.7% vs 65.1%; x^2= 6.897; p= 0.009). Both males and females underestimated the cleanliness of their uniforms.

Self-assessment regarding cleanliness and correct hand-drying methods were compared between doctors, nurses and medical students (Table-2). Most of the doctors were male, and all of the nurses were female, while the medical students had nearly equal gender distribution (x^2= 51.280; p= 0.032). There was no difference in the

perception of uniform cleanliness, although the uniforms from students had the highest contamination prevalence. Compared to doctors and medical students, the nurses showed the highest ratio of correct hand-drying (87.8% vs 71.4%, 87.8% vs 79.3%, respectively; x^2= 6.897; p= 0.009).

Discussion

Of the 122 uniforms screened, 75 (61.5%) were contaminated with bacteria. The contamination prevalence was in accordance with previous studies.[4,7] Chacko et al. systematically examined the survival of HAI-related bacteria and found that many bacteria can survive for a week or more on the cotton-polyester based cloth.[8] Therefore uniforms can be an important reservoir of bacteria and source of infections.

Although a trend was noted among female participants who implemented better hand hygiene and laundered their uniforms more frequently compared to males, no significant difference of prevalence of contamination was found between the two genders. This may be explained by the fact that majority of the female participants were nurses, who are responsible for constant care of patients compared to doctors,[3] which can lead to great colonisation of bacteria on their gowns. The cuff part of uniforms had the highest contamination rate compared with other sample sites. Uniforms should be regularly examined to ensure that the cuffs are fit enough. This is also the rationale to propose that medical staff wear short-sleeved uniforms.[9]

To the best of our knowledge, no study has been conducted to examine the relationship between HAI and the methods of hand-drying. In theory, the back of the uniforms rarely come in direct contact with patients. However, in our study, we noted that incorrect hand-drying method by wiping at the back of uniforms could increase the contamination rate.

There are some limitations of our study. First, it is a cross-sectional study and without a control group, we can only infer the associated factors of HAI. Further cohort study is needed to confirm causality and evaluate the effectiveness of prevention measures. Second, the study was carried out during one week in two hospitals of Suzhou city, therefore the sample size is limited and the results should be interpreted carefully because the sample size is not enough to warrant statistical power. Another limitation is that we only observed the contamination prevalence and did not further analyse the contamination level due to the relatively small sample size. Based on our findings, further studies with larger sample size should be considered for stratified analysis of associated factors. One study shows that the fabric type influenced bacterial survival.[10] A search for new uniform materials to replace traditional cotton-polyester material is needed to reduce bacterial contamination.

Conclusion

Medical uniforms can harbour microorganisms. Education regarding proper handling of uniforms is required for medical staff to decrease the rates of HAI.

Conflicts of Interest: There are no potential conflicts of interest.

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