

The Efficacy of Alcohol-Based Hand Rub, Medicated Soap and Plain Soap on the Hands of Nursing Personnel

¹Tahereh Baloochi Beydokhti, ²Mahdi Moshki and ³Ghasem Zolfaghari

¹Nursing Department, School of Nursing & Midwifery;
and Social Development & Health Promotion Research Center,
Gonabad University of Medical Sciences, Gonabad, Iran, P.O. Box: 397

²Public Health Department, School of Health;
and Social Development & Health Promotion Research Center,
Gonabad University of Medical Sciences, Gonabad, Iran, P.O. Box: 397

³Environment Department, School of Natural Resources,
Tarbiat Modares University, Noor, Iran

Abstract: Nosocomial infections are problems and predicaments that most societies face and the most communicative method of the same is via contaminated hands - or transient flora, to be more specific. Based on the suggestion of the WHO regarding the usage of alcohol-based solutions for hand-hygiene, therefore the aim of this study was to survey the alcohol-based handrub with WHO formulation on reduction of hand's microorganisms. The study was a randomized clinical trial of single blind triple group. 134 nurses participated in this study that was selected. The specimens were taken on blood agar contact plates in 4 stages: prior to and following usage, 1 hour after usage and 1 week subsequent to continuous usage of each hand hygiene procedure. The specimen plates were incubated, counts were made and types of colonies were identified. The results showed that the most common microorganism was Coagulase Negative Staphylococcus. All three variables caused a significant decrease in microbiological load immediately after use ($p=.001$). On the whole, hygiene procedures using alcohol-based rubs showed the greatest reduction in microbiological load, among the three subject procedures ($p=.001$). As alcohol-based handrub has more effect on the decrease of microorganisms than soap and that it is easier to use and does not need water, this procedure is recommended for the disinfection of hands.

Key words: Alcohol-based Handrub • Anti-Septic Soap • Colonization • Plain Soap

INTRODUCTION

Nosocomial infection is still one of the dangers facing hospital patients and in fact it is considered to be a global problem [1-4]. Nosocomial infections are defined as infections which are contracted during or as a result of hospital stay. Generally speaking, if a patient shows infection within the first 48 hours of hospital stay, the cause of infection is considered to have arisen before hospitalization. Any infection revealed after 48 hours of hospitalization is considered as a nosocomial infection [5].

It has been estimated that 40% of all hospital acquired infections are caused by cross transmission [6]. Most of these infections are transmitted by healthcare workers (HCWs) whose hands are either not washed well enough or not Washed *at al.* [7]. The most common types of pathogenic flora that cause Nosocomial infections are Gram-negative aerobic bacteria (*E.coli* and *Pseudomonas*) and Gram-positive aerobic bacteria (*Staphylococcus aureus* and Coagulase Negative Staphylococcus) [8]. Transient Flora is the major cause for nosocomial infections that are initially caused by contact with

adjacent contaminated environmental surfaces or via contact with patients. These microorganisms colonize superficially on the skin and do not have the power to reproduce there and can be removed easily by washing. Examples of this group are *Pseudomonas*, *Shigella*, *Salmonella* and *E. coli* [5, 9]. It has been proven that hand hygiene procedures decrease the levels of transient flora and as a result reduce the manifestation of nosocomial infection [10]. Therefore, in order to safeguard patients from nosocomial infection, hands should be washed routinely and in an appropriate manner; and since nurses are always at the bedside of patients and in constant contact with other HCWs, they play an important role in the identification and control of hospital infection sources [11]. Although hand washing is known as the most important way for preventing infections, HCWs on average, wash or disinfect their hands in half the reported instances [12, 13]. Zobeiri (2006) says, the different causes for the unsatisfactory usage of proper hand washing techniques - which is considered as the most important, the simplest and the cheapest way for the prevention of spreading of infection - could be counted as follows: unsuitability of or lack of lavatory and unfavorable quality of detergent; lack of awareness, an intense workload, a lack of scientific knowledge, a decrease in motivation and tendency and fatigue in personnel [5].

Some steps have been taken for overcoming lack of hand hygiene by way of introduction of hand-washing solutions. The first important step was to increase access to antiseptic solutions that don't irritate the skin or make it dry [14]. While soaps are materials that are detergents and although antiseptic agent is added to them, they have very little efficacy as antimicrobials and with frequent use they can even dry or irritate the skin; on the other hand, alcohol-based antiseptics operate initially by changing the characteristics of the proteins [12]. Research has shown that the usage of hygienic hand-rubbing procedures can be 75% more time saving compared to conventional hand-washing procedures [12]. It has further been proven that the effect of alcohol-based solutions is greater in contrast with gels containing the same concentration of alcohol [15].

It is obvious that the prevention of diseases and their consequences is much cheaper than the cure and treatment of the same. The biggest concern of hospitals is related to contamination and infection acquired in hospitals and utmost efforts are underway

to prevent and control pathogenic agents, or in other words, to care for vulnerable patients with regards to these agents. Keeping the above stated prevention and control criterion in mind, a research was therefore undertaken with the aim of comparing the efficacy of alcohol-based handrubs with antiseptic soaps and plain soaps with regards to the colonization of microorganisms on the hands of nursing personnel.

MATERIALS AND METHODS

Ethical Considerations: Distribution permission for sampling was gained from Mashhad University of medical sciences after obtaining from Research Ethics Committee. The participants were given oral information about the study. All of respondents participated willingly and voluntarily in this study.

Procedure and Participants: A randomized clinical trial of triple group single blind method was applied in this study that was undertaken in the surgical, internal, ICU and emergency wards of a hospital in Mashhad on 134 nurses in 2007. The trial was a single blind study because the samples of microbiology were cultured and examined by one MS in Microbiology that was unaware to the case and control groups.

The study sample size based on pilot study results on 10 selected samples using the formula mean comparison, were calculated 38 samples. Since the study was in three groups, considering the 15% loss probability, 132 patients were studied.

The sampling was done based on flora specimens and consisted of inclusion and exclusion criteria.

The Inclusion Criteria Were:

- The Consent Form of The Ethics Committee of Mashhad Medical Science University had to be signed by participants after they had been informed of procedures.
- The nurse assistants had to at least be high-school graduates, whereas the nursing staff should have had, at minimum, a bachelor's degree.
- They needed to have a direct responsibility for treating patients.
- They had to be working in one of the wards, i.e., the surgical, internal, ICU or emergency wards of Hospital.
- It was required that they work in one particular ward during the length of the research.

- It was necessitated that the recommended product for hand hygiene be used during the one week process of the research.
- Gloving was also required in case of contact with other detergents outside the work place.

The Exclusion Criteria Were:

- Working in more than one ward or hospital during the length of the study.
- Having an injury or deep cut on the hand or any visible infections.
- Having skin allergy to soap or alcohol.
- Non-compliance with any of the stages of hand hygiene as per the observation form.
- Development of skin allergy to the anti-septic product in use.
- Interruption in usage of the antiseptic product (i.e., for more than one day).
- Not having gloved while washing dishes or when in contact with other detergents at home.

Then, the necessary co-ordinations were made with the nursing service office, the microbiology lab and the pharmacy; and after that, the author and an assistant researcher were introduced to the emergency, internal, surgical and ICU wards and the accumulation of data was begun. The sampling was done in 3 shifts of morning, afternoon and night over a two month period (from Aug. - Sept. 2008), in coordination with the supervisor of Infection Control and the Microbiology Lab. First, the shifts and wards were determined and then, we went to the designated ward at the allotted shift and chose the samples via the sample-selection questionnaire and classified the samples for intervention into days of the week, in such a way that on Saturday and Tuesday, the samples would be in the Alcohol-based solution group, on Sunday and Wednesday in the medicated soap group and on Monday and Thursday in the plain soap group, respectively. After that the study samples were given information and directions about the research and its proceedings and any queries on the subject were answered and a letter of consent was signed by them. Next, by using a brochure on the subject, the samples were taught the correct procedure of cleansing practically (washing or hygienic rubbing), adhering to regulatory standards. Thereafter, the samples were evaluated on their compliance with the hand-cleansing procedure they had been taught, on a related observation form. After that, a print was taken from the index finger of

the main hand in a blood agar contact in such a way that the first digit of the index finger was pressed on the plate and rotated 180°. Next, the sampling was done according to the procedure taught: the Medicated soap group washed their hands with 3 - 5 ml of anti-septic soap, depending on to the size of the hand, for 30 sec. The ordinary soap group used 3 - 5 ml. of plain soap depending on the size of the hand for 30 sec. and then the hands were dried using tissues. Whereas, in the Alcohol-based solution group, the hands were rubbed with 3 - 5 ml. of alcohol based solution - depending on the size of the hand - for 20 to 30 seconds or until dry. In the next stage, the checklists were completed by the researcher and elimination from the research occurred if any of the samples had not followed any one of the stages stated in the checklists. Next, a second culture was taken directly after intervention and a third one was taken an hour later to see the endurance of each procedure; and the cultures were directly sent to the laboratory. The number of colonies per square centimeter was counted after 24 hours of incubating the specimens and an identification of microorganisms took place 48 hours after usage. The samples under study were followed for a week to check their level of response to see if they were following the correct procedure of hand hygiene or not and for any signs of possible skin irritation. At the end of one week, a fourth specimen was taken to observe the effect of the solutions after continuous usage. Thus, the 1st specimen was taken before intervention, the 2nd one, immediately after intervention, the 3rd specimen, an hour later and the 4th specimen, a week after intervention.

After taking specimens finger prints in a blood agar contact method by the samplers, the plates were then incubated at 37°C for 24 hrs and the colonies were counted in cubic centimeters. After 48 hrs incubation, the cultured colonies were examined in their different types by a senior laboratory expert. A special test was done to precisely identify the kind of microorganisms. The coagulation test, novobiocin disc sensitivity test, manitol and glucose fermentation and culture in saline were done for identifying staphylococcus and in order to identify enterococcus, culture in 6.5 saline environment and esculin hydrolysis were undergone. While Gram-coloring and lam tests were done to identify corine, glucose fermentation and final identification tests were completed to distinguish *E. coli* and *Klebsiella*. Other microorganisms were also isolated in turn using the stated tests. The results of the cultures were recorded in the Microbiology Result Evaluation Form on the basis of colony-forming units (CFUs).

Statistical Analysis: Statistical analysis was done using SPSS-14 software and by using Kruskal-Wallis H, Mann-Whitney U, Chi-Square and Descriptive tests.

RESULTS

The findings show that 67 percent of the unit samples under study were females. The mean age of the samples was 35.5 yrs and they had an average experience of 10 yrs. 80% of them had a bachelor's degree in nursing, most of whom were working on contract basis or to complete their scheme. The most common microorganisms found in the hands of hospital staff of both sexes included, coagulase negative staphylococcus, enterococcus, corine and bacillus, respectively. However, the Man-Whitney U Test showed that there was no significant difference in the CFUs on the hands of the two sexes. ($p = 0.166$) (Table 1).

The findings showed that the highest mean contamination belonged to the hands of personnel from the Surgical Ward (233.78 CFUs). However, the Kruskal-wallis test did not show a significant difference in level of contamination among hospital wards ($p = 0.126$).

The Kruskal-wallis test showed no significant statistical difference in CFUs of all three groups before intervention ($p = 0.633$). But, this difference was significant immediately after intervention ($p = 0.028$). The Kruskal-wallis test illustrated no significant difference in the CFUs of all three groups an hour after, as well as, a week after intervention. ($p = 0.677$), ($p = 0.143$) (Table 2).

The Man-Whitney U test was done in order to compare the mean in the second samples, immediately after intervention, of the two groups.

Considering the above table, it can be concluded that the immediate effect of alcohol-based solution is more than that of medicated soap. The non-parametric Man-Whitney U test showed that there is a significant difference in CFUs of both groups. Considering the fact that the mean CFUs of alcohol-based solution stands lower, it can be deduced that the effect of alcohol-based solution is more than that of plain soap. This study shows a difference between the mean of CFUs of two groups, but the Man-Whitney U test does not show a significant difference in the same ($p = 0.77$) and thus it can be concluded that there is no difference in immediate effect of both soaps.

Table 1: Demographic data of the participants in the three groups

Variable	Group	Handwashing with Antiseptic Soap		Handwashing with Plain soap		Handrubbing with Alcohole-based handrub		Total	
		n	%	n	%	n	%	N	%
Age (Years)	20-30	16	41.0	23	48.9	17	35.4	56	42.4
	30-40	12	30.8	11	23.4	17	35.4	40	30.3
	Up to 40	11	28.2	11	23.4	14	29.2	36	27.3
Gender	Male	13	33.3	13	27.7	18	37.5	44	33.0
	Female	26	66.7	34	72.3	30	62.5	90	67.0
Job	Nurse	31	79.5	39	83.0	35	79.5	105	78.3
	assistant	8	20.5	8	17.0	13	20.5	29	21.7
Education	Diploma	8	0.5	8	17.0	11	22.9	27	20.0
	Bachelor's	31	79.5	39	83.0	37	77.1	107	80.0

Table 2: Comparison of mean CFU, before, immediately, one hour and one week after the intervention in the three groups (alcohol-based solution, medicated soap and plain soap)

	Handrubbing with Alcohole-based handrub	Handwashing with Plain soap	Handwashing with Antiseptic Soap
	Mean±SD	Mean±SD	Mean±SD
Before	131.5±187.55	189.8±725.99	192.2±321.37
Immediately after	3.8±9.5900	18.2±27.250	35.3±94.850
One hour after	53.6±121.36	108.2±294.62	91.3±184.02
One week after	79.2±116.36	62.2±93.590	91.4±226.31

DISCUSSION

Nosocomial infections is the fifth major cause of death, which results in approximately 90,000 deaths in the United States of America alone [8]. Cross transmission seems to be the cause of 40% of all nosocomial infections [6]. Hand hygiene lowers the level of transient hand microorganisms and it has been proven that it reduce the number of nosocomial infections [16]. This is exactly the reason why the WHO and the CDC have named it the key to prevention of Nosocomial infections [17]. The findings of this research claim that the most common microorganisms found in the hand of HCWs, including coagulase negative staphylococcus, enterococcus, corine and bacillus, are in coordination the result of a research by Kac (2005) titled A Microbiological evaluation of Two Procedures of Hand hygiene among Health Care Workers while Caring for Patients. The most common hand microorganisms in Kac's findings were coagulase negative staphylococcus, coryne, micrococcus and bacillus, respectively [18]. The findings of the present research shows that the most common microorganisms found in both sexes consisted of coagulase negative staphylococcus (82% of total microorganisms) and 93% of the study samples were prone to the same. Moreover, coagulase positive staphylococcus was not seen in males, thus refuting Khalifa Hussaini's claims that the same was the most common microorganism found on males [19]. The findings of the research on effectuality of alcohol-based hand-rubs on the colonization of microorganisms have shown that there was a significant decrease ($p=0.001$) in CFUs immediately after intervention in comparison with that prior to intervention. Moreover, CFUs one hour after intervention also showed a difference with the count taken before intervention ($p=0.01$), but immediate efficacy was more immediately after than one hour later. The results confirm that the growth of microorganisms was slowed [15] by the usage of alcohol. The findings on the effectuality of plain soap on microorganism colonization did show a difference ($p=0.03$) in count taken before and after application, but no significant difference was seen between counts taken immediately after and one hour after application ($p=0.245$). Thus it can be established that plain soap did not have a lasting effect. Further, with regards to the effectuality of anti-septic soap, it was found that a significant difference did exist in CFUs immediately after and one hour after application; and this could be caused by the presence of triclosan in its composition, which causes an enduring effect [15].

All three above mentioned items did not show effectuality one week later. This finding is in agreement with a research done with the objective of comparing the efficacy of hand anti-septic factors in the decrease of bacteria and viruses on the basis that, after regular application, alcohol-based hand rub is less effectiveness than anti-microbial substances [8]. This conclusion refutes Girou's conclusion that claims that the efficacy of alcohol-based rubs is higher after regular usage. A significant difference ($p=0.0001$) in decrease of CFUs was seen when comparing the alcohol-based hand rub and anti-septic soap groups and this decrease was greater in the alcohol-based hand rub group - which is in conformity with previous research [4].

In a comparison between the alcohol-based hand rub and plain soap groups of this research, the efficacy of alcohol-based hand rub was seen to be causing a greater decrease in CFUs ($p=0.024$) compared to plain soap; this coordinates with previous research claiming that hygienic hand-rubbing using alcohol-based solution is more efficacious than washing with water and plain soap [18] and recommends HCWs to use alcohol-based hand rubs instead of plain soap for hand hygiene [20]. The efficacy of plain soap and anti-septic soap was also compared and no significant difference ($p=0.241$) was seen in the same. The only difference seen between these two kinds of soaps was in their efficacy one hour after application, which showed plain soap to be lacking this effect. The reason for the endurance of antiseptic soap can be cited as the presence of chlorhexidine or triclosan.

Research Limitations: One potential limitation of this study includes the fact that we assessed bacterial contamination by taking agar fingerprints of the dominant hand and did not use the glove juice technique, which may be more effective in recovering the whole bacterial burden on hands.

CONCLUSION

This research has discerned that all three products have an immediate effect, but the effect of alcohol-based handrubs was more than that of antiseptic soap or plain soap. No difference was seen in the three groups after a week of continuous use, thereby emphasizing the importance of hand hygiene more than ever before.

Bearing in mind the importance of controlling nosocomial infections and the fact that alcohol-based rubs are more effective than soaps and because they are easy to use, do not need water, have rapid efficacy,

create less skin reaction and are more cost-effective compared to antiseptics, the authors strongly recommend the use of alcohol-based hand rub, formularized by the WHO, in hospital wards.

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Conflict of Interest: The authors declare that they have no competing interests.

Contributions: Study Design: TBB, ARS; Data collection and analysis: TBB, GZ; Manuscript preparation: MM.

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