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ORIGINAL ARTICLE

Presence and Persistence of Different Multi-Drug Resistant Bacteria on Hospital Staff Uniforms

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ABSTRACT

Background: *Uniforms of hospital staff are often contaminated during their daily patient care activities. Although most of microorganisms harbored on uniforms are commensal bacteria but also some pathogens and even multidrug resistant organisms may spread via contaminated uniforms. There are no standard policies regarding wearing uniforms outside the hospitals and this may spread infections to the community. Also, there is a debate regarding ideal policy for laundering uniforms either at hospital laundry or at home.* ***Objectives:*** *This study aimed to investigate the ability of bacteria to spread and survive on different fabrics used for manufacturing uniforms.* ***Methodology:*** *during three months' period (January to March 2018), 50 uniforms (white coats and scrubs) of 20 physicians and 30 nurses were sampled. Bacterial isolates were identified using standard microbiological methods. Multi-drug resistant organisms (MDROs) including Methicillin Resistant Staphylococcus aureus (MRSA), Vancomycin-resistant enterococci (VRE), Extended-spectrum b-lactamase producing E. coli (ESBL), and MDR Pseudomonas auroginosa strains were tested for their survival time on different fabrics used in uniforms.* ***Results:*** *Thirty-five (70%) of uniforms were contaminated. MDROs isolated were 12 (16.2% of isolated bacteria) including MRSA (9.5%), VRE (1.3%), ESBL Escherichia coli (2.7%), and MDR Pseudomonas aeruginosa (2.7%). Different MDROs could survive longer on polyester. The survival time on cotton, cotton/polyester blend, and polyester varied from days to months.* ***Conclusion:*** *Hospital staff uniforms could be a vehicle of transmission of MDROs. Policies regarding wearing uniforms in streets, ideal frequencies of washing and changing uniforms in our hospital should be strictly regulated.*

INTRODUCTION

Every day, multi-drug resistant organisms (MDROs) are increasing in hospitals. It is crucial to investigate the possible environmental factors including staff uniforms that may affect the transmission of such organisms.[1]

Most of common causative pathogens of hospital acquired infections are capable of surviving or persisting on surfaces. That is why the environment can play a major role in transmission of such microorganisms. Textiles and fabrics are very good substrates for bacterial and fungal survival under the suitable temperature and moisture conditions. [2,3]

Another factor that may affect the survival of microorganisms on white coats fabrics is their antibiotic sensitivity. For example, Methicillin resistant *Staphylococcus aureus* (MRSA) and Vancomycin Resistant *Enterococcus* (VRE) are able to survive on many fabrics including smooth cotton for days. Duration of survival depends on the type and the amount of bacterial inoculum. Therefore, even a small inoculum of bacteria or fungi on white coats can cause infections but they are mild. [4]

The ability of healthcare workers' attire to transmit infections has been a rich point of research. Various studies have investigated this issue but there is no clear consensus on the best policy. Generally, when choosing attire, professional appearance and comfort should be considered but also efforts must be focused on how to minimize the spread of infections through infected garments. Many approaches have been described including the strategies such as "bare below the elbows (BBE)". White coats, scrubs and other hospital uniforms should not come in direct contact with patients. Washing uniforms should be done frequently either at home or onsite laundering facility. [5]

Wearing hospital uniforms outside the health care facility is another point to consider. Most of European countries don't permit wearing scrubs and lab coats outside of the healthcare facility.[6] This policy aims to prevent the spread of the hospital microorganisms to the community as health care workers (HCWs) are often using public transportation, and thus a broader spectrum of exposure to possible pathogens is created.[7,8]

Persistence and spread of microorganisms through hospital uniforms is also affected by laundry methods. Centers of Disease prevention and Control (CDC) guidelines for laundry includes the use of water temperatures of at least 160°F (70°C). This can be achieved by industrial machines. Also, CDC

recommendations include the use of 50-150 ppm of chlorine bleach to remove significant number of microorganisms from contaminated linen. This is usually not followed for uniforms when laundered at home because many manufacturers discourage the use of bleach for fear of compromising the dye or color of scrubs. Additionally, most scrub suits, lab coats, and scrub jackets washed at home do not reach temperatures beyond 110°F (45°C) [9].

METHODOLOGY

Study design

This study was performed in Tanta University hospitals during January to March 2018. Participating staff were physicians and nurses from different surgical and medical departments of the hospital. Verbal consents were taken before sampling. Questionnaire were filled prior to sampling. The questionnaire contained information about frequency of changing and washing uniforms, wearing uniforms outside the hospital, and washing at home or in hospital laundry.

- **Sampling of uniforms**

Samples were taken from uniforms of the participating staff's white coats and scrubs. Different sites of the uniforms were sampled. This included cuffs of coats, mid-abdominal zones and side pockets of all uniforms. Samples were taken using sterile cotton swabs moistened in sterile saline.

- **Isolation and identification of different bacteria**

Samples were immediately transferred to the Microbiology and Immunology Department, where they were inoculated on Blood agar and MacConkey's medium and incubated up to 48 hours at 35-37^{0}C. Plates were then examined for total bacterial colony count. Bacterial isolates were identified using standard microbiological methods like Gram staining, catalase and coagulase tests, and biochemical reactions.[10] As a control, 4 uniforms were cultured immediately after receipt from laundry.

- **Antibiotic sensitivity testing identification of MDROs**

Antibiotic sensitivity was tested on Muller Hinton agar by the Kirby-Bauer disc-diffusion method. Methicillin resistant *Staphylococcus aureus* (MRSA) was determined by oxacillin E-test (LIOFILCHEM® - ITALY). Vancomycin-resistant enterococci (VRE) were identified with E-test (LIOFILCHEM®-ITALY). Extended-spectrum b-lactamase producing Enterobacteriaceae (ESBL) were confirmed by the double disc method. MDR *Pseudomonas auroginosa* was defined when resistant to gentamicin, ciprofloxacin, and ceftazidime.[11] Antibiotic sensitivity tests were performed and interpreted following the clinical and laboratory standards institute guidelines. [12]

- **Testing the persistence of MDROs on different fabrics of uniforms**

MRSA, VRE, ESBL, and MDR *pseudomonas aeruginosa* strains were tested for their survival time on different fabrics used in uniforms including; 100% cotton, cotton/polyester blend, and 100% polyester. Survival test was performed as follows; Swatches (≈ 1 cm^2) for each fabric were prepared. Swatches were sterilized, properly aerated and put in rows inside a biosafety cabinet. During the study period, the hood fan was left on, the temperature ranged from 21 to 24°C, and the humidity ranged from 30 to 49%. The three materials for one microorganism were located in the same area [4, 13]. After growing different bacteria on nutrient agar, bacterial suspensions equal a 1.0 McFarland standard were prepared. Swatches were inoculated with 10-µl aliquots of each microorganism suspension. Using sterile forceps, a single swatch of each fabric was picked up every other day and placed onto blood agar plates. After incubation at 37°C for 48 h, plates were scored for the presence or absence of viable bacteria. The bacteria were considered no longer viable when two consecutive swatches were negative.[13,14]

RESULTS

Fifty staff's uniforms (15 white coats and 35 scrubs) were sampled during our study. Participating staff were 20 (40%) physicians and 30 (60%) nurses. Half of participants were from Medical Departments and the other half were from Surgical Departments. Before sampling, staff were requested to fill a questionnaire including profession, department, frequency of changing and washing of uniforms. Data from questionnaire was illustrated in table 1. Total number of swabs taken from the uniforms were 115 swabs. Of these, 74 (64.3%) swabs yielded positive bacterial growth. 41 (35.7%) of swabs showed no growth after 48 hours of incubation. Uniforms were considered contaminated when any of swabs taken from it revealed bacterial growth either of commensal or pathogenic bacteria. Thirty-five (70%) of uniforms were contaminated. Isolated bacteria were *coagulase negative staphylococci (CONS), Staphylococcus aureus (S.aureus), Acinetobacter spp., Pseudomonas aeruginosa, enterococci spp.*, and *Gram negative enterobacteriacae* with percentages of 30%, 28%, 14%, 11%, 9%, and 8% respectively. MDROs isolated were 12 (16.2% of all isolated bacteria) including MRSA (9.5%), VRE (1.3%), ESBL *Escherichia coli* (2.7%), and MDR *Pseudomonas aeruginosa* (2.7%) (Figure 1).

The survival of different MDROs on three common materials used for manufacturing of uniforms (cotton 100%, cotton/polyester blend, and 100% polyester) were evaluated. The survival time in days for each bacterium on different material is shown in table 2.

Table 1: Risk factors as reported in questionnaire in relation to contaminated and non-contaminated uniforms.

Variables (n) (%)	Positive growth (any site) (contaminated uniform)		Negative growth (non-contaminated uniforms)	
	No.	%	No.	%
Profession:				
▪ Physician (20) (40%)	14	70%	6	30%
▪ Nurse (30) (60%)	21	70%	9	30%
Department				
▪ Medical (25) (50%)	14	56%	11	44%
▪ Surgical (25) (50%)	21	84%	4	16%
Uniform type				
▪ White coat (15) (30%)	9	60%	6	40%
▪ Scrub (35) (70%)	26	74.3%	9	25.7%
Frequency of changing (days)				
▪ 1d (27) (54%)	15	55.6%	12	44.4%
▪ 2d (15) (30%)	12	80%	3	20%
▪ ≥3d (8) (16%)	8	100%	0	0%
Frequency of washing uniforms				
▪ Every day (6) (12%)	1	16.7%	5	83.3%
▪ Once/week (32) (64%)	25	78.1%	7	21.9%
▪ Twice/week (12) (24%)	9	75%	3	25%

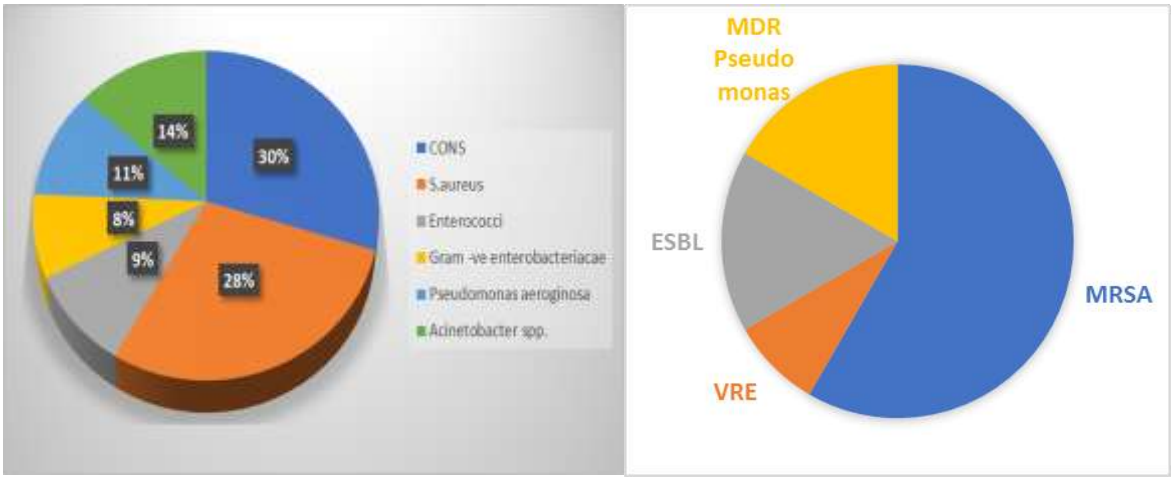

Fig. 1: Percentage distribution of isolated bacteria from uniforms (The distribution of MDROs is shown on the right).

Table 2: The survival time in days of different MDROs on common materials used for manufacturing of uniforms.

Bacteria	Survival time in days		
	Cotton 100%	Cotton/polyester blend	Polyester 100%
MRSA	10	3	30
VRE	47	50	>70
ESBL E. coli	43	36	48
MDR Pseudomonas	13	22	32

DISCUSSION

The role of the healthcare environment in acquisition and transfer of pathogens is not well established. [15] Healthcare workers' uniforms provides professional appearance and can also act as a barrier that prevent spread of infections during the daily patient care activities. However, white coats and uniforms have been shown to play a role in transmitting microorganisms.[16, 17]

During our study, 115 samples were taken from 50 uniforms. Of these, 74 (64.3%) swabs yielded positive bacterial growth, 70% of uniforms were contaminated, MDROs were 16.2% of isolated bacteria. These results agree with much extent with the previously published results of Wiener-Well et al. [11] as they reported that 63% of studied uniforms were contaminated and 50% of their samples were positive for pathogenic organisms of which, 11% were multidrug-resistant. Also, prior studies revealed that contamination of white coats ranged from 23% to 95%.[18-20] It was not surprising that we noticed lower rates of contaminated uniforms in staff who reported higher frequencies of changing and washing uniforms. However, there was no difference in distribution of microorganisms.

Isolated bacteria during our work were *coagulase negative staphylococci (CONS), Staphylococcus aureus (S.aureus), Acinetobacter spp*., *Pseudomonas aeruginosa, enterococci spp.*, and *Gram negative enterobacteriacae* with percentages of 30%, 28%, 14%, 11%, 9%, and 8% respectively. In comparison with our results, Hamid et al. [21] performed a study on contamination of white coats of doctors and paramedical staff and reported that most commonly isolated bacteria were *S.aureus, CONS, Klebsiella, E.coli,* and *Enterobacter* but in their study, they compared the numbers and types of bacteria in washed and unwashed coats. In another study, Sande and Basak[22] revealed the presence of *S.aureus, S.epidermitis, Klebsiella, Enterobacter, Acinetobacter, and Pseudomonas* on the white coats but they found a lower rate of contaminated coats (26.2%) than that shown in our study (70%). This may be due to different population as they examined white coats of paramedical staff and the students and those are less liable to get contaminated than doctors and nurses. Another study reported a higher incidence (54%) of pathogenic and even resistant bacteria on uniforms.[23]

When we tested the survival of different MDROs on three common materials used for manufacturing of uniforms (cotton 100%, cotton/polyester blend, and 100% polyester), we found that VRE had the highest survival ability (47, 50, >70 days on cotton, blend, and polyester respectively). Similarly, Various studies have documented that this bacterium can persist for a few days to more than 90 days on cloth and plastic surfaces[24-26, 14]. Neely et al. [4] reported that MRSA could survive on scrub suits. Takashima et al.[27] suggested that polyester clothes could be a reservoir of *S. aureus*. This agrees with our results as MRSA survived on polyester longer than on other fabrics. Regarding Gram negative bacteria, a study [13] investigated the survival periods of some Gram-negative bacteria on various textiles found that bacterial survival ranged from 2 hours to more than 60 at inoculum of 10^4 to 10^5 bacteria. In our study, we used inoculum of 10^9 colony-forming units, the longest survival time was noticed for ESBL E. coli (43, 36, and 48 days on different materials.

Finally, we can say that our study limitation was the sample size that was not enough to significant statistical power. Based on the results of the current study, further studies with larger sample size are recommended for stratified analysis of risk factors.

CONCLUSION

We suggest that hospital staff uniforms could be a vehicle of transmission of MDROs. Further studies are required to document this role in causing hospital acquired infections. Policies regarding wearing uniforms in streets, ideal frequencies of washing and changing uniforms in our hospital should be strictly regulated.

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