Microbial Burden Evaluation of Conventional Cotton Gowns to Disposable Plastic Gowns: A Comparative Study at a Tertiary Hospital

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Abstract

Background: The increase in number of healthcare associated infections has resulted in huge burden on medical care in the form of morbidity, mortality, and cost. In the current era of high pathogen loads and antimicrobial resistance, items used in patient care such as cotton gowns, are becoming source of cross transmission of infections. In this study, comparative microbial load of cotton gown was made with that of newly introduced disposable plastic gowns.

Methods: A total of 100 samples from cuffs and pockets of cotton gowns; and 100 samples from abdominal area of plastic gowns were taken from doctors and nurses working in a pediatric ICU and nursery. Samples were processed as per standard microbiological procedures for microbial growth followed by antimicrobial susceptibility testing. Results were compared using paired T test and chi square test.

Results: 50% of cotton gown samples and 20% of plastic gown samples showed statistically significant microbial growth (<0.01). Gram positive cocci survived better on cotton gowns whereas plastic gowns promote Gram negative bacilli. Out of two areas covered, gowns from pediatric nursery (40 cotton and 10 plastic gowns) were more contaminated than that of PICU (10 cotton and 10 plastic gowns).

Interpretation & conclusions: Overall, plastic gowns showed less microbial contamination than that of cotton gowns. The result suggest that the healthcare associated infections in more details so as to implement strict guidelines for the evaluation and restriction of articles, such as cotton gowns, which probably contributes to infections in critical areas.

Key Words: Cotton gown, Plastic gown, Bacterial contamination, Good hygiene

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Introduction

Contamination of skin and/or clothing by splashes or touch is practically unavoidable in hospitals. Therefore, prevention of healthcare associated infections (HAI) between patients and healthcare professionals constitutes a great challenge[1]. A number of studies have demonstrated the adherence of pathogenic bacteria to multiple surfaces, such as glass, aluminum foil, polyvinyl chloride, countertops, bed rails, and stethoscopes etc[2]. In addition to these, clothes especially healthcare workers cloths play important role in spread of infections from patient to patient since that can easily become contaminated. The white coat/gown worn over street clothing is a means of protection from such cross transmission. The white coat also brings about the standard of professionalism and emblem of the trust of patients. Despite that, hospital garments have been shown to play a role in transmitting pathogens such as *Staphylococcus aureus*[3-4]. It have been shown that gowns of 65% of nurses were contaminated with MRSA while attended patients with MRSA[5]. In this regard, the ability of the microbe to survive on different environmental surfaces is critical factor for transmission of the same. Few studies have examined the viability of Gram positive bacteria on fabrics, especially the *Staphylococci* on cotton. Neely and Maley[2] have determined the survival of 22 Gram positive bacteria (VRE, VSE, MRSA and MSSA) on 5 common hospital fabrics. All isolates survived for at least 1 day, and some survived for more than 90 days.

In another study, different types of gowns were compared to assess their comparative protective efficacy against blood, body fluids, and other pathogens[6]. It was demonstrated that the protection offered by gowns varies from one situation to another and fluid repellent gowns are more protective than cotton gowns in extensive exposure to fluids situation. In another study, based on the barrier characteristics of different gown types, it was concluded that fluid repellent gowns provides better protection than conventional cotton one[6-7]. Similarly new spun-bonded olefin garments were found to be 100 times better to a cotton cloth in particle penetration test. Moreover, three different designs, a gown, a loose coverall, and a close overall were compared with conventional cotton gowns using *Staphylococcus aureus* as marker strain. The close coverall was 4-7 times better than the other gowns[8]. Rutala and Weber[9] discussed specifically the efficacy of single use and reusable gowns within healthcare settings and concluded that the evidence regarding their use is still inconclusive. It was indicated that the selection of particular gown requires an assessment of the facility's requirements, available products, and costs. Although the use of the white coat tends to contribute to the reduction in the contamination load but the use of the same has also presented higher contamination by microorganisms. Alternatively, gowns made of material other than cotton such as disposable gowns can also be considered. Moreover, the clarification regarding the role of clothes in the dissemination of pathogens can contribute to improve the adherence of healthcare professionals to the measures for the control of microorganisms, especially with antimicrobial resistance[4]. Therefore, the present study was planned with an aim to compare cotton gowns with that of plastic gowns to evaluate the microbial contamination load of both. The result may stress upon using disposable plastic aprons especially at critical areas of the hospital so as to reduce the risk of cross transmission and healthcare associated infections.

Material and Methods

Bacteriological examination: This study was conducted in the pediatrics ICU and Nursery of Lady Hardinge Medical College and Associated Hospitals, New Delhi. The study protocol was approved by institutional ethics committee and informed consent was obtained from each participant. Confidentiality of the participants was maintained as per ethical guidelines. Samples were taken in between patient care, and before hand washing. Samples were taken using sterile swab moistened with sterile saline from side pockets and cuffs of cotton gowns and abdominal area of plastic gowns. A total 100 no. of samples from each gown (cotton and plastic) were collected. Collected samples were immediately cultured on blood agar and MacConkey agar plates. Cultured plates were incubated overnight at 37^{o} C. The plates were examined for growth at 24,48,72,96 hours and after 7 days. The growth obtained was subjected to identification based on standard bacteriological procedures like colony morphology, Gram staining and biochemical reactions[10]. The results were confirmed using biomerieux vitek 2 system[11].

Antibiotic susceptibility: Antibiotic susceptibility testing of isolated microorganisms was done by routinely used antibiotic susceptibility method i.e. Kirby disc diffusion method. Briefly, Mueller Hinton agar plate was divided in two parts. On one part standard strain was plated while on other half, test strain was plated. Antimicrobial discs of different antibiotics were placed on both sides. Plates were incubated overnight for growth at 37^{o}C. Methicillin resistance in *Staphylococcus aureus* was detected by using Mueller Hinton agar with 30µg cefoxitin and 1µg oxacillin disk using CLSI guidelines[12].

Results and Discussion

For the safe care of the patient during treatment in hospital, prevention of cross transmission of HAI is a crucial issue. According to the Association for Professionals in Infection Control and Epidemiology (APIC), practices, which may put the health, and lives at risk, are unacceptable[1]. Therefore, adherence to good hygiene practices is a must for healthcare professionals. The use of aprons or white coats especially of cotton is one such practice. However, it seems that appropriate measures do not take place as HAI are on rise. As an example, medical students use to carry their white cotton gown (used in the hospital) outside the hospital environment without analyzing the possible repercussions in the form of dissemination of microorganisms. It has also necessitated the discussion for the use of disposable plastic gown instead of old cotton white gowns[4]. Therefore, in the present study, an attempt was made to evaluate the microbial burden of white cotton gown and plastic gown after use in hospital settings.

A total of 200 no. of samples (100 each from cotton and plastic gowns) were collected and processed for microbial culture and antimicrobial susceptibility testing. In results, a total of 50% of cotton gown and 20% of plastic gown showed the growth of more than one type of bacteria. In cotton gowns, the major bacteria were *Staphylococcus aureus* (22%), CoNS (24%) and *Acinetobacter baumanii* (4%) while plastic gown includes *S. aureus* (8%), CoNS (6%) and *A. baumanii* (6%) (Table 1). The difference in bacterial load of cotton vs plastic in first two isolates was statistically significant ($p \leq 0.01$). The results indicate that microbial load of cotton gown was significantly higher than that of disposable plastic gowns. Since the cotton gowns are permitted everywhere in the hospital premises and moreover, are not laundered until visibly dirty, this may be the reason for high microbial load. Whereas plastic gowns are disposed off immediately after the shift is over and hence offers higher level of protection and safety. The presence of *S. aureus* in the sleeves of white apron coat has also been demonstrated previously[3]. Another study reported the similar results and significantly more *S. aureus* has been isolated from cotton gown as compared to plastic gown[13]. Gram positive cocci survived more on cotton gowns than on plastic gowns ($p \leq 0.01$) probably due to their increased predilection to dry surface of cotton gowns. Whereas, Gram negative bacilli *Acinetobacter baumanii* preferred plastic gowns than of cotton gowns probably due to their preference for wet environment. The efficacy of disposable gown over conventional one has also been assessed and demonstrated that use of disposable gown help in preventing nosocomial transmission of vancomycin resistant *Enterococci*[14].

Among 100 samples taken from cotton gowns, 70 were from sisters and 30 were from doctors. A total of 40 (40%) cotton gowns of sisters and 10 (10%) of doctors were found contaminated with microorganisms. Among 100 samples taken from plastic gowns, 80 were from doctors and 20 from sisters. A total of 10 (10%) plastic gowns of doctors and 10 (10%) of sisters were found contaminated with microorganisms. This may be attributed to either awareness lacunae or hesitation of nurses to wear plastic aprons during patient care compared to doctors. Moreover, lack of knowledge to gowns as potential source of pathogens dissemination may also be one of reasons. It emphasizes the need for health education and awareness about benefits of using plastic aprons over cotton aprons. Further, gowns of healthcare workers at pediatric nursery (40 cotton and 10 plastic gowns) were more contaminated as compared to PICU (10 cotton and 10 plastic gowns). Since cotton aprons are strictly restricted in PICU, this may be a reason for low microbial load of gowns in PICU as compared to nursery healthcare staff. It have been demonstrated that most of the HCAIs outbreaks involves *S. aureus.* However, multiple factors of transmission including gown play a role in it. Moreover, the occurrence of infections involves multi-factorial interactions among patient, pathogen, healthcare worker, and environment[4, 15].

On antimicrobial sensitivity testing, microbes isolated from cotton gowns showed significantly more degree of resistance towards antibiotics than of plastic gown isolates (Table 2). It again emphasizes that cotton gown play crucial role in the spread of multidrug resistant microbes in hospital settings. The isolation of MRSA (methicillin resistance *S. aureus*) and MRCoNS (methicillin resistance coagulase negative *Staphylococci*) from cotton gowns was a major concern since in hospital settings, these organisms are involved in most of outbreaks[6, 14-16]. In our institution, the retrospective analysis of hospital infection data of one year revealed that *S. aureus* and CoNS were the most common pathogens associated with blood stream infections and ventilator associated pneumonia. The *Acinetobacter* species was the most common casual organism of surgical site infections during the same period. It necessitates the need of implementation of strict guidelines to restrict cotton gowns at least in critical areas such as pediatric ICU and nursery, and hence to encourage the use of disposable plastic gowns during patient care[4]. Previously, many studies have reported *S. aureus* as a major pathogen isolated from long sleeves of cotton gowns, which is in corroboration with the present findings. The isolation of CONS and Gram negative bacilli from pockets of cotton gown were also reported[3, 13]. It indicates that cuffs and pockets are the most probable reservoirs in cotton gown, and hence were selected for sampling in the present study also[13]. Since disposable plastic gown do not have such points and the abdomen area came in contact with environment most, therefore same was selected for sampling in plastic gown. Moreover, during patient care cuff site frequently comes in contact with the patients, therefore this act as a potential site for the bacteria to be transferred, or acquired[3, 14, 16]. Besides this, transfer from sleeves to hands and vice versa is also possible. However, this risk of transfer can be reduced by promoting the use of short-sleeved gowns like plastic gowns.

As observed in the present study, a number of studies have demonstrated previously that the most common sites contaminated with bacteria are cuffs and pockets of gowns[14]. Pockets of gowns are also highly contaminated site because of contaminated hands coming in contact with it, frequently. In the present study, CoNS and Gram negative bacilli were more frequently isolated from pockets. In our previous study, we had shown that CoNS and Gram negative bacilli are the most common isolates from the hands of HCWs[17-18]. It has been documented that bacteria, especially *S. aureus* and CoNS survive longer on cotton gowns because of dry environment compared to plastic material. Whereas Gram negative bacilli requires moist environment such as plastic gowns to survive[3, 13]. However, studies have also reported that plastic is not a good media for bacterial survival, and hence introduction of plastic gowns can be helpful in reducing HAIs in critical areas of hospital[4]. As cotton gowns may have a role in the transmission of nosocomial pathogens, therefore there is a need to promote scrupulous hand washing before and after attending patients along with suitable alternative to cotton gown. The CDC isolation guidelines state that gowns should be worn in order to protect the exposed body parts from contamination with blood/body fluids and/or potentially infectious agents. The guidelines also state that the type of gown worn should depend on the nature of the expected exposure[10]. Thus the result of this study confirms the need for the introduction of potentially less contaminated and repellant gowns such as plastic gowns instead of conventional cotton gowns at least in the critical area of hospital such as pediatric ICU and nursery. This will certainly result in the reduction of healthcare associated infections.

Table 1: Table showing the bacteriological profile of samples collected from cotton gowns (side pockets and cuffs) and abdominal area of plastic gowns

Organisms	**Cotton Gowns Growth-50 (50%)**	**Plastic Gowns Growth-20 (20%)**	***p* Value**
Staphylococcus aureus	22 (22%)	8 (8%)	$\leq$ 0.01
CoNS	24 (24%)	6 (6%)	$\leq$ 0.01
Acinetobacter baumanii	4 (4%)	6 (6%)	$\geq$ 0.05

Table 2: Antibiotic resistance pattern of bacterial isolates from cotton and plastic gowns

Antibiotics	Cotton gown			Plastic gown		
	CoNS (24)	*S. aureus* (22)	*Acinetobacter* (4)	CoNS (6)	*S. aureus* (8)	*Acinetobacter* (6)
Penicillin	12 (50%)	10 (45.4%)	1 (25%)	2 (33.3%)	1(12.5%)	1 (16.6%)
Oxacillin	12 (50%)	10 (45.4%)	-	2 (33.3%)	1 (12.5%)	-
Gentamicin	6 (25%)	6 (27.2%)	2 (50%)	2 (33.3%)	2 (25%)	1 (16.6%)
Ciprofloxacin	6 (25%)	6 (27.2%)	2 (50%)	2 (33.3%)	2 (25%)	1 (16.6%)
Levofloxacin	0%	0%	1 (25%)	0%	0%	1 (16.6%)
Erythromycin	8 (33.3%)	8 (36.3%)	2 (50%)	2 (33.3%)	2 (25%)	1 (16.6%)
Cotrimoxazole	8 (33.3%)	8 (36.3%)	2 (50%)	2 (33.3%)	2 (25%)	1 (16.6%)
Clindamycin	8 (33.3%)	8 (36.3%)	-	2 (33.3%)	2 (25%)	-
Tetracycline	0%	0%	-	0%	0%	-
Linezolid	0%	0%	-	0%	0%	-
Vancomycin	0%	0%	-	0%	0%	-
Piperacillin-tazobactem	-	-	2 (50%)	-	-	1 (16.6%)
Imipenem	-	-	2 (50%)	-	-	1 (16.6%)
Meropenem	-	-	1 (25%)	-	-	1 (16.6%)
Amikacin	-	-	3 (75%)	-	-	1 (16.6%)
Colistin	-	-	0%	-	-	0%
Netilmycin	-	-	0%	-	-	0%
Ceftazidime	-	-	2 (25%)	-	-	1 (16.6%)

Conflict of Interest: None

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