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BACTERIAL CONTAMINATION OF WHITE COATS AND HANDS OF HEALTHCARE WORKERS AT MANSOURA UNIVERSITY CHILDREN'S HOSPITAL, MANSOURA-EGYPT

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Running Title: WHITE COATS AND HANDS CONTAMINATION OF HCWS AT MANSOURA UNIVERSITY

ABSTRACT

Background: Transmission of hospital acquired infections (HAIs) may be associated with contamination of healthcare workers' (HCWs) hands and white coats.

Objective: The purpose of this study was to clarify the role of HCWs' white coats in transmitting HAIs and to determine the association between bacterial contamination of HCWs' hands and white coats.

Methods: A total of 154 HCWs were enrolled in the study; different samples were taken from their hands and white coats. Samples were processed and both microbiological and biochemical characterization of the isolates were done using standard microbiological protocols.

Results: Up to 65.6% of hands and 61% of coats of HCWs were contaminated by microorganisms. *Staphylococcus aureus* was the most commonly isolated organisms from both hands and coats of HCWs (29.2%, 27.3% respectively) followed by MRSA (22.1%, 24.7% respectively).

Conclusions: The risk for contamination of hands and coats of HCWs is high in different clinical settings. In order to reduce the rate of HAIs, a strict dress protocol should be set into play to prevent cross contamination between HCWs and patients.

Keywords: contamination, HCWs, coat, hand, *Staphylococcus aureus*, MRSA.

CONTAMINATION BACTÉRIENNE DE MANTEAUX BLANCS ET DE MAINS DE SOINS DE SANTÉ À L'HÔPITAL POUR ENFANTS DE L'UNIVERSITÉ MANSOURA, MANSOURA-ÉGYPTE

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Titre en cours: MANTEAUX BLANCS ET CONTAMINATION DES MAINS DE LA HCWS À L'UNIVERSITÉ MANSOURA

ABSTRAIT nosocomiales (IASS) peut être associée à la contamination des mains des travailleurs de la santé et des blouses blanches.

Contexte: La transmission des infections

Objectif: Le but de cette étude était de déterminer l'étendue, le type et l'association entre la contamination bactérienne des mains des travailleurs de la santé et les blouses blanches.

Méthodes: Au total, 154 travailleurs de la santé ont été inclus dans l'étude; différents échantillons ont été pris de leurs mains et des manteaux blancs. Les échantillons ont été traités et la caractérisation microbiologique et biochimique des isolats a été effectuée en utilisant des protocoles microbiologiques standard.

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Résultats: Jusqu'à 65,6% des mains et 61% des couches de TS ont été contaminées par des micro-organismes. Le *Staphylococcus aureus* était le plus souvent isolé des deux mains et des deux sexes (29,2%, 27,3%), suivi par le SARM (22,1%, 24,7% respectivement).

Conclusions: Le risque de contamination des mains et des couches de TS est élevé dans différents contextes cliniques. Afin de réduire le taux d'IASS, un protocole vestimentaire strict devrait être mis en place pour prévenir la contamination croisée entre les travailleurs de la santé et les patients.

Mots clés: contamination, agents de santé, manteau, main, *Staphylococcus aureus*, SARM

INTRODUCTION

Hospital acquired infections (HAIs), previously known as nosocomial infections, are those which are not present or incubated before admission of patient to the hospital but obtained during the patient's stay in hospital. The prevalence of these infections is estimated to be 5 to 10% in developed countries and 25% in developing countries.¹ Although the main form of transmission of HAIs is through health care workers' (HCWs) contaminated hands, HCWs' garments as coats and uniforms may play an important part in transmitting pathogenic bacteria within healthcare settings.² Within healthcare facilities, pathogenic bacteria may be transferred from patient to patient or from patient to the HCWs or the reverse.³ Classically, standard infection control precautions have emphasized on hand hygiene and personal protective equipment to disrupt the chain of infection in healthcare settings.

The HCWs' coats can get contaminated by microorganisms due to improper handling practices. They get easily contaminated from infectious microorganisms that are continuously dispersed by patients in the hospital environment.⁴ However, the role of bacterial contamination of uniforms of HCWs in the horizontal transmission of bacteria remains poorly understood.

There are accumulating data about incriminating HCWs' uniforms as a possible source of pathogenic microorganisms. These contaminated uniforms play a role in transmitting bacteria from patients to HCWs and the other way around.⁵ Furthermore, white coats are currently implicated in transmitting the potentially pathogenic multi-drug resistant type microorganisms.⁶

In recent years, there was an increasing attention to prevent HAIs to reduce costs, morbidity and mortality as well as to control the problem of antibiotic resistance.⁷ Our aim was to clarify the role of HCWs' white coats in transmitting HAIs and to determine the association between bacterial contamination of HCWs' hands and white coats.

MATERIAL AND METHODS

We have conducted a prospective cross sectional study during the period between August 2016 and June 2017 in Mansoura University Children Hospital. The study was a conjoined effort between Microbiology and Medical Immunology Department and the Infection Control Committee at Mansoura University Children Hospital. All the participating

HCWs were informed about the study and informed consent was taken. The study protocol has been approved by Faculty of Medicine - Mansoura University ethical committee.

Samples Collection

Samples were collected from the participating HCWs' hands and white coats across intensive care units (ICUs), internal wards and outpatients' clinics in Mansoura University Children Hospital. In addition to obtaining samples, data were collected including date, unit and profession of the HCWs. None of the approached HCWs refused to participate in this study.

We obtained swabs from the hands of the HCWs as well as from their white coats. Four predetermined sites of the white coats were sampled: the sleeve ends, the front panel at the level of the chest, the upper part of pocket and the collar. The collection of microbiological samples from coats was performed by rolling a sterile swab moistened in sterile saline on the target site.

Culture and Identification

All swabs were cultured immediately using blood agar plates. All plates were aerobically incubated at 37 °C for 24 hours. Gram staining was used to examine the morphology and staining reaction of the organisms. Gram-negative organisms were then sub-cultured on MacConkey agar plates. Biochemical evaluation included testing for catalase, coagulase, oxidase, triple sugar iron, indole and citrate using standard protocols for identification and characterization of microorganisms. Methicillin resistant *Staphylococcus aureus* (MRSA) species were identified by using cefoxitin and oxacillin disks on Mueller Hinton agar.⁸ Kirby Bauer's disc diffusion method was used to determine the antibiotic sensitivity of bacterial isolates.⁸

We classified isolated bacteria into pathogens (including *Staphylococcus aureus* (*S. aureus*), any Gram-negative bacilli and *Candida*) and skin flora (including coagulase-negative *Staphylococci*, *Bacillus* species and *Diphtheroids*).

Statistical Analysis

Statistical analysis was performed using the SPSS statistical package software for windows version 22 (SSPS Inc, Pennsylvania, USA). Differences between two categorical variables were evaluated using Chi-

square test while the one-way analysis of variance (ANOVA) was used to determine any statistically significant differences between three variables. P value < 0.05 was considered significant difference.

RESULTS

Of the study participants, 31 (20.1%) were doctors, 105 (68.2%) were nurses, and 18 (11.7%) were other professions (e.g., technicians, therapists). A total of 154 HCWs hands were swabbed in different ICUs, ward and outpatients' clinics (Table 1).

Bacterial growth was detected on 100 (64.9%) HCWs' hands; 45 (29.2%) grew *S. aureus*, 34 (22.1%) grew MRSA, 4 (2.6%) grew Gram-negative bacilli and 6 (3.9%) grew normal skin flora. While bacterial growth was detected on 92 (59.7%) HCWs' white coats; 42 (27.3%) grew *S. aureus*, 38 (24.7%) grew MRSA and 1 (0.6) grew Gram-negative bacilli. Hand cultures revealed Gram-positive cocci in 79 samples (51.3%) while 80 (52%) coat samples recovered Gram-positive cocci. Negative cultures were revealed from 54 (35.1%) hand swabs and 62 (40.3%) coat samples (Table 2).

TABLE (1): DISTRIBUTION OF SAMPLES IN DIFFERENT CLINICAL SETTING AND AMONG DIFFERENT HCWS

| Place | ICU No (%) | Wards No (%) | Outpatients' clinic No (%) | Total No (%) |
|--------------|------------------|------------------|-------------------------------|------------------|
| Doctor | 11 (7.1) | 9 (5.8) | 11(7.1) | 31 (20.1) |
| Nurse | 46 (29.9) | 46 (29.9) | 13 (8.4) | 105 (68.2) |
| Other HCWs | 1 (0.6) | 14 (9.1) | 3 (1.9) | 18 (11.7) |
| Total | 58 (37.7) | 69 (44.8) | 27 (17.5) | 154 (100) |

TABLE (2): BACTERIA ISOLATED FROM HCWS' HANDS AND WHITE COATS

| Isolated Bacteria | Hand No=154 (%) | Coat No=154 (%) |
|-----------------------------|--------------------|--------------------|
| No growth | 54 (35.1) | 62 (40.3) |
| <i>S. aureus</i> | 45 (29.2) | 42 (27.3) |
| MRSA | 34 (22.1) | 38 (24.7) |
| Bacillus | 5 (3.2) | 6 (3.9) |
| Diphtheroids | 1 (0.6) | 0 |
| Klebsiella | 4 (2.6) | 0 |
| Pseudomonas | 0 | 1 (0.6) |
| MRSA + Bacillus | 3 (1.9) | 2 (1.3) |
| <i>S. aureus</i> + Bacillus | 5 (3.2) | 1 (0.6) |
| Klebsiella + Enterococci | 1 (0.6) | 0 |
| <i>S. aureus</i> + Candida | 1 (0.6) | 1 (0.6) |
| MRSA + Candida | 1 (0.6) | 0 |
| MRSA + Pseudomonas | 0 | 1 (0.6) |
| Total | 154 (100) | 154 (100) |

TABLE (3): CONTAMINATION RATES OF SAMPLES AMONG DIFFERENT HCWS

| Variable | Doctors (n=31) | Nurses N=(105) | Others N=(18) | P |
|---------------|-------------------|-------------------|------------------|------|
| Hands | 8 (25.8) | 27 (25.7) | 2(11.1) | 0.23 |
| Coats | 6(19.4) | 21(20.0) | 2(11.1) | 0.12 |
| Hands & Coats | 12(38.7) | 44(41.9) | 7 (38.9) | 0.74 |
| Neither | 5(16.1) | 13 (12.4) | 7 (38.9) | 0.02 |

In our study, 63 (40.9%) HCWs had microorganisms on their hands and white coats at the same time; and only 25 (16.2%) HCWs were negative for both their hands and coats. Bacterial contamination was found on the hands of doctors and nurses more than those of other HCWs but the difference did not reach a statistical significance, (25.8, 27.7 and 11.1 percent respectively, P=0.23). Similarly, the coats of doctors and uniforms of nurses were found to be contaminated with bacteria more than coats of other HCWs and the difference did not reach a statistical significance (19.4, 20.0 and 11.1 percent respectively, P=0.12). The combination of both hands and coats of all the HCWs were almost contaminated equally, P=0.74. Nevertheless, the percentage of other HCWs who found to be negative for bacterial contamination was significantly higher than those of doctors and nurses, p=0.02 as shown in Table 3.

TABLE (4): CONTAMINATION RATES OF SAMPLES IN DIFFERENT CLINICAL SETTING

| Variable | Inpatients (n=127) | Outpatients (n=27) | P |
|---------------|-----------------------|-----------------------|-------|
| Hands | 26 (20.5) | 11 (40.7) | 0.02 |
| Coats | 24 (18.9) | 5(18.5) | 0.89 |
| Hands & Coats | 53 (34.4) | 10 (37.0) | 0.68 |
| Neither | 24(18.9) | 1 (0.6) | 0.001 |

Inpatients includes ICU and ward

The hands of the HCWs in the outpatients' clinics were significantly contaminated with bacteria more than hands of HCWs in the inpatient wards and ICU, 40.7 vs 20.5, P=0.02. However, the percentage of contaminated coats and contaminated both hands and coats did not show any statistical significance P=0.89 and P=0.68 respectively. Health care workers hands and coats in the inpatient wards and ICU that did not show any bacterial contamination were significantly higher than those of outpatients, 18.9 vs 0.6, P=0.001 as shown in Table 4.

DISCUSSION

White coat is a symbol of identification for HCWs and is considered to be a sign of protection for our patients. However, they may act as a potential source

in the transmission of pathogenic bacteria, including multidrug resistant types, in different hospital settings.⁹

In our study, the hands of the HCWs in the outpatients' clinics were significantly contaminated with bacteria more than hands of those in the inpatient wards and ICU, that may be explained with busy working environment in the outpatients set up and insufficient time for proper implementation of infection control measures between examined patients who continuously detach off infectious bacteria compared to inpatient wards and ICU. As the HCWs attend to patients without proper hand washing carries a great possibility of bacterial contamination and subsequently cross-contamination to other patients.

Lack of white coats and hands contamination among HCWS in the wards and ICU compared to outpatients' HCWs enforces our previous finding and suggests a solid relation between coats and hands contamination and lack of patient after care management that could carry a risk of HAIs in susceptible individuals.

We have shown that both doctors and nurses, who are more knowledgeable and medically experienced in implementing infection control measure, had more contaminated coats and hands than other HCWs such as technicians which might be due to nature of their work that is lacking direct contact with patients. The majority of the isolated organisms in our study were *S. aureus* and MRSA while normal skin flora was not detected on a large scale. The rate of contamination of HCWs' hands was up to 64.9%, while their white coats were contaminated in a rate of 59.7%. Similarly, *Surase et al.*, found that the rate of contamination was 79% for hands of the HCWs and 75% for their coats.¹⁰ Other studies showed contamination of white coats ranging from 23% to 95%.¹¹ Therefore, white coats possess a risk of cross contamination in different healthcare settings.

Gram-positive cocci were the dominant isolated organisms, followed by Gram-negative organisms with the difference being statistically significant (p< 0.05). Gram-positive cocci have been recovered from (51.3%) and (52%) of hand and coat samples respectively making it the predominant bacterial group contaminating the hands and coats of the

HCWs. Other studies reported a similar predominance of Gram-positive cocci which might be potentially pathogenic particularly if the host is immune compromised.^{6,12,13}

Among the Gram-positive cocci, *S. aureus* was recovered from 87 samples (hand: 45; 29.2%, coat: 42; 27.3%), while MRSA was detected in 72 samples (hand: 34; 22.1%, coat: 38; 24.7%). Fifty-four (35.1%) of the hand samples were negative, and 6 (3.9%) had skin flora only. High level of contamination of white coats with MRSA has been previously reported.^{11,14} In a study conducted by *Surase et al*, MRSA accounted for 12% of the potential pathogens.¹⁰

Potentially infectious Gram-negative bacilli were also isolated in this study, but they were significantly lesser in number, as was reported by previous studies.^{15,16}

Despite of multiple infection control measures implementation, the horizontal transmission of nosocomial pathogens, including multidrug-resistant types, persists which suggest the presence of an overlooked reservoir for these pathogens. Previously, contamination of HCWs' uniforms with potentially pathogenic bacteria and skin flora has been reported.¹⁷ Similarly, those studies found pathogenic bacteria such as *S. aureus*, MRSA, Enterococci and Gram-negative bacilli.

A prohibition of wearing of white coats and any other long-sleeved garment while providing patient care

was recommended by the British Government in a uniform and dress code for physicians that was published in 2007. This prohibition is not applied in other developed countries such as the United States and developing countries such as Egypt. Despite the emerging evidence indicating bacterial contamination of uniforms and the lack of frequent washing of white coats, white coats banning during patient care remains a controversial issue.¹⁸ However, we recommend, due to our findings, that a strict dress protocol should be implemented in order to prevent cross contamination between HCWs and patients and to guard against transmission of infection in different healthcare settings. Furthermore, HCWs should be encouraged to keep their white coats clean, to wash their hands frequently and to avoid touching their coats in particular after hand washing.

CONCLUSION

The risk for contamination of hands and coats of HCWs is high in different clinical settings. A large proportion of HCWs' white coats and hands might be contaminated with potentially pathogenic *S. aureus* and MRSA. HCWs' coats may be an important vector for transmission of nosocomial pathogens. In order to reduce the rate of HAIs, a strict dress protocol should be set into play to prevent cross contamination between HCWs and patients.

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