

Chlorhexidine or povidone-iodine: Which solution is more effective on skin colonization in neonates?

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ABSTRACT

Background: Infection control should be an integrated part of patient care, especially to ensure safety and survival in hospitalized neonates. Although povidone-iodine (PVP-I) solution has been used as the most common antiseptic in hospitals of Iran, chlorhexidine is currently used in some wards for skin disinfection. However, there is no evidence about the superiority of either antiseptic solution over the other one. This clinical trial carried out in two university hospitals affiliated to Isfahan University of Medical Sciences, Isfahan, Iran, aimed to compare the effects of chlorhexidine and PVP-I solutions on skin bacterial colonization in hospitalized neonates.

Materials and Methods: The participants were 98 hospitalized infants. In each infant, one area on the skin was disinfected by chlorhexidine while the contralateral site was disinfected by PVP-I. Skin cultures were taken before and after disinfection. Microorganisms were determined and colony count was performed based on a standard method. The collected data were analyzed using descriptive and inferential statistical methods in SPSS v. 14.

Results: The mean of microorganism colony count before and after disinfection by either solution was statistically different ($P < 0.001$). There was no significant difference between the two groups in terms of mean microorganism colony count before disinfection. However, a significant difference was observed after disinfection.

Conclusions: PVP-I is more efficacious than chlorhexidine for skin disinfection. Consequently, it seems better to use PVP-I for skin preparation before invasive procedures.

Key words: Bacterial infection, chlorhexidine, disinfection, Iran, neonate, newborns, povidone-iodine

INTRODUCTION

Infections are important causes of mortality and morbidity in the world.^[1] Out of 4 million annual neonatal deaths, approximately 36% are due to infection.^[2] Infections increase therapeutic costs and prolong hospitalization. They also cause anxiety and stress in parents and other family members.^[3] Therefore, infection control is of high importance to save patients and provide hospitalized infants with optimal life conditions.^[4] Infection control should consequently be a major part of patient care.^[5]

Invasive skin pathogens play an important role in occurrence of infections and mortalities in infants.^[6] An infant's skin may be infected during labor through the

birth canal, labor team, or medical instruments.^[7] It might also be infected by relatives, care providers, and the surrounding environment after birth. These microorganisms could become the normal flora of the infants and damage their immune systems later.^[1] Hence, skin is an important potential place for entrance of infectious agents and the cause of neonatal infections.^[8] This risk manifests as the increased incidence of bacterial sepsis in diseased infants who require longer hospital stay and invasive procedures such as blood sampling, peripheral and central catheter insertion.^[9]

Various antiseptic solutions are used before any invasive procedure to remove microorganisms from the skin.^[10] Povidone-iodine (PVP-I) and chlorhexidine are the most common antiseptics. They are both accessible as solutions mixed with water or alcohol^[11] and are used in neonatal wards. However, previous studies on identification of the best antiseptic have reported different results. For instance, many studies have shown that the incidence of infection at catheter insertion site was lower after disinfection by chlorhexidine than by PVP-I.^[12] In addition, Darouiche *et al.* (2010) used chlorhexidine-alcohol versus PVP-I for surgical site antisepsis and suggested that the infection rate of surgical site was significantly lower ($P = 0.004$) in

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the chlorhexidine-alcohol group compared to the PVP-I group (9.5% vs. 16.1%),^[13] while the study of Garland et al. (2009) on infants showed no difference in bacterial colonization rate of inserted catheters between two antiseptic methods with chlorhexidine and PVP-I.^[14]

One of the responsibilities of trained nurses is performing research about nosocomial infections and their control procedures, diagnosing underlying infectious agents, and providing suggestions to eliminate such factors. They are also required to supervise and control the clinical and care methods employed in various wards, particularly neonatal intensive care units (NICUs).^[15] On the other hand, PVP-I–water solution is the most frequently used solution for skin antisepsis in Iran. Since it may not be the best option,^[16] we decided to conduct the present study to compare the effects of chlorhexidine and PVP-I on reducing the amount of skin bacterial flora among hospitalized neonates.

MATERIALS AND METHODS

Subjects

In a single-blind clinical trial with a single-group pretest posttest design, 98 eligible infants were enrolled. After obtaining written consents from the parents, the infants who met the inclusion criteria were selected through convenience sampling. The inclusion criteria were birth weight over 1 kg, gestational age over 28 weeks, not having infections and dermal diseases, and a minimum NICU stay of 24 h. Patients were selected from NICUs of two university hospitals affiliated to Isfahan University of Medical Sciences, Isfahan, Iran. Subjects were excluded and replaced by others if the blood sampling site was used for therapeutic procedures or disinfected by another solution or if the infants died before taking all required cultures. Before taking skin cultures, four pieces of cotton balls (Iran, Sahand Co) were placed in graft paper and sealed. They were then sterilized in an autoclave.

Technique

Blood sampling and catheterization are invasive procedures which can increase the risk of infection by skin flora, and are usually performed on areas behind the hand and anterior middle areas of elbow and ankle. So, of these areas, we assigned the site of skin culture sampling for each infant randomly. Afterward, one side of the body was determined randomly by coin flipping to be disinfected by PVP-I and the contralateral site by chlorhexidine. Skin cultures were done as below:

One of the researchers used a 2 × 2 cm² template to draw a square on the selected area of the skin.^[8] She scrubbed her hands with Epi-Max hand scrub solution (Iran, Emad Pharmaceutical Products), soaked cotton in antiseptic solution, and disinfected each area from center away to the sides. Skin

cultures were taken from the selected area before disinfection and immediately after drying the antiseptic solution. However, due to difference in color of the solutions, blinding during the skin culture sampling was not possible. All skin cultures were taken through rubbing a sterile swab wetted in normal saline solution (Samen Co., Mashhad, Iran) gently on the mapped area five times horizontally and twice vertically.^[8] The cultures were immediately placed in Amies transport medium (Amies transport medium with charcoal, *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922) and were immediately sent to the laboratory of Al-zahra Hospital, Isfahan, Iran. A microbiologist unaware of the study cultured the swabs on sheep blood agar (ATCC 25922, ATCC 33400, ATCC 8668) and eosin methylene blue agar (ATCC 25922, PTCC 1609) plates. Using a standard method, they were maintained at 37°C for 2 days to identify the count and types of bacteria.^[6,8,17,18] Afterward, bacteria type and count of colonies were determined for nine common pathogens which are the main causes of neonatal sepsis in developing countries (*Klebsiella*, *S. aureus*, *Acinetobacter*, *Enterobacter*, *Salmonella*, *Candida*, *Pseudomonas*, *E. coli*, and coagulase-negative staphylococci). The cultured skin that contained one or more of these pathogens was considered as positive.^[8]

The data were recorded in an information sheet including a demographic part and another part for culture results. The collected data were analyzed in SPSS V. 14. Paired *t*-test was used to compare mean counts of microorganisms before and after disinfection with each of the solutions. On the other hand, independent *t*-test was employed to compare the two groups in terms of mean counts of microorganisms before and after disinfection. The significance level was considered as $P < 0.05$ in all calculations.

Finally, it should be noted that the researchers had no bias toward any of the solutions since no financial benefit was gained from the companies.

RESULTS

The results showed that out of 98 infants who were enrolled in the study, 60.2% were males and 39.8% were females. The mean (SD) gestational age of the subjects was 33 (3.5) weeks. The mean age of the infants at the time of sampling was 9.94 (8.66) days (1-28 days). Their mean birth weight was 2005 (833) g. During sampling, two infants were excluded since the sampling site was used to take peripheral vein, one case was transferred to neonatal surgery department, and two other subjects were excluded because the sampling site was infected by the staff. All excluded cases were replaced. In total, 392 skin cultures, including 196 skin cultures from PVP-I antiseptic solution 10% and 196 from chlorhexidine, were taken.

Comparisons of mean counts of skin microorganisms before and after disinfection in each group of PVP-I 10% and chlorhexidine 2% as well as intergroup comparisons are presented in Table 1. Percentages of positive skin cultures before and after disinfection with each solution are shown in Figure 1.

Paired *t*-test showed that mean counts of skin microorganisms reduced significantly after disinfection with both chlorhexidine 2% and PVP-I 10% solutions ($P < 0.001$). According to independent *t*-test, mean counts of skin microorganisms in the two groups were not significantly different before disinfection ($P = 0.93$, $t = 0.08$). However, significant differences were observed after disinfection ($P = 0.049$, $t = 1.97$).

DISCUSSION

The present study showed that both PVP-I and chlorhexidine were effective on reducing skin bacterial flora in infants. However, the effect of PVP-I 10% was significantly more compared with chlorhexidine 2%.

Although Veiga *et al.* (2008) reported 33% of skin cultures to be negative after PVP-I shower,^[18] in the present study, 94.9% of skin cultures were negative after disinfection with PVP-I. Therefore, it seems that compared to PVP-I shower

method, using PVP-I through skin preparation is more effective in reducing microorganisms' counts.

Bekibele *et al.* (2010) studied the effects of PVP-I 5% on removing bacteria in the upper lid. They showed that mean counts of skin microorganisms reduced significantly (by 82.6%) after the intervention ($P = 0.001$).^[19] However, in the present study, the reduction in mean count of skin microorganisms was 94.9% after antiseptics with PVP-I. This difference can be due to using a solution with a higher concentration of PVP-I (10%) in the present study. Difference in areas of sampling might have been another reason since we took skin cultures from behind the hand and the anterior middle areas of elbow and ankle, while Bekibele *et al.* evaluated upper eye lids.^[19]

Darmstadt *et al.* (2007) assessed the safety and efficacy of chlorhexidine skin cleaning on skin flora of neonates in Bangladesh. They suggested that in skin cultures taken from the armpits, around the navels, and the groins of infants, mean counts of microorganism had significant differences 2 h after cleaning the areas with chlorhexidine compared with before the intervention.^[8]

According to the results of the above-mentioned research and the present study, the microorganism counts would obviously be reduced after disinfecting with any antiseptic solution. However, comparison of efficacy of chlorhexidine 2% and PVP-I 10% in reducing microorganisms by Garland *et al.* (2009) revealed a higher (although insignificantly) colonization rate at the tip of catheters in the chlorhexidine group compared to the PVP-I group.^[14] Similarly, in the present study, the amount of positive skin cultures in the chlorhexidine group was significantly higher than the PVP-I group. However, we used a larger sample size compared to Garland *et al.* (98 vs. 48 infants),^[14] and thus our results might be more reliable.

Valles *et al.* (2008) reported that the incidence of catheter colonization in the chlorhexidine 2% group was significantly lower than the PVP-I 10% group. However, the incidence of catheter-related bacteremia was similar in both groups. Besides, they showed that chlorhexidine was more effective than PVP-I in preventing catheter colonization due to gram-positive bacteria.^[12] On the contrary, in the present study, the effects of the both solutions were similar on gram-positive and gram-negative bacteria. It can therefore be concluded that the difference between the results of the two studies originated from the types of microbial flora in the environment. In addition, the study of Valles *et al.* was conducted in an intensive care unit for adults while our research was performed in NICUs. Khera *et al.* could not find significant differences in the mean counts of

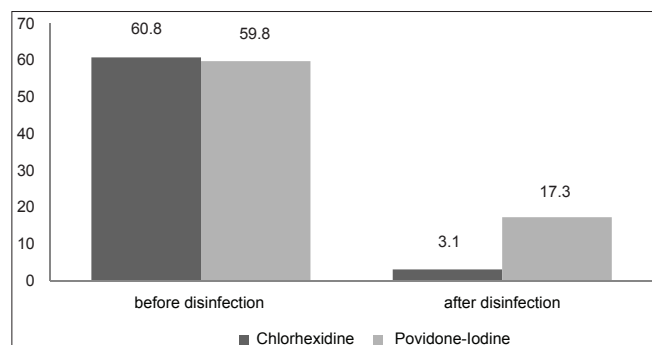


Figure 1: Percentage of positive skin cultures before and after disinfection with povidone-iodine 10% and chlorhexidine 2% solutions

Table 1: Comparisons of mean counts of skin microorganisms before and after disinfection (based on colony count) in each group and intergroups

Time	PVP-I group		Chlorhexidine group		Independent <i>t</i> test	<i>P</i>
	Mean	SD	Mean	SD		
Before disinfection	166.27	24.2	163.40	23.13	0.08	0.93
After disinfection	15.31	8.75	48.29	14.17	1.97	0.049
Paired <i>t</i> -test	6.11		4.74			
<i>P</i>	<0.001		<0.001			

Values are expressed as mean (SD)

microorganisms after disinfection with chlorhexidine and PVP-I.^[20] However, in the present study, the PVP-I was more effective than chlorhexidine in reducing microorganisms. This inconsistency might have been caused by the higher concentration of chlorhexidine in the study of Khera *et al.* than the present study (4% vs. 2%).^[20]

Darouiche *et al.* (2010) used chlorhexidine-alcohol versus PVP-I for surgical-site antisepsis. They indicated that the infection rate of surgical site was significantly lower in the chlorhexidine-alcohol group compared to the PVP-I group ($P = 0.004$).^[13] Likewise, Mimoz *et al.* (1999) showed that skin preparation with chlorhexidine-alcohol was more efficient than PVP-I in reducing contamination of blood cultures.^[21] In a similar study, Suwanpimolkul *et al.* (2008) reported that the contamination rate of blood cultures was significantly lower after disinfecting the venipuncture site with chlorhexidine-alcohol 2% than with PVP-I 10% ($P < 0.001$).^[22] The results of the present study were not in accordance with the results obtained by Darouiche *et al.*,^[13] Mimoz *et al.*,^[21] and Suwanpimolkul *et al.*^[22] The difference can be due to the form of chlorhexidine-alcohol solution in the above studies, i.e., perhaps alcohol enhances the germicidal properties of chlorhexidine. In the present study, we did not use the alcoholic compound due to potential unknown complications of chlorhexidine-alcohol on infants.

Our results showed that skin disinfection with PVP-I 10% compared to chlorhexidine 2% was more effective on reducing bacterial skin colonies. Therefore, PVP-I 10% solution can be suggested to be used in NICUs for skin disinfection before implementing invasive procedures. In this study, investigating the stability of the solutions was not possible due to time limitation. The stability of these two antiseptic solutions (chlorhexidine and PVP-I) is hence recommended to be assessed in further studies.

ACKNOWLEDGMENT

This study was sponsored by Research Deputy of Isfahan University of Medical Sciences (Research project No. 390189). We would like to thank all the staff and managers of Beheshti and Al-zahra hospitals affiliated to Isfahan University of Medical Sciences, who assisted us in conducting the present study. Furthermore, special thanks go to the lab officer of Al-zahra hospital and Emad Pharmaceutical Company.

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How to cite this article: Majidipour N, Abdeyazdan Z, Zargham-Boroujeni A. Chlorhexidine or povidone-iodine: Which solution is more effective on skin colonization in neonates?. *Iranian J Nursing Midwifery Res* 2013;18:54-8.

Source of Support: Isfahan University of Medical Sciences, **Conflict of Interest:** None.