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Comparing the effects of chlorhexidine and povidone-iodine on bacterial colonization and local infection at Shaldon catheter insertion site among patients receiving hemodialysis

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ABSTRACT

Aims: One of the commonest complications of hemodialysis is infection secondary to central venous catheterization. The aim of this study was to compare the effects of chlorhexidine and povidone-iodine (Betadine) on bacterial colonization and local infection at Shaldon catheter insertion site among patients receiving hemodialysis.

Methods: This study was conducted by using a Quasi-experimental design in 2013. In total, 56 patients who had undergone central venous catheterization for receiving hemodialysis at Golestan hospital, Ahvaz, Iran, were recruited and randomly allocated to either the chlorhexidine or the Betadine groups. The catheter insertion site in the chlorhexidine and the Betadine groups was cleaned and disinfected by using chlorhexidine 4% and Betadine 10%, respectively. Groups were then compared with each other in terms of bacterial colonization and local infection at catheter insertion site. The $SPSS_{16}$ was used for performing the Fisher's exact, the Chi-square, and the independent-samples t-tests.

Results: The incidence of bacterial colonization and local infection at catheter insertion site in the chlorhexidine and the Betadine groups was 3.6% and 21.5%, respectively. The Fisher's exact test showed a significant difference between the two groups regarding bacterial colonization (P value<0.001).

Conclusions: Chlorhexidine is more effective than Betadine in minimizing bacterial colonization and local infection at the insertion site of Shaldon catheter among patients receiving hemodialysis.

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1. Introduction

Chronic renal failure (CRF) or end-stage renal disease (ESRD) refers to the irreversible decline in the functions of the kidneys for at least three months [1]. According to the Iranian Charity Foundation for Special Diseases, the number of patients who were receiving hemodialysis in November 2012 was about 20,000 [2].

The only treatment for saving the lives of patients with ESRD is dialysis or kidney

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transplantation. For beginning hemodialysis, a patent vascular access—such as fistula, arteriovenous graft, or central venous catheter (CVC)—needs to be created. The best vascular access for hemodialysis is fistula. However, a fistula becomes mature only after four to six weeks. During this period, a temporary vascular access such as CVC is established and used for hemodialysis [3 and 4].

CVC may be associated with different complications. Studies have shown that more than 15% of patients with CVC experience some kinds of associating complications [5 and 6]. The most prevalent late complication of CVC is infection at the insertion site which may finally necessitate mandatory removal of the catheter [7 and 8]. CVC-induced bacteremia prolongs patient's hospital stay from 2.4 to 7.5 and increases infection-related mortality rate [9].

Most of CVC-induced infections are secondary to the bacterial growth at the insertion site. Accordingly, maintaining sterilization and using antiseptic agents during and following establishing a CVC are among the most critical measures for preventing CVC-induced infections [10 and 11]. However, great controversies exist over the most effective antiseptic agents for reducing the rate of bacterial colonization and local infection at catheter insertion site. Therefore, further studies are still needed for providing conclusive evidence regarding the most effective antiseptic agents. The aim of this study was to compare the effects of chlorhexidine and povidone-iodine (Betadine) on bacterial colonization and local infection at Shaldon catheter insertion site among patients receiving hemodialysis.

2. Methods

This study was conducted in 2013 by using a quasi-experimental. Considering a confidence interval of 0.95, a power of 0.80, a P_0 of 0.033, and a P_1 of 0.233, the sample size was determined to be 28 patients in each group. A random sample of patients was selected from all patients with ESRD who referred to Golestan Hospital, Ahvaz, Iran, for undergoing central venous catheterization and receiving hemodialysis. Patients were included in the study if they had CRF, needed central venous catheterization by using Shaldon catheter, and the result of their microbial test sampled from the catheter insertion site showed few skin flora and no pathogenic microorganism. Patients were randomly assigned to either the chlorhexidine or the Betadine groups.

Study data were collected by a researcher-made checklist containing items on the signs and the symptoms of local infection at the insertion site of Shaldon catheter. Items included tenderness, pain, redness, fever, shivering, and serous or purulent secretions. After creating the checklist, we invited ten faculties affiliated to Shahid Beheshti Nursing and Midwifery Faculy, Tehran, Iran, to evaluate its validity. They commented on the checklist and the checklist was amended according to their comments. The reliability of the checklist was assessed by using the inter-rater technique. Accordingly, two raters (the second author and a master's nursing student) assessed ten patients for local infection at catheter insertion site by using the checklist. Besides, a sample was obtained from each patient's CVC insertion site. Samples were cultured on blood agar. Culture media had been produced by our microbiology laboratory by using the standard formula for the blood agar medium. The reliability of the culture tests was also evaluated by performing the inter-rater technique. Accordingly, ten patients were recruited and two samples were obtained from each of them. Each set of samples was sent simultaneously to a referral as well as our own laboratories. The kappa coefficient for the correlation between the results provided by the two laboratories was 0.81.

In the chlorhexidine and the Betadine groups, CVC insertion site was cleaned after each hemodialysis session by using respectively chlorhexidine 4% for 30 seconds and Betadine 10% for two minutes. Then, a transparent

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dressing was applied. Before cleaning and dressing, the catheter insertion site was assessed for any signs of local infection by using the study checklist. If there were signs of infection, a sample was obtained and sent to laboratory for microbiological study. Otherwise, the sample was obtained only at the end of the fourth round of hemodialysis.

SPSS16 was used for data analysis. Study groups were compared regarding categorical and continuous variables by using the Fisher's exact, the Chi-square, and the independent-samples t tests.

3. Results

The means of participants' ages in the chlorhexidine and the Betadine groups were 51.11±14.29 and 51.04±15.64 years, respectively. The independent-samples t-test showed that the two groups did not differ significantly regarding participants' ages (p=0.986). Most of the patients in the chlorhexidine and the Betadine groups were female (56.5% and 54.5%, respectively; Table 1). The most and the least frequent educational status was respectively 'illiterate' and 'university degree' (Table 1). In the chlorhexidine group, four participants were retired, ten were unemployed, four were blue-collar workers, one was white-collar worker, and seven were self-employed. On the other hand, the numbers of unemployed, blue-collar workers, white-collar workers, and self-employed participants in the Betadine group were respectively equal to seven, seven, four, one, and nine (Table 1). The results of the Fisher's exact test showed that there were no significant differences between the two study groups regarding gender (P=0.587), educational status (P=0.263), and employment status (P=0.892; Table 1).

Bacterial colonization rates in the chlorhexidine and the Betadine groups were 3.6% and 21.5% respectively. The Fisher's exact test indicated that the difference between the groups regarding bacterial colonization rate was statistically significant (P<0.001). Accordingly, bacterial colonization rate in the Betadine group was significantly lower than the chlorhexidine group (Table 2). Moreover, the

Table 1: Study participants' demographic characteristics

Variables	Group / Frequency	Chlorhexidine N (%)	Betadine N (%)	Sum N	Test	p value
Gender	Female	13 (56.5)	10 (43.5)	23	Fisher	0.587
	Male	15 (45.5)	18 (54.5)	28		
Age (year)	15–30	4 (57.1%)	3 (42.9)	7	T	0.986
	31–45	3 (33.3)	6 (66.7)	9		
	46-60	16 (61.5)	10 (38.5)	26		
	> 60	5 (35.7)	9 (64.3)	14		
Education	Illiterate	9 (56.2)	7 (43.8)	16	Fisher	0.263
	Primary	5 (55.6)	4 (44.4)	9		
	Guidance school	7 (70)	3 (30)	10		
	High school	4 (26.7)	11 (73.3)	15		
	University	3 (50)	3 (50)	6		
Employment	Retired	5 (41.7)	7 (58.3)	12	Fisher	0.892
	unemployed	10 (58.8)	7 (41.2)	17		
	Blue-collar worker	5 (55.6)	4 (44.4)	9		
	White-collar worker	1 (50)	1 (50)	2		
	Self-employed	7 (43.8)	9 (56.2)	16		
Central vein	Jugular	15 (39.5)	23 (60.5)	38	Chi-square	0.044
	Subclavian	13 (72.2)	5 (27.8)	18		

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incidence of local infection at catheter insertion site in the chlorhexidine and the Betadine groups was respectively 3.6% and 21.5%, respectively. The Fisher's exact test revealed no significant difference between the two groups regarding the incidence of local infection (P=0.101; Table 3). Finally, we found that all bacterial colonization at CVC insertion site ultimately turned into local infection.

4. Discussion

Study findings revealed that the rate of bacterial colonization in the chlorhexidine group was significantly lower than the Betadine group. This finding is almost in line with the findings of previous studies. For instance, Saranai (2000) found that chlorhexidine was more effective than alcohol, Betadine, and alcohol-Betadine in decreasing the rate of catheter-induced phlebitis [12]. However, Ishizuka et al. (2009) reported that chlorhexidine 5% and Betadine 10% had similar effects on the prevention of CVC-related bacteremia (P=0.045) [13]. This conflicting finding can be attributed to differences in the samples and the settings of the studies. Moreover, Ishizuka et al. (2009) did not provide detailed information about the criteria for and the time of infection assessment.

We also found that the number of local infection in the chlorhexidine group was less than the Betadine group. However, the difference between the groups was not statistically significant (P=0.101). Weheida et al. (2011) and Girard et al. (2011) also found that chlorhexidine 0.25% was more effective than Betadine 10% in reducing the occurrence of local infection at the insertion site of CVC (P<0.05) [14 and 23]. Other studies also have reported that compared with Betadine, chlorhexidine provided more effective protection against local infection at the insertion site of temporary transvenous pacemaker catheter [17] and intravenous infusion catheters [18]. Moreover, Kapadia et al. (2013) found that preparing the surgical site of total hip arthroplasty by using chlorhexidine significantly reduced the incidence of local infections [19]. Besides its significant effects on preventing local infections at the insertion sites of intravascular catheters, chlorhexidine has been shown to be more effective than normal saline in reducing urinary tract infections secondary to urinary catheterization

Table 2: The rates of bacterial colonization in both study groups

Group	Chlorhexidine		Betadine		Sum	
Frequency / Colonization	N	%	N	%	N	%
Negative	20	35.7	5	8.9	25	44.6
Rare	3	4.5	10	17.9	13	23.2
Few	4	7.1	7	12.5	11	19.6
Moderate (Positive)	1	1.8	5	8.9	6	10.7
Heavy (Positive)	0	0	1	1.8	1	1.8
Sum	28	50	28	50	56	100

Table 3: The incidence of local infection in both study groups

Group	Chlorhexidine		Betadine		Sum	
Frequency / Infection	N	%	N	%	N	%
Yes	27	96.4	22	78.6	49	87.5
No	1	3.6	6	21.4	7	12.5
Total	28	100	28	100	56	100

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[20].

The overall incidence of local infection in the current study was 14.28%. This is congruent with the findings of the previous studies. For instance, Hartmann et al. (1989) reported an intravenous catheter-related infection rate of 22%. However, Sherbaf (2006) found that the incidence of catheter-related becteremia was 54% per patient. This conflicting finding can be attributed to the differences in sample sizes of the studies [15 and 16].

We also found that most cases of bacteremia had been caused by Staphylococcus epidermidis. Taghinezhad et al. (2004) also reported the same finding [21). However, Yegane and Kolahi (2005) found that the commonest pathogen causing bacterial colonization at the insertion site of CVC was coagulase-negative staphylococci [5]. Staphylococcus aureus is the main natural skin flora. It may be transmitted to the catheter insertion site either from patient's own skin or from the skin of the healthcare professional who inserts the catheter. Accordingly, a stringent sterilization technique and effective disinfectant(s) should be used during catheterization to minimize the possibility of bacterial transmission and local infection [22].

The confounding factors that might have affected the findings of this study included participants' unknown underlying conditions, their different dietary regimens, healthcare professionals' poor adherence to the principles of sterilization and sterile practice, and differences in the employed catheterization techniques.

5. Conclusions

Considering the study findings, we can conclude that chlorhexidine is more effective than Betadine in minimizing bacterial colonization at the insertion site of Shaldon catheter. Study findings can be used in nursing education, practice, and management. Nursing education authorities can use the study findings for educating nursing students about the most effective solutions for cleaning and disinfecting CVC insertion site. Moreover, nurses who work in hemodialysis units as well as hospital infection control authorities can use the study findings for preventing and managing CVC-related infections among patients who receive hemodialysis. Hospital administrators and managers can also use the findings to choose the most effective disinfectants and hence, minimize the risk of nosocomial infections.

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