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SHORT REPORT

Bacterial flora on the white coats of medical students

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Summary: This study has demonstrated that the white coats of medical students are more likely to be bacteriologically contaminated at points of frequent contact, such as the sleeve and pocket. The organisms identified were principally skin commensals including *Staphylococcus aureus*. The cleanliness of the coat as perceived by the student was correlated with bacteriological contamination, yet despite this, a significant proportion of students only laundered their coats occassionally. This study supports the view that the students' white coat is a potential source of cross infection on the ward and its design should be modified in order to facilitate hand washing. Hospitals training medical students should consider taking on the burden of providing freshly laundered white coats for the students.

Keywords: White coats; medical students; bacterial flora.

Introduction

The white coat has a long association with all things medical, scientific, and healing and it is the most recognized and respected dress of a doctor. Contamination of skin and clothing by 'splashes' or touch is practically unavoidable in hospitals [especially in the Accident and Emergency (A&E) Department[1]]. The white coat, worn over personal clothing, is a means of protection from such contamination.

It has been well documented that an important spread of infection from patient to patient is via clothes.[2] Nurses uniforms and other hospital garments have been shown to play a role in transmitting pathogenic bacteria such as *Staphylococcus aureus* in the hospital environment.[3] The doctor's white coat has also been shown to be a potential source of cross infection.[4] *Staphylococcus aureus* has been isolated from nurses uniforms,[3] and also from doctors' white coats[5] especially from those within the surgical specialties.

In a medical school such as the Royal Free and University College Medical School (London), it is a requirement for medical students to wear white coats on the wards and when seeing patients. Medical students are amongst the medical personnel with the most contact with patients, but who have the least knowledge about the consequences of nosocomial infections. The considerable numbers of medical students may have a cumulative effect on the spread of pathogenic organisms. In addition students' white coats, when not worn, are frequently stored in lockers. It is also a generally believed that medical students rarely wash their white coats routinely and many only wash them when there are visible signs of dirt or stains.

However, there is currently no literature on the contamination of medical students' white coats. Our objective therefore was to determine the level and type of bacterial contamination present on white coats of medical students in order to assess the risk of the spread of nosocomial infections by such contact in a hospital setting.

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Materials and methods

The study was carried out at University College Hospital Medical School, a busy urban multidisciplinary medical school covering three hospitals. A random survey of 100 medical students from surgical (Surgery, Orthopaedics, Obstetrics) and medical (Oncology, HIV&AIDS, Cardiology, Gastroenterology, Chest, Renal, Geriatrics) specialities participated in this study. All the students wore white coats which were manufactured from a blend of cotton and polyester and obtained from one company. The policy of University College Hospital Medical School is for the students to launder their own white coats, which they do with varying degrees of regularity. Samples were collected over a 4 week period (23 March 1999 to 6 April 1999) at common meeting points for medical students. A survey was conducted by a questionnaire, assessing the duration the white coats had been used, how frequently they were changed and the place of storage. The students were also asked to grade arbitarily their white coat as clean, moderately clean or dirty. The outer surface of three sites of the white coat were tested; the cuff and side pocket of the dominant hand, and the back of the white coat, 10 cm down from the collar. Impressions of these sites were taken with a flat, round object of 6 cm in diameter onto 5% Colombia blood agar plates (Oxoid, U.K.). The plates were incubated aerobically for 36 h and examined for total bacterial count and the presence of potentially pathogenic bacteria such as *S. aureus* and Gram-negative bacteria. On each plate, the two most frequently occurring colony-types were Gram stained and identified by standard microbiological methods. Staphurex (Murex, U.K.) positive staphylococci were confirmed as *S. aureus* by DN'ase and a coagulase test. Antibiotic sensitivity was tested on all *S. aureus* on Iso-sensitest agar with lysed blood (Oxoid, UK) by disc-diffusion method against a known reference sensitive strain. Any Gram-negative bacteria were further identified using API 20E (bioMerieux, France). Statistics analysis was by the χ^2 test and Mann-Whitney test.

Results

A total of 100 medical students took part in this survey. Based on the questionnaire, a total of 34 students in surgical rotations and 66 students in medical rotations were surveyed. Of these students surveyed, six wore their white coats for 2 days or less in an average week, 26 wore them for 3–4 days in an average week and 68 students wore them daily (5 days). The majority of students kept their coat in a locker at the Medical School. The main reasons quoted for wearing their white coats were: it is a medical school requirement (55), followed by other reasons such as to be easily identified whilst on the wards by staff and patients (32), and to carry objects such as notepads and books (six) and lastly, for protection (five). Twenty-nine students rated their white coats clean and 71 as dirty.

All the coats were bacteriologically contaminated to varying degrees at all three sites. Most organisms grown were normal skin commensals such as *Staphylococcus* sp. (from all the students), *Acinetobacter* sp. (from seven of the students), and diphtheroids (from 12 of the students). Of the five *S. aureus* that were present, isolated from different students, none were methicillin-resistant (MRSA). Gram-negative organisms were rarely seen (three students) and those identified were normal environmental bacteria that are rarely associated with significant infections, e.g. *Alcaligenes sp*.

There was no correlation between where students stored their coat and the bacterial colony counts. The colony counts in the different areas sampled are shown in Table I. The sleeve was more likely to be heavily colonized than the back of the white coat (29 v 10; $P = < 0.001$). Most students laundered their coats at either 1 or 4 weekly intervals (Table II) with over a third of them laundering it monthly. Despite the fact that a proportion of students thought that the coat was dirty, half (15 students) still only had their coats laundered monthly. The coats considered to be dirty by the students tended to have more bacterial contamination than those considered clean, particularly at the sleeve (144 v 73; $P = < 0.05$) (Table III). However, there

Table I *Colony counts (colony forming units) in relation to the site of sampling*

Colony counts	Back	Pocket	Sleeve
0–99	83	66	59
100–199	10	19	29
200–299	2	8	8
>300	5	7	4

Table II *Perceived dirtiness of coat compared to frequency of laundering*

Rating	Sample size	1 week	2 week	3 week	4 week
Dirty	30	4	6	5	15
Moderate	40	6	15	6	13
Clean	30	15	1	6	8

Table III *Student self-assessment of white coats compared to bacterial contamination (average colony-forming units)*

Rating	Sample size	Back	Pocket	Sleeve	Average
Dirty	30	90	127	144	120
Moderate	40	76	112	111	100
Clean	30	43	91	73	69

Table IV *Frequency of laundering compared to average colony count*

Time (Weeks)	Sample size	Back	Pocket	Sleeve
1	25	75	116	92
2	22	82	102	121
3	17	113	119	143
4	36	48	84	98

was no correlation between the frequency of laundering and the bacterial contamination at any of the sample sites (Table IV).

Discussion

Because of the frequency of patient contact and the busy schedule of students it is reasonable to expect the white coats to become colonized with potentially pathogenic bacteria and this is demonstrated by the study. The data suggest that the coats become contaminated quickly once worn, as there appears to be little difference between the colony counts according to the frequency of laundering. It is noteworthy that the students' estimate of whether or not their coats were dirty correlated with the bacterial counts, especially at the sleeve. It is also noteworthy that despite the perceived dirtiness of the coat, a significant proportion of students only laundered their coats at monthly intervals.

Sites with the highest contamination were the sleeve and the pocket. As students examine patients, the sleeve of the coat, especially the cuff, is the site that most frequently comes into contact with patients; therefore the potential exists for bacteria to be transferred to, or acquired from, the patient. Furthermore, transfer of bacteria from sleeves to hands (and vice versa) is also possible. This risk might be reduced by providing the students with short-sleeved coats thus facilitating their ability to wash adequately their hands and removing a potential source of bacterial contamination-the sleeve.

Both doctors and students are likely to change and wash their personal clothing more often than their coats, so not wearing a white coat would be a simple solution in reducing such exposure. It may be difficult to overcome the tradition of wearing a white coat which additionally protects the personal clothing of the individual. A good means of preventing clothing-borne cross contamination between patients and staff is the wearing of impermeable clothing, such as plastic aprons and gloves[6] as these have been found to reduce contamination of clothing.[3] Indeed these results strongly suggest that healthcare personnel including students should remove their white coats when examining patients. Another solution may be to change the material from which white coats are made, as plastic-laminated material and closely woven waterproof cotton were found to have a low bacterial transfer rate.[7]

Barrier clothing is needed when examining patients. Therefore, the white coat should be removed and aprons worn when examining patients, especially at wound sites. Furthermore the bacterial contamination carried by coats and

demonstrated in this study, supports the ban on white coats from non-clinical areas such as canteens and library and suggests that stricter coat changing and washing regimes should also be implemented. Many students said that they would change their coats more often if someone were to provide and launder them. In areas of high contamination risk, such as intensive care units, both students and doctors should perhaps change into single daily use freshly laundered theatre clothes. In A&E departments, where clothes have a higher chance of being soiled, other forms of impermeable barrier clothing, should be considered.

The white coat is a symbol of the medical profession in the public's perception. Wearing a white coat is a tradition although reasons for its use may have changed. The white coat is a potential source of cross infection. However, rather than abolishing its use, an alternative design, different material and stricter regimes of changing and washing may be appropriate.

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