



Comparison of Decontamination by Conventional Domestic Wash versus Chemical Wash of Health Professional Uniforms and its Relationship with Frequency of Microorganisms on their Uniforms

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ABSTRACT

Infection control is a high priority for all healthcare organizations with the cost of providing a safe and infection-free environment to the patients. The spread of pathogens from hospitals by health care professionals' uniforms and kits into communities and societies is a major public health concern. That's why, the current study was conducted to assess the frequency of microorganisms on healthcare professionals' uniforms and to evaluate and compare the effectiveness of decontamination through germicidal chemicals.

Material & Methodology: A randomized control trial study design was employed using a systematic random sampling technique on 32 health professionals working in general wards of teaching hospital in Lahore.

Result: After intervention microorganisms were found on only 06 (19%) uniforms, in which all the positive uniforms were from the Control Group while in the Interventional group, there were no microorganisms found. The following microorganisms were observed during the study such as Staphylococcus Aureus strains, Proteus Mirabilis, E-Coli, Streptococcus, and Klebsiella.

Conclusion: Microorganisms' reduction from health professionals' uniforms was less effective by using domestic washes than the chemical one, which was able to completely remove bacteria on all microorganisms. The study will serve as an evidence-based source for policymakers to implement hospital-based washing of contaminated uniforms.

Key Words: Microbial Contamination-1, Health Care Professionals-2, Conventional Domestic Wash-3, Chemical Decontamination-4.

INTRODUCTION

Background:

The spread of pathogens breaching hospital walls is a major public health concern, several studies have confirmed the presence of pathogens on health professionals' uniforms during their shifts (Wiener-Well et al., 2011). The studies found a relationship between the presence of pathogens such as Methicillin-Resistant Staphylococcus Aureus (MRSA) and Vancomycin-Resistant Enterococci (VRE) on healthcare providers' uniforms and the spread of nosocomial infections. To address this problem, in countries like the United Kingdom, Belgium, Australia, and Canada, health professionals are discouraged to wear hospital clothing outside the workplace (Treakle et al., 2009). This situation is alarming because the cost of care for infections due to pathogens such as MRSA is estimated to be over \$20 billion annually in the United State (Sanon and Watkins, 2012). Taking precautionary measures such as proper laundering of uniforms decreases the financial and health burdens experienced by those who become infected due to exposure to vector infected hospital uniforms. (Reynolds et al., 2022). A study conducted in Karachi by Iqbal et al. (2020) presented parallel findings as it found that white coats of health professionals' carry about 53% microorganisms. Moreover, a study conducted by Munoz-Price et al. (2012) recovered 26 Staphylococcus aureus isolates from 119 scrubs and white coats, including 4 of 21 (19%) MRSA isolates specifically from scrubs. However, it is recommended that healthcare uniforms should always be laundered after every shift, and a detergent /germicidal chemical should be used (Laird et al., 2018).

Laundering as a Germicidal Chemical (Hydrogen Peroxide) H_2O_2 :

Hydrogen peroxide decomposes molecular oxygen and water. It has been postulated that some of this molecular oxygen is in a reactive, electronically excited state known as singlet oxygen (102) and that it is this singlet oxygen which is the active bleaching species (Jiang et al., 2018). Hydrogen peroxide (H_2O_2) is an oxidizing agent that can be used as laundry bleach. The 3% solution sold in drug stores as a first-aid disinfectant is the best choice for laundry. It is safe to use on all washable, dye-stable fabrics. Just like other oxygen-based bleaches, hydrogen peroxide breaks down safely into water and oxygen and is a more environmental friendly bleach than chlorine bleach (sodium hypochlorite) (Bockmühl et al., 2019). H_2O_2 has long been proven to be highly effective against bacteria, viruses, fungi, and spore, this was found to be more effective

at deactivating microbial particles of methicillin-resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile*, and *Acinetobacter baumannii* (Torres et al., 2020).

Conventional Domestic Method of Washing of Health professionals' Uniform:

Infection control is a priority for all hospitals to reduce the spread of healthcare-associated infections (HAIs). Nordstrom et al. (2012) conducted a study found that there are significantly fewer bacteria on hospital-laundered scrubs in comparison with home-laundered scrubs. Samples from uniforms taken before staff started a shift, 22 out of 57 (39%) from renal, medical, and surgical wards tested positive for one or more of MRSA, VRE or *Clostridioides difficile*, while at the end of the shift, 31 of 57 (54%) uniforms were contaminated with one or more of these microorganisms (Al-Benna, 2010). Concern has been expressed that domestic washing machines do not provide a sufficiently controlled environment in which to decontaminate staff uniforms. It has been suggested that if washed with other clothing, cross-contamination with hospital pathogens may occur. Although one of these studies suggests that home laundering did not remove microbial contamination (Cataño et al., 2012).

Objective:

- To assess the frequency of microorganisms on health professionals' uniforms before and after decontamination.
- To compare the effectiveness of decontamination through germicidal chemical disinfection and conventional domestic wash of health professionals' uniforms.

Significance:

Inadequate domestic laundry hygiene can be of great concern to certain at-risk groups (e.g., immunocompromised individuals, the elderly, pregnant women & children, etc.), as contamination or recontamination from hygienically inadequately cleaned health professionals' uniforms or even cross-contamination between household members could cause certain health problems, it has been found that hygienic uniform can only be achieved at a washing with germicidal chemical. So, the findings from this study could be significant to all healthcare organizations in setting guidelines for preventing transmission of hospital pathogens from hospitals to communities via health care professionals' uniform as presence of bacteria explored on their uniforms. The study will serve as an evidence-based source for policy makers to implement hospital-based washing of contaminated uniforms. Moreover, the comparison of efficacy of decontamination of health workers uniform

with germicidal chemical or conventional domestic wash provides evidence for effective washing methods to control spread of infectious organisms in communities. The focus of primary prevention of disease transmission will be achieved. Ultimately the health care cost incurred on treating infectious diseases and suffering of patient will be reduced. This research study will be the first endeavor in Pakistan to add information regarding decontamination of health professional uniform by H₂O₂.

METHODOLOGY

Study Design & Design:

In current study randomized control trial was used. This study was conducted at the University of Health Sciences (UHS), Lahore in collaboration with Shaikh Zayed Hospital Lahore.

Sample Size and Sample Calculation:

The sample size was calculated by keeping the power of the study equal to 80% and the level of significance equal to 5% as expected. **calculated sample size was 32.**

Sampling Technique and Randomization:

Systematic Random sampling technique was adopted for study purposes. The researcher at first step, created a list of health professionals then select a beginning number followed by an interval gather from a list of health professionals based on the interval number every 5th health professional were selected from the duty roster until the total of 32 sample size achieved. After collection of uniform from health professional, the uniform was equally divided into 2 parts, cut vertically. Thus, 32 subjects (Parts of Uniform) were in the interventional group and 32 in the control group, group division were performed by third party by coin method, are single blind to control confounding.

3.6: Sample Selection:

The collection of samples from the study population were based on the following inclusion and exclusion criteria. All those Doctors & Nurses working in general wards of Shaikh Zayed Hospital Lahore were included. Health professionals (Doctors & Nurses) working in general wards but not involved in direct patients care such as Head nurses excluded.

Sample Collection Procedure:

This study was conducted on 32 participants (Doctors & Nurses) from various wards. The sterilized uniform was distributed among selected participants working in Shaikh Zayed Hospital Lahore.

- Informed consent was taken from every participant prior to the start of the study.
- The uniform was sterile before handling by health care workers.
- Uniform was given for one complete shift.

The distributed uniform after one shift was checked for the presence of microorganism growth. The sample was taken from the uniform using sterile culture swab, the uniform was swabbed firmly and evenly with one swab in a horizontal direction, and with the other in a vertical direction back and forth (one stroke back and one stroke forward) to cover the entire area. Each sample was processed according to standard microbiology operating procedures. Cultures were applied on nutrient & MacConkey agar. Next day, plates were examined and samples showing suspected growth. Gram staining was done where needed. Identification of microorganisms was done through the catalase test for Gram Positive bacteria and oxidase test for Gram negative bacteria and biochemical standard test for Oxidase negative sample. The test was run according to standard protocol.

Intervention

The disinfectant 3% hydrogen per oxides(H_2O_2) was used to disinfect the uniform of intervention group and conventional domestic wash method was used to disinfect the uniforms of control group.

Washing Method	Time	Temperature	Disinfectant / Detergent
Conventional Domestic Wash	15 Mints	40 °C	30 g/kg of detergent
Chemical Wash	15 Mints	40 °C	30 g/kg detergent + 5 ml/kg of disinfectant (3% H_2O_2)

Ethical Considerations:

Subjects were assured that their participation in the study would be voluntary and that their identity would be kept anonymous. The participants were clarified about the aim and nature of the study and that they could withdraw from the study at any time. The information collected was kept strictly confidential and used solely for the purpose of this study.

RESULT OF THE STUDY

This section is intended to analyze and elaborate the collected data from the participants. The collected data has been tabulated and analyzed by using Statistical Package for Social Sciences (SPSS) version-25. The result is presented into two parts. The first part comprises of descriptive statistics and second part consists of analytical statistics.

Descriptive Statistics

There was a total of 32 participants (Doctors & Nurses) recruited for this study. Out of 32 health professionals (53%) were nurses, and (47%) were doctors, where most of the participants education level was graduation such as (66%) of the health professionals' education was bachelor, (31%) was Post graduation, while only one participant education level was just undergraduate. About 25% of participants had contact with 01 to 05 patients in their duty hours, while (18.8%) participants were that whose contact was with 06 to 10 patients, whereas other participants were contact with more than 10 patients during their duty hours.

Microorganisms were assessing health uniforms, out of 64 uniform parts microorganisms found on (50%) uniforms before wash, in which (53%) were from Control Group While (47%) were from Interventional group. In positive sample the Doctors and Nurses ratio was 44:56. In positive sample (78%) *S. aureus* strains were isolated. while (09%) strains were *Proteus Mirabilis*, (06%) *E-Coli*, and (3%) were *Streptococcus* and *Klebsiella*.

While after wash of uniform of control group with detergent and interventional group with detergent + 3% -H₂O₂. The microorganisms were found on only (19%) uniforms in control group in which only *Staphylococcus Aureus* strains were isolated from that samples. While he other (81%) uniforms there was no growth found of microorganisms.

Analytical Statistics

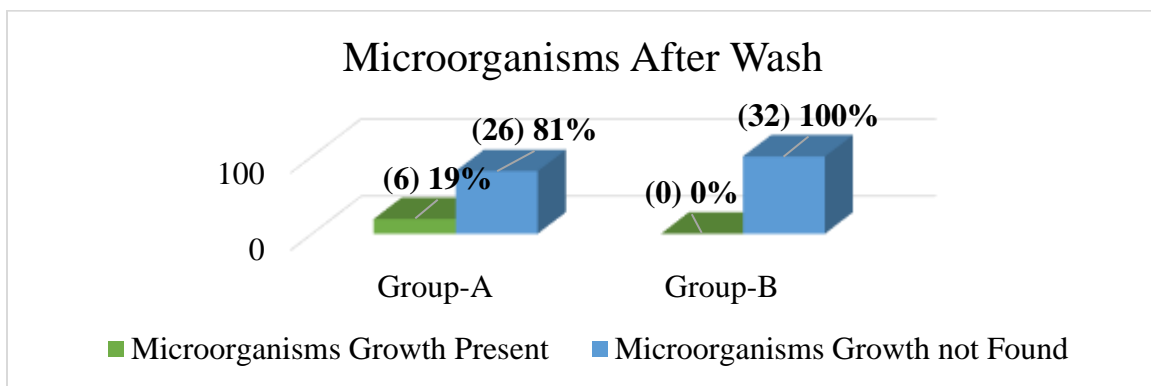
Comparison between Control and Interventional Group

Table-1: Comparison between Control (Conventional Wash) Versus Interventional Chemical Wash group before Wash

	Microorganisms before Wash		P-Value
	Microorganisms Present	No growth of Microorganisms	
Control (Conventional Wash) Group	17 (53.1%)	15 (46.9%)	0.83
Intervention (Chemical Wash) Group	15 (46.9%)	17 (53.1%)	
Total	32 (50%)	32 (50%)	

Out of 32 in control group (53%) were positive for microorganism's growth while (47%) were negative. In the intervention group (47%) were positive while (53%) were negative for microorganism's growth. although the association was not statistically significant (P-value = 0.83), which revealed that control and intervention groups were equally infected.

Figure-1: Comparison between Control (Conventional Wash) Versus Interventional Chemical Wash Group After Wash



Out of 32 in control group (19%) were positive for microorganism's growth while (81%) were negative. In the intervention group no microorganism growth was found. However, the association was statistically highly significant (P-value = 0.024). Thus, it shows that there is significant differences in the microbial decontamination of health professionals' uniform through germicidal chemical disinfection and conventional domestic wash.

Table-2: Comparison between type of microorganisms in Control (Conventional Wash) Versus Interventional Chemical Wash Group before Wash

Types of Microorganisms before Wash							P- Value
		Staphylococcus	Streptococcus	Escherichia coli	Proteus Mirabilis	Klebsiella	
Control (Conventional Wash) Group	Count	12	1	2	1	1	0.48
	%	37.5%	3.1%	6.3%	3.1%	3.1%	
Intervention (Chemical Wash) Group	Count	13	0	0	2	0	
	%	40.6%	0.0%	0.0%	6.3%	0.0%	
Total	Count	25	1	2	3	1	
	%	39.1%	1.6%	3.1%	4.7%	1.6%	

Before wash the health professional uniform of intervention and control group was almost equally infected by different microorganism, from control group the following microorganism's species was isolated Staphylococcus 38%, Streptococcus 3%, Escherichia Coli 6.3%, Proteus Mirabilis 3%, Klebsiella 3%. While from intervention group Staphylococcus 41%, and Proteus Mirabilis 6% was isolated. However, the association is not statistically significant (P-value = 0.48).

While after washing the health professional uniform, only (19%) Staphylococcus species were isolated. While in intervention group there were no growth of microorganisms found. However, the association is highly statistically significant (P-value = 0.012) which proves that uses of 3% H₂O₂ with detergent for the laundering of health professional uniform are effective.

DISCUSSION

In the present study, frequency of microorganisms on health care professionals' uniform was assessed and the effectiveness of decontamination of health professionals' uniforms through domestic laundering was compared with that of chemical laundering. A total of 32 health professionals were recruited for the study purpose. Results are discussed under two sections: Frequency & Types of Microorganism Presence Before Wash and after wash.

5.1: Frequency & Types of Microorganism Presence Before Wash

In the present study, microorganisms were found to be present on 50% uniforms after use of one complete shift of duty hours, in which (53%) were from Control Group While (47%) were from Interventional group. Before washing of those infected uniforms (78%) staphylococcus aureus strains were isolated from 32 samples. The highest number of *S. aureus* isolates (28%) were obtained from Gastroenterology wards followed by Nephrology wards (24%), Medical wards (16%), Urology and Private rooms (12%) and Neurosurgery and Orthopedic wards (4%). while 3 (09%) strains were *Proteus Mirabilis*, 02 (06%) *E-Coli*, and 01 (3%) were *Streptococcus* and *Klebsiella*. Result of this study are comparable with some Pakistani studies revealed that *S. aureus* contamination of hospital environmental surfaces is 28.7% (Shaheen and Baqai, 2016), 32% (Khan et al., 2018), 29% (Khattak et al., 2015), and 40% (Zaib et al., 2019). Similarly, several studies have reported that *S. aureus* is one of the most frequently isolated pathogens in health care settings, and nurses' uniforms is one of the major transmission route of healthcare-acquired infections (HCAIs) when they wash at home (Tarrant et al., 2018).

5.2: Frequency & Types of Microorganism Presence After Wash

After wash of uniforms of control group with detergent and interventional group with detergent + 3%-H₂O₂ microorganisms were found to be present on (19%) uniforms in control group in which only *Staphylococcus Aureus* strains were isolated from those samples. While in interventional group there was no growth of microorganisms found. Our findings are in line with the study revealing that after domestic laundering practices established by nurses' there were different microorganism such as *Staphylococcus aureus* and *Escherichia coli* are found (Riley et al., 2017). Similarly, another study conducted in which some fabric samples inoculated with high bacterial loads (108) – to mimic and were washed using detergent, to determine whether cross-contamination could occur in the wash (Laird et al., 2018). Current study also highlights that the frequency of microorganisms after domestic wash with detergent were (19%) which show that

there is chance of cross-contamination and can transmit microorganisms to other media. The study supported by previous study which revealed that cross-contamination can occur during laundering processes that also contain items soiled with microorganisms (Patel *et al* 2006, Lakdawala *et al* 2011). Similarly, several physical and chemical factors are responsible for the removal of microbes by normal laundering processes. Studies have shown that a satisfactory reduction in microbial contamination can be achieved by chemical laundering in hospitals (Patel *et al.*, 2006).

The method of in-effective laundering is confirmed by a survey that reported 91% (242/265) of respondents who answered the question on use of detergent, none stated that they use germicidal chemical for laundering. One reason for this could be the social perception that use of detergent is necessary to clean clothes and that it may be ‘unhygienic’ to launder without using detergents (Tarrant *et al.*, 2018). Our results confirm that washing of health professionals’ uniforms with detergents + 3% H₂O₂ at the hospital level ensures complete decontamination of clothing, and the risk of cross-contamination is minimal when using a hospital laundry facility.

In conclusion, microorganisms’ reduction from health professionals’ uniforms was less effective by using domestic washes than the chemical one, which was able to completely remove bacteria on all microorganisms. In fact, the epidemiology of the healthcare-associated infections attributed to laundered reusable healthcare textiles strongly supports the effectiveness of the chemical laundry processes in interrupting infection transmission (Schulster, 2015).

Recommendations:

On the basis of the study findings, the following recommendations are made:

- At time of induction, the health professional shall be provided guidelines for uniform usage and its laundering.
 - The government should enact policies for safe laundering of uniforms that the uniform should be laundered with 3% H₂O₂ along with detergents.
- Uniforms should be stored (pre-wash) and washed separately from other clothing.
- Uniforms should be washed after every shift, and within 24 hours of the shift starting.
- During this study, it was not assessed whether residual bacteria on the uniforms after the domestic washings were transferred to patients and whether this represented a risk for healthcare workers and patients. In our opinion, for those areas further research should be preferred.

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