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Evaluation of the Daily Chlorhexidine Bath Effect on Skin Colonization of the Intensive Care Unit Patients

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ABSTRACT

Background: Chlorhexidine is a common and safe antibacterial agent applied for hand hygiene and skin decontamination. Given the fact that the majority of nosocomial infections are observed in the special units of hospitals, this study aimed to assess the effect of daily chlorhexidine bath on skin colonization of the patients in the Intensive Care Unit (ICU).

Methods: This quasi-experimental study was conducted on 80 patients admitted to ICU of a teaching hospital affiliated to Zahedan University of Medical Sciences, Iran, in 2016. Patients were selected through convenience sampling and were non-randomly divided into the two groups of intervention and control, each of which consisting of 40 individuals. Patients of the intervention group were bathed with a sponge soaked with chlorhexidine 2% solution daily for five days, whereas subjects of the control group received no particular skin bath or disinfecting intervention.

Results: The positive results of the first culture were not significantly different (P=0.63). However, 100% of the control subjects and 7.5% of the participants in the intervention group had positive results in the second culture. Fisher's exact test indicated that the difference between the two groups was significant in this regard (P<0.001).

Conclusion: Given the reducing effect of bathing with chlorhexidine 2% on skin colonization and superficial skin infections, this method could be recommended as an approach for decreasing the risk of nosocomial infections in patients admitted to ICUs. However, further studies are suggested to evaluate these effects more precisely.

1. Introduction

An infection due to treatment procedures, which is transferred by hospital personnel or equipment, is known as a hospital-acquired or nosocomial infection. Indeed, there is no sign or symptom of infection at the time of admission.[1] Nosocomial infections are an important mortality cause, infecting 10-13% of the patients.[2, 3] Two third of these infections are related to surgical site infections, central venous catheters, ventilation-associated pneumonia, and infections resulting from urinary catheters.[4]

Hospital infections impose need for financial and workforce resources, as well as much expense on healthcare systems, patients, and their families.[5] In addition, these types of infections increase the duration of patients' hospital stay up to 4-5 days, resulting in taking more medication, and excessive use of antibiotics, which altogether raise the costs for healthcare systems and families.[6, 7]

Patients admitted to ICUs are more prone to nosocomial infections.[8, 9] According to the literature, the prevalence rate of hospital infections with multi-drug resistance has been 55.7%, 19.4%, 17.4%, and 7.5% in ICUs, internal wards, operating rooms, and transplant wards, respectively.[10] Skin is the largest body organ and the reservoir of many microorganisms. This organ is the interface between the outside and inside of the body, and various factors including the individual and environmental conditions, injuries, sanitation, and antibiotics all affect the number and diversity of bacterial colonies on the skin.[11] Patients admitted to the ICUs are more susceptible to getting colonized by the bacteria on the skin due to the environmental change, skin damages caused by invasive cares, and excessive use of antibiotics.[12] The bacteria colonized on the

skin play a critical role in nosocomial or iatrogenic infections since these bacteria are the source of infection, contamination of blood cultures, and also personnel's hands contamination.[13]

With proper planning, we can largely control the prevalence of nosocomial infections and reduce the mortality rate, disabilities, pain, and psychological aspects of the issue in patients and their families.[14] Several strategies have been introduced by healthcare specialists to deal with and prevent hospital infections, including commitment to sanitation and hand washing in addition to disinfection and isolation techniques. However, it is difficult to continuously adhere to these guidelines.[15] One of these methods, which is relatively easy to use, is the application of chlorhexidine bath. Bathing the patients with antiseptic chlorhexidine is a proper method for controlling the source of infection.[16]

Chlorhexidine, which was first used as local antiseptic in 1970,[17] is a potent disinfectant that affects a wide range of bacteria, fungi and viruses and has no microbial resistance or carcinogenicity effect.[18] It has been reported to have a great antimicrobial influence and low toxicity.[19] Chlorhexidine has extreme cationic properties, binding capacity, and considerable adhesion, which are among its advantages, and all lead to gradual release after use, constantly creating an antibacterial environment for a while. Enhanced effectiveness and more durability of chlorhexidine compared to other washing solutions are considered as its key properties.[19] While chlorhexidine has positive electrical load, bacteria have negative load; therefore, this substance can destroy the bacterial cytoplasm by binding that leads to inhibition of their growth.[16]

Studies on the efficacy of chlorhexidine bathing have yielded contradictory results. In this regard, results obtained by Fernandez et al. (2014) and Cassir et al. (2015) have indicated the positive effects of this compound. On the other hand, Noto et al. (2015) have marked chlorhexidine as ineffective.[20-22] In Iran, conflicting results have been obtained; for example, Ashktorab et al. (2006) demonstrated the positive antimicrobial effect of skin disinfection with chlorhexidine 2% on phlebitis.[23] Nevertheless, studies by Ranjbar et al. (2010) and Rostami et al. (2011) indicated that use of chlorhexidine 2% solution as mouth wash had no effect on reduction of pneumonia and nosocomial infections.[24, 25] While hospital infections have been recognized for many years, this complication is still a major healthcare problem in Iran and throughout the world due to the significant number of infected patients, high treatment expenses, and the mortality caused by resistance of microorganisms. Given the lack of sufficient studies in this area in Iran, there is a need for more clarification of chlorhexidine impact. Therefore, this study aimed to evaluate the effect of daily chlorhexidine bath on skin colonization of patients admitted to ICU.

2. Methods

2.1. Design

This quasi-experimental study was conducted on patients admitted to ICU of one of the teaching hospitals affiliated to Zahedan University of Medical Sciences, Iran in 2016.

2.2. Participants and setting

Sample size was estimated as 80 according to the study performed by Cassir et al. (2015)[21] with confidence interval of 95% and statistical test power of 90% using the ratio difference formula as mentioned below. Therefore, 40 participants were allocated to each of the intervention and control groups.

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2 \left[P_1(1-P_1) + P_2(1-P_2)\right]}{(P_1 - P_2)^2}$$

In which: P_1=6.3 %, 1-P_1=93.7%, P_2=31.3%, 1-P_2= 68.7%, Z1-β=0.85, and $Z_{1-\alpha}$=1.96.

The patients were selected through the convenience sampling method. Since there was no possibility for randomization and simultaneous evaluation of intervention and control groups, subjects of the control group were assessed first. The necessary information was collected on the first and fifth days of hospitalization. Afterwards, the eligible patients were selected for the test group and undertook the intervention.

The inclusion criteria entailed: 1) the age range of 20-60 years, 2) lack of any history of previous infections and underlying diseases, 3) not being pregnant, and 4) not being affected by skin diseases and multiple traumas.

The exclusion criteria included: 1) bed sore, 2) discharge from ICU in less than five days, 3) allergies, 4) sepsis, and 5) expiration of the patient.

2.3. Instruments

In this research, forms for demographic data and records of laboratory cultures results were utilized. Demographic characteristics included age, gender, and number of hospitalization days. In addition, the form for laboratory results contained laboratory and bacteriology culture results as positive or negative, type of the cultured microorganisms, and presence or lack of drug resistance.

2.4. Data Collection

The control group received no skin care intervention, other than the routine cares of the ward. The first culture was performed in this group from groin, armpit, and neck wrinkles upon admission to the ward. Next, the second culture was performed after the fifth hospitalization day (the sixth day) from the same regions and by the same method.

Sampling was carried out using separate sterile swabs for each area. One of the researchers rubbed the swab on the mentioned areas and immediately transferred the swabs to liquid or broth media to be cultured in the laboratory of hospital. The obtained sample was then cultured by the laboratory expert. It is worth mentioning that samples were taken by a trained male or female colleague (according to the gender of the patients).

The patients in the intervention group were bathed with chlorhexidine 2% every morning at a specific time (at 10-12). Bathing method of the patients was as follow: first, the curtain beside the bed was drawn and covers of the patients were removed. A large towel was laid on patients and their cloths were taken out in the same position. During the intervention process, ethical considerations were followed by the nurses in order to respect the privacy of the patients.

To bath the patients, at first one hand was taken out from under the blanket and the whole arm was bathed with chlorhexidine wash cloths measured 33×23 cm from distal part to proximal. Then, leg and groin areas of the same side were washed through the same method (from toes to the root).

When one side was finished, the other side was bathed using the same technique. After that, chest, abdomen area, body sides and perineum were all bathed with separate pads. At the end, the patients were placed on their side and back and perineum were bathed with the fourth pad. Finally, patients were put on new clothes and placed in a suitable position.

Four pads were used for each patient at each bathing session (two for the arm and leg of each side, one for the front of the body and perineum and one for the back and perineum). It should be mentioned that Sistan and Baluchestan province has a dry and hot climate and high temperature. In addition, patients with multiple or head trauma often have fever; therefore, it was not needed to warm the pads and they had the same temperature as the environment.

In the intervention group, the first sampling was performed upon the admission of the patients to ICU. After performing the intervention using the same technique for all the patients (i.e., the daily chlorhexidine bath for five days), the sampling procedure was repeated on the fifth day and the samples were delivered to the laboratory to be tested. It is noteworthy that before the intervention, allergy to chlorhexidine solution was tested for all subjects of the intervention group.

To this end, an area of forearm (5 cm in diameter) was washed with the desired solution and was assessed after 20 minutes to detect the probable allergies. The intervention process would continue in case of no allergy.

In this research, no allergy to chlorhexidine was observed in the intervention group. In order to prevent the spread of infections, all patients admitted to the ward, even those who did not participate in the study, were daily bathed with chlorhexidine.

Agar culture mediums including blood, EMB, and MacConkey were required for the first culture of each patient. After 24 hours of incubation, presence of a colony in the culture medium was indicative of bacterial growth. Exclusive and differential cultures were required to detect the type of bacteria. These steps were performed using Mannitol Salt agar culture medium, which can be applied to identify Staphylococcus aureus.

Moreover, differential cultures by MR-VP, TSI and SIM, Simon citrate and urea agar were required to detect Enterobacteriaceae, in which Escherichia coli, Klebsiella, Proteus, and Pseudomonas are classified. After identification of the bacteria, Muller Hinton Agar medium was compulsory to assess the antibiotic resistance pattern.

The microbiological tests were performed after inoculation of the clinical specimens into the culture mediums of Blood and EMB agars and incubation. Finally, the macro and microscopic examinations of the colonies were conducted.

The slides were prepared from the developed colonies and were stained. Based on being gram-positive or negative, the diagnostic tests were performed to identify the species.

Identification of the microorganism type not only determines the source of infection, but it also helps in treating the infections with skin origins. It should be noted that laboratory personnel had no information about the samples group.

2.5. Ethical considerations

At first, objectives of the study were explained to the participants and their companions, and they were tested in terms of allergy to chlorhexidine. Written informed consents were obtained from the participants, and all the patients of the ward were bathed simultaneously with the intervention group to prevent spread of the infection.

2.6. Statistical analysis

Data analysis was performed using descriptive statistics, Chi-square test (to compare the study groups in terms of the grown microorganisms' type), independent t-test (for comparing the two groups regarding quantitative variables, such as age and duration of hospitalization), Fisher's exact test (to compare two-state qualitative variables, including gender, history of hospitalization, marital status, and frequency of positive culture results). All the analysis was completed through the SPSS version 21.

3.Results

Demographic characteristics of the subjects are shown in Table 1, according to which no significant difference was observed between the subjects of the study groups regarding these characteristics.

According to Table 2, the frequency of positive result (the first culture) was 37.5% in the intervention group, which revealed no statistically significant difference with the second culture. However, the results of the second culture indicated that only 7.5% of the intervention group samples were positive after bathing the subjects with chlorhexidine. This difference was significant between the groups (P=0.0001) (Table 2).

Regarding the type of grown microorganisms in the second round of culture, it was demonstrated that Staphylococcus aureus, Escherichia coli, Staphylococcus epidermidis and Proteus were the most common grown microorganisms observed in 62.5% of the subjects in the control group. Meanwhile, Escherichia coli and Staphylococcus epidermidis were the most common microorganisms grown in the intervention group (Table 3).

Table 1. Demographic characteristics of the participants

Variable	Group	Intervention N(%)	Control N(%)	P-value
Gender	Male	25(62.5)	29(72.5)	0.47*
	Female	15(37.5)	11(27.5)	
Marital status	Married	32(80)	28(70)	0.43*
	Single	20(8)	12(30)	
History of hospitalization	Yes	3(7.5)	2(5)	0.99*
	No	37(92.5)	38(95)	
Age (year)	Mean±SD	42.10±14.51	37.92±13.4	0.18**
Duration of hospital stay	Mean±SD	10.95±7.04	8.37±6.77	0.1**

*Fisher's exact test; **Independent t-test

Table 2. Frequency distribution of culture results in the intervention and control groups

Group	First culture		P*	Second culture		P*
Result of culture	Intervention N(%)	Control N(%)		Intervention N(%)	Control N(%)	
Negative	25(62.5)	28(70)	0.63	37(92.5)	0(0)	<0.0001
Positive	15(37.5)	12(30)		3(7.5)	40(100)	

*Fisher's exact test

Table 3. Frequency distribution of the grown microorganisms types in the second culture of the intervention and control groups

Order	Infectious agent	Control	Intervention
		N(%)	N(%)
1	Staphylococcus aureus+Staphylococcus epidermidis	9(22.5)	0(0)
2	Escherichia coli	7(17.5)	1(2.5)
3	Staphylococcus epidermidis	5(12.5)	2(5)
4	Proteus	4(10)	0(0)
5	Pseudomonas+Staphylococcus aureus	2(5)	0(0)
6	E.coli+Staphylococcus epidermidis	2(5)	0(0)
7	Staphylococcus aureus	2(5)	0(0)
8	Staphylococcus epidermidis+fungi	2(5)	0(0)
9	E.coli+Staphylococcus aureus + Staphylococcus epidermidis+Fungi	2(5)	0(0)
10	Staphylococcus aureus + Fungi	1(2.5)	0(0)
11	Staphylococcus aureus+Staphylococcus epidermidis +Fungi	1(2.5)	0(0)
12	E.coli+Staphylococcus aureus	1(2.5)	0(0)
13	E.coli+Pseudomonas+Staphylococcus aureus	1(2.5)	0(0)
14	Pseudomonas	1(2.5)	0(0)
15	Negative culture result	0(0)	37(92.5)
	Total	40(100)	40(100)

4. Discussion

According to the results of the present study, daily chlorhexidine bath might significantly decrease the skin colonization , which was revealed as negative culture of the skin samples taken from the patients admitted to ICU.

In line with our findings, the meta-analysis of Huang et al. (2016) indicated that chlorhexidine 2% bath could reduce septicemia, urinary tract infection, and pneumonia caused by intravenous catheters, urinary catheters, and ventilators, respectively.[15] Climo et al. (2013) conducted a research on several patients from nine ICUs and bone marrow transplant wards. Following their results, chlorhexidine 2% bath for 24 weeks declined septicemia and infections due to methicillin-resistant Staphylococcus aureus and vancomycin-resistant enterococcus.[25] Cassir et al. (2015) demonstrated in their study on patients admitted to ICU, that chlorhexidine bath significantly decreased hospital-acquired infections in the intervention group, compared to washing the skin with soap and water. Their findings are consistent with the results of the current study. In addition, the frequency of the positive gram-negative bacterial cultures was significantly lower in the intervention group of the mentioned study.[21] Other studies, such as a research by Michael et al. (2013) indicated the reducing effect of daily chlorhexidine bath (twice) on hospital-acquired infections. In addition, Ewan et al. (2010) marked the impact of daily chlorhexidine bath for six months on blood infections caused by urethral catheter in patients with trauma. On the other hand, Cassir et al. (2010) have also affirmed the positive effect of daily chlorhexidine bath for seven days on various skin bacteria.[21, 26, 27] In congruence with our findings and considering the beneficial influence of chlorhexidine bath, Kassakian et al. (2011) demonstrated that bathing with chlorhexidine 2% decreased the nosocomial infections induced by methicillin-resistant Staphylococcus aureus and vancomycin-resistant Enterococcus up to 64% not only in ICUs, but also in other hospital units.[28]

It seems that chlorhexidine can have more profound effects, which last longer on infections (minimum of six hours) due to its cationic property and high adhesion strength to anionic groups presented in glycoproteins and phosphoproteins. Through all these capacities, this substance can reduce both resident and migratory bacteria on the skin, and affect all the gram-positive and -negative pathogenic microorganisms, viruses, molds, mycobacteria, and spores.[16, 19]

Contrary to the results of the current research, Noto et al. (2015) indicated in their cross-over study that wearing disposable clothes soaked with

chlorhexidine 2% for ten weeks in ICUs, had no significant impact on reduction of the nosocomial infections, compared to non-antibiotic clothes.[22] Efficacy of the chlorhexidine solution has not been confirmed by some studies in Iran, which have most of them had used it topically or as a mouthwash solution, such as the clinical trial performed by Rostami et al. (2011). In the aforementioned study, mouthwash was performed every six hours with chlorhexidine 2% solution since one day pre-surgery until one day post-surgery; the effect of this solution on hospital-acquired infections occurrence was monitored for one month afterwards. This study demonstrated no significant difference in emergence of infection between the study groups.[25] Moreover, a clinical trial by Ranjbar et al. (2010) revealed that mouthwash with chlorhexidine solution twice a day did not influence on prevention of the ventilator associated pneumonia, while was relatively effective on the incidence of late-onset pneumonia.[24]

The disagreement between the results reported by the other studies in Iran and the present study might be due to the fact that although the propagation site and reservoir of most pathogenic agents is the skin, chlorhexidine was used as mouthwash in the previous studies.

A remarkable difference existed between the current study and the other evidences regarding the incidence and the positive results of the second culture for the control group of the studies. This difference could be the result of not following the washing guidelines neither in the control group of this study nor in routine cares of the wards, and only the skin was cleaned with wet gauze in some cases. Whereas, in other studies, the controls as well received regular and simple baths with wet pads or solutions of water and soap.

A noteworthy point of the present study was that complete and short washing of the patients' skin with chlorhexidine for several days was more effective than using disposable clothes soaked with chlorhexidine or local use of this substance for a longer time, which requires further investigations.

5. Conclusion

Daily bath with chlorhexidine 2% might significantly reduce the skin colonization and decrease the frequency of positive culture results, which perhaps be indicative of reduced incidence of nosocomial infections with skin origin. Given the role of colonized bacteria of the skin in nosocomial infections and other infections caused by interventions and nursing procedures, it is recommended that this disinfection method, which is relatively easy and cost-effective, be appplied to prevent contaminations and reduction of the nosocomial infections in ICUs.

While performing daily chlorhexidine bath for all ICU patients can remarkably take time and energy of the nurses, it is regarded as a solvable challenge and beneficial action due to its positive impact on control and prevention of nosocomial infections. Despite the recommendations for utilizing this method in some guidelines, it is necessary to perform larger studies, given the possibility of increased microbial resistant due to its application.

There were some limitations in the current research including the impossibility of simultaneous evaluation of the intervention and control groups, not assessing the medications-resistant bacteria, and not being blinded.

Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions

Hamed Sarani: primary design of the research, participation in data collection, and monitoring the research process. Ali Navidian: data analysis and drafting of the manuscript. Somayeh Jahani: culture and identification of the microorganisms and antibiogram. Ebrahim Ebrahimi Tabas: participation in research design and data collection. Soleiman Bidar: was responsible for the study design, data collection, and drafting of the manuscript.

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