

Original Article

Comparative Study of Routine Handwashing Versus Use of 70% Isopropyl Alcohol in Reducing Resident Bacterial Flora in the Hands of Nursery Personnel

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ABSTRACT

Objective: To compare the efficacy of soap and water versus 70% isopropyl alcohol as a handwashing agent in the neonatal intensive care unit.

Design: Prospective randomized trial

Setting: UP-PGH Neonatal Intensive Care Unit

Subjects: Forty six (46) subjects comprised of 9 doctors, 30 nurses, and 7 nursing aides assigned at Neonatal intensive care unit from June 1, 1997 to June 30, 1997.

Methodology: The subjects were randomly assigned to either Group A or Group B each having twenty three (23) subjects. Group A performed handwashing with Perla soap as an agent while Group B used 70% isopropyl alcohol as a handwashing agent. Cultures of the dominant hand by imprint method using blood agar plate was done on each subject before and after the application of handwashing agents. The inoculated blood agar plates were incubated for 48 to 72 hours at 37°C. The identification and colony count of the organisms isolated were done. The mean change in the number of colony count on cultures before and after handwashing was used as the primary measure of the efficacy of handwashing agent.

RESULTS: The use of soap and water increased the mean colony count from 125 to 146 after handwashing, while 70% isopropyl alcohol reduced the mean colony count of resident bacterial flora from 116 to 7 after handwashing. Testing for significance using the T test revealed that the mean change in the number of colony count of resident bacterial flora using soap and water was +21 while using 70% isopropyl alcohol

was 109 with a P value of <0.0001, hence 70% isopropyl alcohol is more effective in reducing the number of colony count of resident bacterial flora in the hands of nursery personnel.

Conclusion: This study concludes that 70% isopropyl alcohol is more effective than soap and water in reducing the number of colony count of resident bacterial flora specifically coagulase-negative *Staphylococcus* organisms and can be used as an alternative handwashing agent in the Neonatal intensive care unit especially during busy work and when rapid disinfection is necessary.

INTRODUCTION

Nosocomial infection is an acknowledged problem. Microorganisms are disseminated mainly via the hands but there is evidence that hand decontamination, the most important means of prevention, is performed too seldom, and not always after activities likely to result in heavy contamination.

Handwashing is generally considered the most important procedure in preventing nosocomial infections because many types of these infections may be caused by organisms transmitted on the hands of personnel. Handwashing with plain soap and water has been shown to be effective in significantly reducing the transient microbial flora found on the hands of medical personnel. In 1938, Price described the existence of two kinds of organisms on the hands: resident and transient flora. Resident flora were described as organisms that survived and multiply on the skin and could be cultured repeatedly. Transient flora were described as organisms that did not survive and multiply and could be cultured for only a short time.²

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Because overcrowding and understaffing contribute to increased infection rates, an adequate nursing staff helps us to prevent nursery acquired infections. Handwashing removes transient flora from the caretaker's hands and controls the overgrowth of potentially pathogenic resident flora.³ Vigorous scrubbing with soap and water for at least 15 seconds remove transient bacteria; resident flora requires longer period of handwashing and an antibacterial detergent for adequate control.⁴ In a study done by Noskin et al (October 1995), a 30-second handwash with water plus soap was necessary to eradicate vancomycin-resistant enterococci on fingertips and environmental surfaces. Rossoff and Borenstein et al (July 1995) confer significant reduction in the number of microorganisms after a rigorous antiseptic handwashing of bare hands with alcohol. Bettin et al performed a study regarding the use of liquid soap versus chlorhexidine for removal of *Clostridium difficile* from bare hands. The study revealed that either soap or chlorhexidine is effective in the removal of *Clostridium difficile* from the hands.

The aliphatic alcohols, especially ethanol, have been widely employed as skin disinfectant because of their bacteriological action and ability to remove lipids from skin surfaces. Their action as detergents, however, is severely restricted by their inability at normal temperature to kill spores, and for this reason they should not be relied on for the sterilization of instruments. Ethanol is used extensively to sterilize the skin before cutaneous injections. It is active against gram positive, gram negative, and acid-fast organisms and is most effective at a concentration of 50 to 70%.⁵ Bellamy et al (July 1993) revealed that alcoholic solutions are more effective in removing rotavirus from contaminated hands compared to soap and water. The use of 80% ethyl alcohol reduces the number of methicillin-resistant *Staphylococcus aureus* from experimentally contaminated fingertips.

It is of prime importance to use an alternative handwashing agents in certain instances or conditions like lack of time or busy work, inaccessibility of handwashing facilities, inconvenience of handwashing technique, unavailability of soap and water and contaminated tap water. Is alcohol a good substitute? The aim of this study is to prospectively evaluate the efficacy of routine handwashing using soap and water versus 70% isopropyl alcohol in reducing the number of colony count of bacterial resident flora in the hands of nursery personnel.

This study would benefit the nursery personnel in reducing the possibility of nosocomial infections and mortality in the nursery care unit by having an alternative handwashing agent which can be used easily in their busy work and readily available.

MATERIALS AND METHODS

Forty six (46) subjects consisting of 9 doctors, 30 nurses, and 7 nursing aides assigned at the Philippine General Hospital

Neonatal Intensive Care Unit were included in the study. The subjects were randomly assigned to either Group A or Group B. Each group was composed of twenty three (23) subjects.

Under the supervision of the investigator, Group A performed the following handwashing procedure: wetting the hands with running water, applying Perla soap bar on one palm and spreading it over the hands in washing movements, rinsing under running water for fifteen (15) seconds and drying the hands using a clean dry towel. Group B were given 3 ml of 70% isopropyl alcohol as handwashing agent applied on both hands and air dried. Cultures of the dominant hand of each subject were done twice, that is, before the application of either soap and water or alcohol as handwashing agents and after the handwashing procedure. Fingers of the dominant hand were lightly pressed on blood agar plates for three (3) seconds. The two (2) samples of inoculated blood agar plates obtained from each subject were sent to a private laboratory and incubated for 48 to 72 hours at 37°C. Growth was determined by only one medical technologist who was blinded to the study groups. Gram stain was done to categorize organisms isolated either gram positive or gram negative. Catalase test was done to differentiate *Staphylococcus* from *Streptococcus* while 3% KOH was used to differentiate gram positive from gram negative bacilli. Colony count was done on all organisms isolated from blood agar plates.

The mean change in the number of colony count of resident bacterial flora on cultures before and after handwashing was used as the primary measure of the efficacy of handwashing agent. The T test was used to test for significant differences between the two groups.

RESULTS

Table 1 shows the number of nursery personnel in the study where various organisms were isolated.

Table 1: Number of nursery personnel where the various organisms were isolated

	Group A soap and water	Group B 70% isopropyl alcohol
Doctors	5	4
Nurses	15	15
Nursing aides	3	4
Total	23	23

Table 2 summarizes the actual colony counts of resident bacterial flora and mean change before and after application of two handwashing agents. The use of Perla soap and water either increased the mean colony count of resident bacterial flora to 434 or reduced it to 181 colonies after handwashing, while 70% isopropyl alcohol reduced the mean colony count of resident

bacterial flora by 4 to 497 colonies after handwashing. Testing for significance using T test revealed that the mean change in the number of colony count of resident bacterial flora using soap and water was -21. This means that the use of Perla soap and water increased the number of colony count of resident bacterial flora by 21 colonies. The mean change in the number of colony count of resident bacterial flora using 70% isopropyl alcohol was 109 colonies, hence, it reduced the number of colony count of resident bacterial flora by 109 colonies after handwashing. Using logarithmic transformation of the number of colony count of resident bacterial flora to analyze the data between the two (2) handwashing agents had a P value of < 0.0001 which was statistically significant as seen in Table 2A. Therefore, 70% isopropyl alcohol is more effective than Perla soap and water in reducing the number of colony count of resident bacterial flora.

Table 2: Comparison of actual colony counts and mean change colony count before and after application of two handwashing agents

	Group A soap and water n=23		Group B 70% isopropyl alcohol n=23	
	Mean	Standard deviation	Mean	Standard deviation
Before handwashing no. of colonies	125	± 96	116	± 103
After handwashing	146	± 206	7	± 13
Mean change	-21	± 117.1	109	± 101
Range of mean change	-434 to 181		4 to 497	

Table 2A: Comparison of the logarithmic transformation of the number of colonies of resident bacterial flora of two handwashing agents

	Group A soap and water	Group B 70% isopropyl alcohol	Mean difference	P value
n	23	23		
log mean ln (1+x)	0.493	2.971	-2.478	< 0.0001
standard deviation	0.275	0.258	0.377	

Table 3 showed the organisms isolated from the hands of nursery personnel. *Staphylococcus* coagulase-negative organisms were the predominant resident bacterial flora isolated. Four (4) out of twenty three (23) nursery personnels had complete eradication of these organisms after using 70% isopropyl alcohol as handwashing agent while none were completely removed after the use of Perla soap and water. Some transient organisms isolated were *Streptococcus* non-hemolytic and *Klebsiella* which were completely eradicated after handwashing with 70% isopropyl alcohol while *Escherichia coli* was completely removed after using Perla soap and water.

Table 3: Distribution of organisms isolated from the hands of nursery personnel

Organisms isolated	Group A soap and water n=23		Group B 70% isopropyl alcohol n=23	
	before handwashing	after handwashing	before handwashing	after handwashing
<i>Staphylococcus</i> coagulase-negative	23	23	23	19
<i>Streptococcus</i> hemolytic	not cultured	not cultured	1	not cultured
<i>Klebsiella</i>	not cultured	not cultured	1	not cultured
<i>Escherichia coli</i>	1	not cultured	not cultured	not cultured

DISCUSSION

Infection is spread in hospital mainly by hands, making hand decontamination the most important means of preventing dissemination. There is some evidence to suggest that when access to hand decontaminating agents is poor or the agents available are disliked, hands are washed too seldom, increasing risks of cross-infection.⁸

The great importance of handwashing by hospital personnel in the prevention of nosocomial infections was recognized by Semmelweis over 100 years ago.⁹ Today, the sites of nosocomial infections are more diverse, and they commonly include urinary tract infections, lower respiratory tract infections, intravenous catheter-associated bacteremias, neonatal skin infections, and surgical wound infections.¹⁰ Organisms transmitted on the hands of physicians, nurses, and technicians may cause infections at these sites,¹¹⁻²⁰ and many outbreaks have occurred, particularly in nurseries, where this was thought to be the means of cross infection.²¹⁻²³ Because of the high susceptibility of newborn infants to skin infections, handwashing between infant contacts is particularly important for nursery personnel. Therefore, the Center for Disease Control and the American Hospital Association have recommended that personnel wash their hands before and after taking care of every patient.^{24,25} The risk of transmitting organisms to or acquiring organisms from a given patient varies with the type of contact and the susceptibility of the patient. Thus, the real need for handwashing by personnel is before and after certain procedures and before caring for particularly susceptible patients.

Nosocomial infections affect up to 30% of the ICU patients. Although rates decline with increasing handwashing frequency, handwashing rates in ICU's are poor.⁴¹ Although personnel frequently do not wash their hands when they should, the principal disagreement among physicians about handwashing involves which agent or agents should be used. Some believe that antiseptic agents (products used on the skin that kill microorganisms) should be used for all personnel handwashing,

while others believe that they should be reserved for special purposes and that plain soap or detergent preparations (products that do not kill but suspend certain easily removable organisms, thereby allowing them to be washed off) should be used for routine handwashing.

Most studies have used the comparison of the microbe counts on the hands before and after handwashing as the single criterion for the effectiveness of the handwashing agent.²⁶⁻³¹ To determine an effective handwashing policy, one must know something about the skin's inhabitants. As described by Price in 1938, the two kinds of organisms on the hands are resident and transient flora.⁷ Though the resident flora differ quantitatively and qualitatively on different parts of the body and on different people,^{32, 33} everyone has aerobic *staphylococci* (*Staphylococcus epidermidis* and *micrococci*) and diptheroids in all skin areas.^{34,35} The greatest number of organisms on hands are found around and under the fingernails.³⁴ Most resident organisms found on the superficial skin surface, but 10% to 20% of total flora are concentrated in skin crevices, where lipid and superficial cornified epithelium make their removal difficult^{27,36} and make complete sterilization of the skin impossible.³² Fortunately, resident flora are usually of low virulence and rarely cause infections other than skin infections, except when introduced into the body through invasive procedures such as surgery or catheterization. They are not easily removed by scrubbing²⁶ but can be inactivated by antiseptics.

Transient flora may consist of many different pathogenic organisms (including those that commonly cause nosocomial infections) such as *Streptococci*, *Escherichia coli* and *Pseudomonas*.³⁷ Transient flora are not firmly attached to the skin and can usually be removed quickly and almost as effectively by handwashing for about 30 seconds with a soap or detergent and water instead of with an antiseptic.³⁸ In fact, friction and water alone are almost as effective as soap and water.^{3, 38}

The purpose of handwashing in patient care is simply to remove transient microbial contamination that has been acquired by recent contact with infected or colonized patients or environmental surfaces. However, it should be emphasized that the effectiveness of handwashing practices depends on several factors: use of an agent, handedness, frequency of rubbing, source and volume of rinsing water, and drying of the hands.³⁹

In our institution, Perla has been used as the routine handwashing agent in the Neonatal intensive care unit because it is less expensive and has few side effects. However, performance of routine handwashing is related to workload and availability of hand decontaminating agents especially when the nursery personnels became busy.⁴⁰ Is alcohol a good substitute? Thus, this study was conducted.

In this study, the use of Perla soap bar and water as handwashing agent would either increased the mean colony count

of resident bacterial flora to 434 colonies or reduced it to 181 colonies after handwashing. This increase in the number of resident bacterial flora could be explained by the rubbing action during handwashing which might transferred the organisms from one hand to the other. Resident flora are not easily removed from the hands but can be inactivated by the use of antiseptics.⁷ Alcohol has been used as an antiseptic for years and is still one of the most effective. In 1946, Cardner and Seldon (30) showed that 70% alcohol would "virtually disinfect" the skin in 15 to 20 seconds. At 70% concentration by weight, both ethyl and isopropyl alcohol are effective antiseptics, although Spalding³¹ believes that ethyl alcohol is generally a better virucidal agent.

The mean change in the number of colony count was used as the primary measure of efficacy of handwashing agent. In this study, the mean change in the number of colony count of resident flora using Perla soap and water was -21 while the use of 70% isopropyl alcohol decreased the number of colony count of resident bacterial flora to 109 colonies from the baseline. Using logarithmic transformation of the number of colony count of resident bacterial flora to analyze the data, the mean change in the number of colony count between the two (2) handwashing agents had a P value of <0.0001. Therefore, 70% isopropyl alcohol is more effective in reducing the number of resident bacterial flora in the hands of nursery personnel.

The resident bacterial flora isolated from the hands of nursery personnel was *Staphylococcus* coagulase-negative organisms. Some transient organisms isolated were *Klebsiella* 1 (2%) which were completely eradicated after using 70% isopropyl alcohol, non-hemolytic *Streptococci* 1 (2%) and *Escherichia coli* 1 (2%) which were removed after handwashing with Perla soap and water. Four (4) out of 23 nursery personnels had complete eradication of resident bacterial flora after handwashing with 70% isopropyl alcohol while it remained in the hands of 23 nursery personnels after using soap and water as handwashing agent.

The efficacy of soap and water versus 70% isopropyl alcohol in removing the transient organisms in the hands of nursery personnel were not tested in this study. The number of colony count were expressed as the actual number of colonies seen on blood agar plates and not in colony forming units (cfu) since no standard suspension of organisms were used in the study. There were no side effects noted after the single use of 70% isopropyl alcohol.

CONCLUSION AND RECOMMENDATION

This study concludes that 70% isopropyl alcohol is more effective compared to routine handwashing using Perla soap bar and water in reducing the number of resident bacterial flora in

the hands of nursery personnel specifically coagulase-negative organisms. Four (4) out of 23 nursery personnels had complete eradication of bacterial flora after using 70% isopropyl alcohol but it remained in the hands after using Perla soap and water.

This study recommends the use of 70% isopropyl alcohol as an alternative handwashing agent in areas with limited facilities for handwashing or when rapid disinfection is necessary to ensure significant reduction of bacterial resident flora in the hands of personnel. It is highly possible that the use of 70% isopropyl alcohol may significantly reduce nosocomial infections thus further studies is recommended.

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