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Research Article

The study of microbial flora on doctors white coats in tertiary care hospital in outskirts of Hyderabad, Telangana, India

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ABSTRACT

Background: White coats are known to harbour microorganisms; this study aims to determine the microorganisms present on the white coat and investigate the factors associated with contamination, reasons for wearing, usage and attitudes of doctors towards the white coat.
Methods: A cross sectional type of quantitative and qualitative study to determine the contamination of white coats. Participants completed a questionnaire and samples were taken from the cuffs and pockets of white coat.
Results: 94% of the white coats screened were harbouring organisms. Diphtheroids are the most common bacterial isolate and *Aspergillus* is the only fungal isolate. The medical speciality, frequent washing and the use of disinfectants is associated with decreased contamination.
Conclusions: As white coats harbour microorganisms, this may result in transmission of these microorganisms to the patients and that may result in nosocomial infections, especially in the immuno-compromised. Therefore, measures need to be taken to decrease this risk of transmission by hand washing and frequent washing of white coats with disinfectants.

Keywords: White coats, Microbial contamination, Nosocomial infection

INTRODUCTION

The white coat is to medical profession, as skin is to a human. It is used for identification, as a sign of authority, and brings credibility to the medical profession.[1-3] It has been demonstrated that the white coat can instill confidence, and improve doctor-patient communication.[5]

White coat ceremony has become a ritual in many medical institutions to welcome medical students to the field of medicine, as this marks the student's transition into the profession with humanistic values.[5] The white coat is thought to connote life and goodness therefore, can be considered a symbol of medical profession.[6] Furthermore, the coat is specifically chosen as white to represent the characteristics of purity and cleanliness.[4] However, this symbol may play a role in spreading nosocomial infections, as it may become contaminated with bacteria that could spread to patients.[6] These bacteria may be antibiotic-resistant bacteria such as methicillin-resistant *Staphylococcus aureus* (MRSA) which results in increased mortality.[7] In fact, these concerns in September 2007 brought about instatement of the bare below the elbow policy in England.[4] This policy sets dress code guidelines and bans the white coat to prevent cross-infection and control nosocomial infection in British hospitals.[2,4,7]

White coats play an important role in doctor patient relationship as patients tend to be more comfortable and confident in doctors wearing white coat.[4] However, the functionality of the white coat is questionable as white coats are not only worn during patient interactions but in non-clinical areas as well. These non-clinical areas where

doctors and students wear their white coat include library, the cafeteria and even the restroom.[1,3,8,9] Changing rooms are usually not present in many hospitals and so medical students may be seen wearing the white coat as they commute to and from the hospital.[1,8,9] This might lead to in the contamination of the white coat.

In this research project, microorganisms present on white coats were studied. Also, factors associated with contamination, reasons for wearing, usage and attitudes of doctors towards white coat, were investigated. This study reveals the microorganisms harboured by the white coat and if it plays a role in transmission of infections in a hospital setting. It is important, as once these aspects are understood then appropriate policies such as, bare below the elbow could be implemented. Awareness on issues such as handling of white coats and ways to reduce contamination can be raised, especially because research on this particular subject needs to be improved upon in India. Also, patient safety initiatives can be established to decrease nosocomial infections.

Controversy surrounds the, bare below the elbow policy as studies contradicting and supporting the role of healthcare workers uniform and nosocomial infection exist. The American Medical Association (AMA) has not followed suit to ban the white coat and instead has recommended more research concerning the matter.[10] This is also a burning topic in India as recently an article has been published by Dr. Edmond Fernandes, in which he questions the need to wear white coats, stating that in India's tropical climate white coats should be discouraged and an easy way to reduce hospital acquired infection by India's Ministry of Health would be to ban doctors and students white coat.[8]

Previous studies have revealed that white coats do harbour bacteria.[1,3,6,7,9,11-14] This contamination has ranged from 28.46% to 95%.[12,14] Srinivasan et al conducted a study on doctors and students white coat and found 95% white coat contamination with mainly non-fermenting Gram negative bacilli and aerobic spore bearers.[14] In another study, it was found that 92% of dental students white coats were contaminated with mainly gram positive cocci followed by gram negative bacilli.[13] Uneke et al found that 91.3% doctors white coats were contaminated, with mostly diphtheroids.[6] While, Banu et al found 69% medical students white coat contamination with *Staphylococcus aureus* as major contaminant.[1] Pandey et al demonstrated 28.46% physicians white coats to be contaminated with predominantly *Escherichia coli*, indicating the isolation of pathogenic gram negative bacteria.[12] Contrary to this, Wong et al did not isolate any pathogenic gram negative bacteria, instead skin commensals such as coagulase negative staphylococcus (CONS) and diphtheroids were isolated.[11] Muhadi et al found *Staphylococcus aureus* followed by *Bacillus* species as most common isolates on short and long sleeved coats of medical students.[9]

The study population has varied in various studies. In the present study, doctors from various speciality and grades as well as students participated. Srinivasan et al carried out a similar study in Tamil Nadu involving doctors and students; however, this study was limited to medical and surgical speciality.[14] Pydi et al compared the white coat contamination of preclinical and clinical dental students and the findings suggested that clinical students white coat harboured more pathogenic bacteria.[13] Pandey et al investigated the accessories of doctors which included white coats along with pens, stethoscopes and cell phones; revealing that these common accessories were colonized by microorganisms.[12] Muhadi et al associated increased bacterial load with sleeves and pockets of long sleeved coats and just pockets of short sleeved coats.[9] Banu et al and Robati et al studied medical students white coat and also, investigated where and why it is worn.[1,3]

In the present study, two sterilised swabs moistened with saline were used to take samples from the cuffs and pockets of the white coat. Most studies had similar methodology with minor differences. For example, the sites additionally sampled were the back, lapels, sides, collar, chest region and hem.[1,6,3,9,12-14] Contrary to this methodology, Wong et al took direct impressions of the coat onto blood agar.[11] This method was avoided in the other studies as well as the present study as it was thought to decrease participation due to possible staining during sampling.[6] Blood agar is the media used for the present study. Media used differed from study to study, the commonly used media other than blood agar were: nutrient agar, brain heart infusion broth, McConkey's agar, and Sabauraud's dextrose agar.[1,3,6,7,9,12]

Certain factors have been associated with increased contamination in previous studies. Some of these factors include gender, certain departments, work location, relationship between usage and handling, and personal carriage. Uneke et al demonstrated that cuffs were more contaminated than the pocket because sleeves frequently come in contact with patients.[6] When it comes to gender, white coats belonging to females have been associated with increased contamination.[3,6,9] However, Banu et al and Wong et al indicated that white coats belonging to males were more contaminated.[1,11] Few studies have found less contamination with white coats from the medical speciality.[6,11,14] On the other hand, Treakle et al demonstrated higher contamination with internal medicine department, inpatient and ICU work locations.[7] In some studies, no association between usage and handling of white coat has been attributed to the plateau effect according to which maximal contamination is reached within the first week.[1,3,7,9] Contrarily, studies have been able to associate decreased usage and daily washing with decreased contamination.[6,14]

As white coats tend to have a high degree of contamination, measures need to be taken to decrease this contamination. These measures include hand washing before and after seeing patients, close fitting cuffs,

frequent washing of white coats, possession of two or more white coats, not using white coat in non-clinical areas, and the use of protective gowns as alternatives.[1,3,6, 7, 9,11-14]

Aims and Objectives

- To study the bacterial and fungal contamination of white coats in a period of two months.
- To correlate these findings with the tertiary care hospital's nosocomial infection data.
- To investigate the attitudes of doctors towards the white coats ability to transmit infections.
- To evaluate white coat usage and laundering habits.
- To compare degrees of contamination among different specialties and units.
- To suggest methods to decrease contamination.

METHODS

This was a cross sectional type of quantitative and qualitative research study conducted in a tertiary care hospital in Malla Reddy Health City situated on the outskirts of Hyderabad, Telangana. Approval from the institutional ethical committee was obtained before the start of the study. The study was conducted from July to September 2015. 100 participants white coats were sampled. Of these 70 were doctors from different grades and specialities and 30 were medical students attending clinical postings. The medical students were additionally included in this study to provide for the purpose of comparison. The study was voluntary and one could choose not to participate. This was done to increase participation by keeping the data anonymous.

A self-administered questionnaire was used to collect demographic data and laundering habits regarding the white coat. Demographic variables included: gender, position, specialty, years of experience, reason for wearing white coats, number of white coats possessed and location of white coat usage. Usage in this study will refer to when and where doctors wear the coat.[6,11] Laundering habits included: frequency of washing and washing agents used.

This self-administered questionnaire was labelled with a number. The samples taken corresponded to the number on the questionnaire and an alphabet, "A" for cusps and "B" for pockets. This allowed for the data to be anonymous to ensure confidentiality.

The cuffs and pockets were the sites on white coat that were sampled, as these are areas that come in contact with patients and objects frequently; therefore, are thought to have greater microbial contamination.[6,9,11] One plain sterilized swab was moistened with saline and passed up and down twice on the cuffs. Another plain sterilized swab was moistened with saline and passed up and down twice on the pocket mouth of the white coat. The swabs were then inoculated onto blood agar plates which were incubated at 37°C for 24 hours under aerobic conditions. The plates were examined for total microbial count. Plates after 48 hours showing no growth were considered negative. The bacteria and fungi grown were identified and examined using standard procedure.[16] The bacterial smears were gram stained while lactophenol cotton blue stain was used for fungi.

Data obtained was compiled and compared using Microsoft Excel. Associations were tested with the help of Chi-square test, p value <0.05 was considered significant.

RESULTS

A total of 200 samples were taken from 100 white coats belonging to 30 medical students and 70 doctors from various medical specialities including Medical (13), Surgery (12), Obstetrics and Gynaecology (17), Dermatology (5), Paediatrics (6), ENT (7), Orthopaedics (3), Psychiatry (4), Ophthalmology (2), and Dentistry (1). Table 1 lists the various organism's bacteria and fungi isolated from doctors white coat.

Table 1: Isolates from white coats of doctors.

Organism	Number of isolates	Percentage of isolates
Bacteria		
Coagulase negative *staphylococcus* (CONS)	60	30.8%
Enterococcus	9	4.6%
Micrococcus	39	20.0%
Diphtheroids	75	38.5%
Bacillus species	6	3.1%
Non-fermenting Gram negative bacilli	1	0.5%
Fungus		
Aspergillus	5	2.6%

The predominant microorganism isolated is diphtheroids (38.5%) followed by coagulase negative *staphylococcus* (CONS) (30.8%). The only fungus isolated is *Aspergillus* and this was isolated from white coats belonging to the departments: obstetrics and gynaecology (1) dermatology (1) paediatrics (2) psychiatry (1). The isolates from the students white coats are listed in Table 2. The predominant isolate here is diphtheroids (44.8%) followed by *Micrococci* (25.4%). No fungi were found from white coats belonging to students. Relationship between departments and contamination of coats is given in Table 5. Most departments have 100% contamination except obstetrics and gynaecology (94.1%) and medicine (92.3%).

Table 2: Isolates from white coats of students.

Organism	Number of isolates	Percentage of isolates
Coagulase negative staphylococcus (CONS)	16	23.9%
Enterococcus	3	4.5%
Micrococcus	17	25.4%
Diphtheroids	30	44.8%
Bacillus species	2	2.9%

The contamination of cuffs (52.6%) is more than the contamination of pockets (47.4%) in doctors white coats. While the pockets and cuffs of students white coats were equally contaminated (50%). The distribution frequency of bacteria can be seen in Figure 1. The number of colony forming units in relation to cuffs and pockets is in given in Table 3. Relationship of gender, usage and laundering habits with contamination is shown in Table 4.

Table 3: Bacterial contamination of white coat cuffs and pocket mouth.

No. of colony forming units	Cuffs N (%)		Pockets N (%)	
	Doctors	Students	Doctors	Students
0	7 (6.5)	7 (17.1)	4 (4.3)	8 (19.0)
1-20	85 (79.4)	30 (73.2)	77 (81.9)	33 (78.6)
>20	15 (14.0)	4 (9.7)	13 (13.8)	1 (2.4)

Table 4: Relationship between gender, usage and laundering habits with contamination of white coats.

	Doctors		Medical Students	
Parameter assessed	**No. of white coats examined**	**No. (%) of white coats contaminated**	**No. of white coats examined**	**No. (%) of white coats contaminated**
Gender				
Male	33	32 (96.96)	0	0
Female	37	36 (97.3)	30	26 (86.7)
Number of white coats possessed				
1	19	19 (100)	2	1 (50)
2	36	35 (97.2)	16	13 (81.3)
3	10	9 (90)	10	10 (100)
>3	5	5 (100)	2	2 (100)
Frequency of washing				
<3 days	12	11 (91.7)	14	12 (85.7)
1 week	48	47 (97.9)	16	14 (87.5)
2-4 weeks	5	5 (100)	0	0
>1 month	5	5 (100)	0	0
Washing agents				
Soaps	27	26 (96.3)	7	7 (100)
Liquid wash	28	28 (100)	19	16 (84.2)
Disinfectants	7	6 (85.7)	4	3 (75)
Other	8	8 (100)	0	0

White coat belonging to females (97.3%) is more contaminated than those belonging to males (96.66%) however, this difference is not statistically significant (X^2=0.007, df=1, p>0.05).

There is no association seen between number of white coats possessed and contamination with owning more than three coats being equally contaminated to owning just one coat in doctors.

In washing agents the contamination is less when disinfectants are used however, this is not statistically significant (X^2=3.98, df=3, p>0.05). Frequency of wash is associated with a decreased contamination however this too is not statistically significant (X^2=2.25, df=3, p>0.05). Figure 2 shows the relationship between frequency of washing and contamination.

Responses to the reasons for wearing the white coat, location of use and if it can play a role in transmission of infection are seen in Table 6.

Dress code of hospital (28.7%) and to appear professional (25.4%) are the common reasons for wearing.

Most selected location of white coat use is hospital only (44.4%) however; always (19.3%) is the third most commonly selected option, which indicates the use of

white coat in non-clinical areas as well as use outside the hospital. Figure 3 gives the responses to the question can white coat play a role in transmission of infections. Majority (82%) have answered yes.

Table 5: Relationship between department and contamination of white coats.

Department	No. of white coats examined	No. (%) of white coats contaminated
Medicine	13	12 (92.3)
Surgery	12	12 (100)
Obstetrics and Gynaecology	17	16 (94.1)
Dermatology	5	5 (100)
Paediatrics	6	6 (100)
ENT	7	7 (100)
Orthopaedics	3	3 (100)
Psychiatry	4	4 (100)
Ophthalmology	2	2 (100)
Dentistry	1	1 (100)

Table 6: Reason for wearing and location of use and transmission of infection.

Reason for wearing	Selected by	Percentage
Cover clothing	11	6.1%
Usage of pockets	17	9.4%
Tradition	7	3.9%
Dress code of hospital	52	28.7%
Appear professional	46	25.4%
Identification	19	10.5%
Protects from infection	29	16.0%
Other	0	0
Location of white coat use	**Selected by**	**Percentage**
Patient interactions	28	20.7%
Hospital only	60	44.4%
Always	26	19.3%
Meetings with superiors	13	9.6%
Official gatherings	8	5.9%
Other	0	0
Can white coat play a role in transmission of infection		
Yes	82	82%
No	18	18%

DISCUSSION

White coats may be considered as a symbol of medical profession, bringing it credibility and are thought to connote purity.[2,6] Nonetheless, they have been demonstrated to harbour microorganisms and may possibly transmit infections. The aim of this study was to identify the microorganisms on white coats, investigate possible factors associated with contamination, the usage and attitudes of doctors towards the white coat.

The results suggest that white coats do harbour many microorganisms because 94% of the white coats screened were contaminated. This is similar to other studies with contamination ranging from 28.46% to 95%.[6,12,13] This high load of bacterial contamination begs to question the place of white coat in the medical or healthcare profession. There are two reasons associated with high bacterial contamination of white coats, the first being that microorganisms are shed by patients with whom doctors are in frequent contact; next reason being the ability of microorganisms to survive 10-98 days on fabric material such as cotton or polyester that may be used to make the white coat.[1,3,6]

The microorganisms isolated were predominantly diphtheroids, CONS and *Micrococcus*. Although these are normally present as skin commensals, they may contribute to nosocomial infection in immunosuppressed patients who are frequently visit the hospital. This is similar to the findings of other studies in which skin commensals were also the most common isolates.[6,11] Non fermenting Gram negative bacilli and aerobic spore bearers were also seen similar to the study done by Srinivasan et al however, they were not the predominant microorganisms isolated.[14] Similar to Wong et al findings no pathogenic Gram negative bacteria were isolated.[11]

Fungal contamination is seen as *Aspergillus* has been isolated. This is an important finding because it has not previously been isolated from other studies. This may be because there is ongoing construction around the hospital. According to a study done by Hospenthal et al there have been nosocomial aspergillosis outbreaks in association with construction in or near hospitals.[15] This may be because construction increases the airborne *Aspergillus* concentration. Consequently, this may cause aspergillosis in immunocompromised patients. Therefore, isolation of *Aspergillus* is significant.

Many participants chose more than one area for work location hence an association linking work location and contamination could not be made. The most common reason for wearing the white coat is dress code of the hospital (28.7%), followed by wearing it to appear professional (25.4%). The reasons for wearing are similar to other studies.[1,7,8] The location of white coat use is hospital only (44.4%) followed by patient interactions (20.7%) and always (19.9%). Always indicates that the white coat is worn in clinical as well as nonclinical areas. 82% of the participants believe that white coat can play a role in transmission of infections while 18% do not. This indicates that majority of the participants are knowledgeable in regards to white coat harbouring organisms that could spread to cause infections.

The white coats belonging to female doctors (97.3%) were more contaminated, also seen in previous studies.[3,6] General medicine (92.3%) had the lowest contamination compared to other departments, this finding is similar to other studies.[6,11,14] No association is seen between the number of white coats possessed and contamination. A possible reason for this could be that it is not the number of white coats, but how frequently a particular white coat is washed that relates to contamination. According to the plateau effect, contamination reaches a maximum steady state within the first week and does not change much afterwards.[1,3,11]

This holds true as the findings from frequency of wash suggest that coats washed after a week were equally contaminated. White coats if washed within a week or less and the use of disinfectants could result in decreased contamination. However, these results were not statistically significant and hence need to be examined in future studies.

Muhadi et al found that pockets of short sleeved coats were most commonly contaminated, however in the present study both pockets and sleeves were equally contaminated in students wearing short sleeved white coats.[9]

This is an important finding that warrants future research because it suggests that even though the sleeves are shorter, the contamination is still high. In this study, the cuffs from long sleeved white coat were the most contaminated site, with a contamination of 52.6%. An interesting finding is that the pockets from students white coat (50%) were more contaminated than pockets from doctors white coat (47.4%). This may be because students use the pockets more and frequently remove or keep things in the pockets.

Staphylococcus aureus has not been isolated in this study. This may be because the hospital where the study has been carried out is a new hospital with 300 beds (15 ICU beds); the nosocomial infections rate in the hospital is low, well below the standard cut-off and strict infection control practices are in place.

CONCLUSION

In conclusion, this study demonstrates bacterial and fungal contamination of the white coat. The bacteria isolated were diphtheroids, CONS, *Micrococcus*, *Bacillus* species, *Enterococcus* and non-fermenting Gram negative bacilli. *Aspergillus* is responsible for the fungal contamination. Although the predominant bacteria isolated are considered skin commensals, these are still significant because they may cause infections in immunocompromised patients.

The fungus isolated is significant, as *Aspergillus* spores can cause aspergillosis, allergies, and lung infections in the immunocompromised. The results have implicated the white coat in harbouring organisms which may contribute to transmission of nosocomial infections. Therefore, it is essential to try and reduce the white coat contamination.

This may be done by washing hands before and after interacting with patients, and washing the white coats every three days with disinfectants. As the predominant isolate differs from study to study, hospitals could try to determine the predominant organism in their hospital to compare with their own nosocomial data.

Further research needs to be done using freshly laundered, unworn white coats as controls. Antibiotic sensitivity analysis should be carried out for pathogenic isolates, if obtained. Contamination of cuffs from short sleeved white coats needs to be studied. Also, patient preference for doctor attire in India should be investigated.

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Questionnaire

Demographic data:

1. Designation: _____
2. Years of experience: _____
3. Department: _____
4. Gender:
   a. Male b. Female
5. Current work location:
   a. Inpatient d. Operating room
   b. Outpatient e. Other_____
   c. ICU
6. Reason for wearing:
   a. Cover clothing e. Appear professional
   b. Usage of pockets f. Identification
   c. Tradition g. protects from infection
   d. Dress code of hospital h. Other _____
7. Location of white coat use:
   a. Patient interactions d. Meetings with superiors
   b. Hospital only e. Official gatherings
   c. Always f. Other_____
8. Number of white coats possessed:
   a. 1 c. 3
   b. 2 d. >3
9. Can the white coat play a role in transmission of infections?
   a. Yes b. No

Laundering Habits:

1. Frequency of washing:
   a. <3 days c. 2-4 weeks
   b. 1 week d. >1 month
2. Washing agents:
   a. Soaps c. Disinfectants
   b. Liquid wash d. Other _____