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Effect of Antimicrobial Finish in Reducing Bacterial Load on White Coats

Research Article

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Abstract

Garments of health care workers are important aspects of the environment of a healthcare facility and are known to get contaminated with microbes during use. They can act as carriers as well as transmitters of infections. As the nurses work in the hospital the newly laundered uniforms may also get contaminated within hours of donning. Hence, there is a need of an effective strategy to prevent cross contamination by reducing the bio-burden on the surface of the uniforms/white coats. One of the strategies that can be used for microbial control is the use of antimicrobial finishes. Silver based antimicrobial finishes have been tested extensively in laboratories, but there are few studies which have been carried out in vivo, that are on fabrics and garments being used in a hospital under real life conditions. This paper investigates the efficacy of commercial silver based antimicrobial finish in reducing bacterial load on nurses' white coats in a hospital.

The study was conducted in 100 bedded tertiary care government hospital in Delhi. Polyester and polyester cotton blend fabric was treated with Antimicrobial (AM) finish. Swatches of 20cm x 10cm each were cut from both fabrics and stitched to make a composite patch of 20cm x 20cm. At the beginning of shift a composite patch of untreated and treated fabric respectively was stitched on the left and right side of the washed white coat of participating nurse. The patched coat was worn by the nurse during her shift after which the patches were removed and plated. Microbial contamination on polyester and blend fabrics after 6 hours shift was compared in Brain Heart Infusion broth (BHI). Isolates of Staphylococci, Salmonella, Streptococci, Pseudomonas Aeruginosa, Klebsiella, Escherichia coli (E. coli) and Vancomycin Resistant Enterococci (VRE) were studied in selective media.

Untreated polyester and blend fabric showed a total bacterial count of 886 and 1525 CFUs respectively after the 6 hours shift. After treatment with antimicrobial finish, bacterial count on both fabrics reduced by 81%. Isolates of all seven bacteria were detected on all untreated swatches, ranging from 18 CFUs (VRE) to 440 CFUs (E. coli) on polyester and 46 CFUs (VRE) to 627 CFUs (E coli) on blend. Nearly 100% reduction in the number of colonies was observed for Salmonella, Streptococci, Pseudomonas Aeruginosa, Klebsiella and E. coli while 73.7% reduction in Staphylococci genus and 94.4% in VRE was observed. Use of a silver based antimicrobial finish can bring down bacterial contamination in nurses' white coats by nearly 81% irrespective of the type of fabric used to make the coat. Antimicrobial finish can be an effective strategy in reducing the bacterial burden in hospital uniforms.

Keywords: Antimicrobial finish; Silver; Uniforms; Infection control; Bacteria

Introduction

Microbial contamination of different surfaces including textiles can lead to infections and consequently to cross-infections is a common problem in hospitals and healthcare institutions. Hospital Acquired Infections (HAI) not only lead to delayed healing and additional healthcare cost to the patients or the government but can potentially lead to illness with serious and sometimes fatal implications [1,2].

Textiles such as curtains, upholstery, apparel etc. play an important role in acquisition and transmission of pathogens in healthcare [3-5]. As microbes thrive in moisture and protein rich soil apparel worn in

the healthcare environment is likely to represent a better source of substrate for bacterial growth. Sixty five percent of nurses who had performed patient care activities on patients with Methicillin-Resistant Staphylococcus Aureus (MRSA) in wound and urine contaminated their nursing uniforms with MRSA [6]. In another study S.aureus, Clostridium difficile and Vancomycin Resistant Enterococci (VRE) were detected on uniforms of nurses who had cared for patients with the same bacteria [7]. In a study by the authors, all white coats of nurses sampled after one and two shifts were found to be contaminated with Staphylococci, Salmonella, Streptococci, Pseudomonas Aeruginosa, Klebsiella, Escherichia coli and VRE [8].

Other than adopting high level of hygiene to eliminate human body based bacterial spread, various fabrics being used in healthcare facilities such as gowns, uniforms, sheets, pillow-covers, curtains, can be treated with certain antimicrobial agents to deter the spread of bacteria [9,10].

Silver has a long and intriguing history as an antibiotic in human health care. Silver ions and silver based compounds are highly toxic to microbes. This toxicity enables the silver ion to inactivate the critical physiological functions of a cell such as membrane and electron transport protein folding and function cell wall synthesis nucleic acid synthesis and translation required for the growth of microorganisms thereby not only inhibiting their growth but also killing them in some cases [11,12].

Most of the researches carried out in the field of antimicrobial textiles; report the antimicrobial efficiency of a particular antimicrobial finishing agent or additive on a specific substrate against Gram-positive and Gram-negative microbes. But there are limited studies to show the effect of antimicrobial activity of antimicrobial finish treated nurses' uniforms in a real hospital set up. In this study effect of a silver based antimicrobial finish on microbial load on nurses' coats was assessed after use of coat for one shift (six hours) in the hospital environment. Also the effect of fabric composition on the extent of bacterial contamination on nurses' white coats after the treatment with antimicrobial finish was assessed.

Methodology

The study was conducted in a 100 bedded Government hospital located in North West Delhi. The five wards which participated in the study were Paediatric (P), Medicine (M), Gynaecology (G), Intensive Care Unit (ICU) and Casualty (C). Two nurses from each ward were recruited as subjects for the study. Approval from the institutional ethical committee was duly obtained.

Treatment with AM Finish

Effect of antimicrobial finish on microbial load was compared on polyester and polyester cotton blend fabric. Hundred percent polyester and 70/30 polyester-cotton blend fabric was padded with 3% of finish on weight of fabric (owf) and cured in an oven at 180°C for 3 min.

Microbial Sampling

A fabric patch method developed by Gupta et al. [8] was used to estimate the microbial contamination on coats. A sterilized composite patch comprising of untreated and treated fabric was stitched over the left and right pocket respectively of the white coat at 8:00 Am. The nurse was asked to wear the patched coat and perform her clinical duties for the day. After the six hours shift the patches were removed kept in a sterilized bag and taken to the microbiology lab for plating. A total of 320 swatches were sampled in this study - 10 nurses x 2 fabrics x 2 (control/treated) x 8 media.

Plating and Colony Count

All samples were plated in Brain Heart Infusion broth (BHI) to estimate the total microbial load. Subsequently, isolates of Staphylococci, Salmonella, Streptococci, Pseudomonas Aeruginosa, Klebsiella, Escherichia coli and Vancomycin Resistant Enterococci (VRE) were estimated in selective media, Mannitol salt agar base, Muller Kaufman Tetrathionate broth base, Esculin Azide broth, Centrimide broth, Hichrome VRE agar base, Hicrome Klebsiella selective agar base and Rapid Hicoliform agar respectively.

From the swatches, test samples of size 4cm x 3cm were cut inside a biological safety cabinet as per sampling scheme shown in (Figure 1). The cut samples were placed in Phosphate Buffer Saline (PBS) for five minutes, taken out and kept on agar plates for 15 minutes with the exposed area facing the media. The swatches were then removed and discarded. The inoculated plates were dried and incubated for 24 hours at 37°C. After 24 hours the colonies were counted.

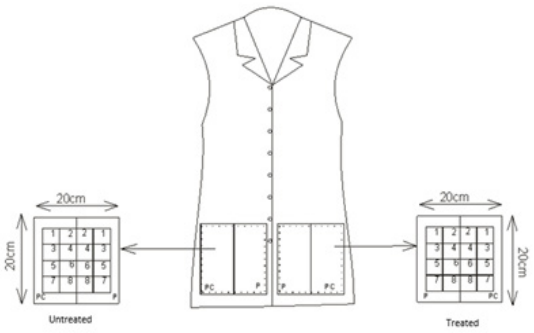

Figure 1: Scheme for bacterial sampling of nurses' white coat Patch on the right side was treated with antimicrobial finish and that on the left side was untreated samples on the coat. (P= Polyester, PC= Polyester cotton; Numbers indicate samples used in selective media; 1=Staphylococci, 2=Salmonella, 3=Streptococci, 4=Pseudomonas, 5= VRE, 6= BHI, 7= Klebsiella, 8= E. coli).

Control

For control sample, sterilized 100% polyester and 70/30 polyester cotton blend fabric patches (treated and untreated) were plated and incubated on BHI media for one day and the colonies counted.

Results

Microbial Count in BHI Broth

No growth was observed on the any of the control samples, indicating that there was no contamination in samples. Total colony counts obtained on test samples in BHI broth on polyester and polyester cotton blend fabric are shown in (Table 1). Mean count of bacteria (CFU) was 88.8 (65-112.5) and 152.5 (102.5-185) on untreated polyester and blend swatches ($12cm^2$) respectively. Contamination on blend was nearly 72% higher than polyester fabric. After antimicrobial treatment microbial load reduced by 79.9% on polyester and 81% on blend.

Bacterial Isolates in Selective Media

All swatches were sampled for bacterial isolates in selective media for seven potentially pathogenic microbial genus. Results are shown in (Table 2) for polyester and (Table 3) for blend fabric. All seven isolates were detected in all untreated swatches sampled after the six hours shift. Maximum prevalence (314 CFUs) was of E coli on untreated polyester followed by Staphylococci (293 CFU). Least prevalent was VRE with 9 and 23 CFUs respectively on the two fabrics. For each isolate, number of colonies (CFU) is higher- 130 (23-314) in blend than in polyester - mean count of 86 (9-220). Antimicrobial finish

used in the study reduces the bacterial counts significantly. Number of colonies (CFU) observed for Salmonella, Streptococci, Pseudomonas, Klebsiella and E coli was zero on both fabrics. VRE was reduced by 94.4% on polyester and 100% on blend. Interestingly, Staphylococci was found to be most resistant to the finish with about 71% reduction observed for both fabrics.

Discussion

Bacteria were detected on all untreated samples after the six hours shift with blend fabric showing higher contamination. Nearly 100% reduction was observed for most genus sampled in the study when silver based antimicrobial finish was applied on fabric. Staphylococcus was found to be relatively resistant to the finish. Earlier studies have also shown that Gram-negative bacteria are subject to more structural damages than Gram-positive organisms (staphylococcus) when silver is used as an antimicrobial agent [13]. This can be explained based on the structure of the cell wall. Gram-positive bacteria have a thicker peptidoglycan layer than Gram-negative bacteria and because peptidoglycan/outer layer is negatively charged and silver ions are positively charged more silver may get trapped [14]. This underlines the importance of antimicrobial treatment as a viable strategy in reducing infections in health care settings.

Conclusion

Despite improved hygiene and infection control programs the transmission of bacteria to and from patients remains of great concern. In terms of transmission fabric plays a crucial role in the chain of infection for pathogenic/opportunistic microorganisms. The study highlights the importance of silver based antimicrobial finish in the area of uniform hygiene. Bacterial load can be reduced by more than 90% by using antimicrobial finish on hospital uniforms. After antimicrobial treatment, microbial load reduced by 79.9% on polyester and 81% on polyester cotton blend fabrics. Hospital staff uniforms endowed with antimicrobial properties may be of great help in reducing the occurrence and spread of infections.

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