Original Article

Effect of Peripheral Venous Catheter Care on Microbiological Colonization: A Randomized Controlled Trial

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Abstract

Bacground: Peripheral venous catheters (PVC) are one of the most commonly used medical tools. PVCs are inevitably required in many cases, but do cause some complications. The avoidance of catheter infections is considered one of the indications of qualified nursing care. Additionally, it has been emphasized that nurses may affect quality of care significantly by performing PVC care and carrying out the principles related to its safe management. Therefore, nurses should develop their knowledge and skills related to PVC.
Objective: The purpose of this study was to evaluate the effect of peripheral venous catheter (PVC) care on microbiological colonization.
Design: In this double-blind study, PVC care was administered by two researchers in patients randomized into experimental and control groups.
Methods: PVC was applied in patients in the experimental and control groups by two researchers. 10% poviodine was applied the area around the catheter insertion site every 24 hours in the experimental group. This application was repeated 2 times for 72 hours. In the control group, no care was administered during the same time period. After 72 hours, the catheter tip was cut with a sterile lancet from the very end, transferred to a sterile petri dish, and sent for microbiology culture test at once.
Results: Colony reproduction was observed in 58.8% of patients in the control group. However, no colony reproduction occurred in the PVCs of patients in the experimental group.
Conclusion: PVC care has a positive effect in preventing microbiologic colonization and colony reproduction.

Key Words: Peripheral venous catheter care, Peripheral Venous Catheter, nursing care

Introduction

In all institutions where healthcare services are provided, nurses play important roles in preparation and safe administration of medications and in monitoring the responses of patients (Craven and Hirnle, 2004; Taylor, Lillis et al., 2008; Kaya and Pallos, 2013). One of the practice areas of nurses in the course of performing their important roles in the administration of medications is intravenous (IV) treatment (Akça Ay, 2011; Potter and Perry, 2011). IV treatment involves the direct injection of the liquid (medication) into the vein (Harkreader & Hogan, 2004; Taylor Lillis et al., 2008) and various catheters are used for such treatments (Kaya and Pallos, 2013). These catheters may be peripheral or central. Peripheral venous catheters (PVC) are one of the most commonly used medical tools for hospitalized patients on the grounds that they are economical and simple (Harkreader and Hogan, 2004; McCallum and Higgins, 2012). It was reported that PVCs have been administered in 30%-80% of hospitalized patients (Akça Ay, 2011), but PVCs are only appropriate for short-term use in patient care (Harkreader and Hogan, 2004; Craven and Hirnle, 2004).

PVCs are inevitably required in many cases but do cause some complications (Harkreader and Hogan 2004; Cicolini, Bonghi, Labio and Mascio 2009). These complications can be divided into local and systemic complications. Local complications are the ones that occur at or near the vein insertion site, whereas systemic complications occur at areas distant from the vein insertion site and can cause serious, life-threatening conditions (Kozier, Erb, Berman, and Snyder, 2010). Infections developing as a complication of catheterization include catheter colonization, phlebitis, exit site infection, pocket (port) infection, tunnel infection, blood stream infection (bacteremia/fungemia), septic thrombophlebitis, and infusion liquid-related bacteremia (O'Gray, Alexander et all., 2002). Catheter-related infection (CRI) includes infection types that have high mortality rates and are observed to increase in frequency of occurrence in parallel with invasive interventions (Kampf, 2009). It has been reported in the 2002 Intravenous Catheter (IC) guideline of the Centers for Disease Control and Prevention (CDC) that more than 250,000 CRI cases are encountered per year (O'Grady Alexander et al., 2002; CDC, 2002). Risks of CRIs vary depending on the catheter types used and have been stated to be 72% for central venous catheters, 35% for peripheral venous catheters, and 16% for arterial catheters (Öncül, 2008). In addition, catheter-related infections are also important on the grounds that they cause circulatory system infections, which are reported to be the fourth most commonly encountered infection type among hospital infections (Vincent, Bihari et al., 1995).

Catheter-related infections are also an important element of nursing care. Nurses' primary field of interest in terms of PVC care should be the prevention of infections and phlebitis. Therefore, nurses should develop their knowledge and skills related to PVC (and PVC care) methods in an evidence-based manner in order to reduce the complications caused by these catheters (McCallum and Higgins, 2012). The avoidance of catheter infections is considered one of the indications of qualified nursing care. Additionally, it has been emphasized that nurses may affect quality of care significantly by performing PVC care and carrying out the principles related to its safe management (HPS 2012). In addition to having a key role in order to increase quality in PVC care, nurses are also responsible for evaluating the patient's clinical condition, preventing infections, and protecting the patient from possible hazards (INS, 2006). Therefore, when a PVC-related infection occurs, all eyes will be on the nurse who performed the catheterization procedure.

Both the literature and the PVC guides emphasize that the catheterization site needs to be cleaned with an antiseptic solution only before application of the PVC. But it been not emphasize that cleaned periodically with an antiseptic solution (Akça Ay, 2011; CDC, 2011; Gorski, Eddins et all, 2011; Harkreader and Hogan, 2004; HPS 2012; Kaya & Pallos, 2013, Lovedaya, Wilsona et all., 2014; Potter and Perry 2005; PIVC 2013). On the other hand, literature of about with central venous catheters (CVC) expresses that the location of CVC entry has be cleaned periodically with an antiseptic solution and medical dressing change (CDC, 2011; PIVC, 2013). There are also many studies on this subject (Levy, Katz et all. 2005; Ho & Litton, 2006; Timsit, Schwebel et all. 2009). However, PVC is more commonly used than CVC and requires more active handling of the catheterization site due to drug administration or other reasons. This is could present more

potential opportunities for infection. It is thought that the entry site of the PVC should be cleaned periodically with an antiseptic solution. However, no studies were found that actively dealt with this topic. In light of this information, it is thought that care of the catheter site with an antiseptic solution may reduce catheter-related infections. Therefore, the purpose of this study was to assess the effect of PVC care on colonization

Materials and Method

Sample: Data of the study were collected from a university hospital. The population of the study consisted of the patients hospitalized in the Neurology and Neurosurgery Clinics of the hospital between June 2014 and August 2014. The sample group of the study consisted of 50 patients who met the inclusion criteria within the defined population. Inclusion criteria of the study were the following; age between 18 and 65 years; who did not have any infection in other areas, did not have hemiplegia. Eight of these patients were excluded from the study due to being discharged from hospital and 7 were excluded due to infiltration development, leading to the study being completed with 35 patients (Figure 1).

Research design: PVC was applied in patients in the experimental and control groups, which were determined through randomization by two researchers (G.A, B.Ç). Skills, education, hand-washing status, and method used to close the catheter during administration may affect CRI. Therefore, insertion, closing and detection of PVC, catheter care and collection of samples were performed by the same researchers (G.A, B.Ç) in order to keep these variables that could impact study results under control. Since lower extremities have higher risks of infection compared to upper extremities among peripheral catheters applied in adults (Kaya & Pallos 2013), patients with PVC applied in their upper extremities were used both for the control and the experimental groups. Before fitting catheters, the area was wiped with 10% poviodine with a single movement from the top down Catheters in both the control group and the experimental group were fastened with 'Hypafix 10 cm*10 m Anti-allergic Plaster' (Figure 2).The Patient Description Form and the Catheterizasyon Follow-up Form were used to collect data for the study. The patient's personal identity information, intravenous treatment, and personal characteristics that may have had an effect on the catheter's microbiological colonization (age, gender, educational status, period of hospital stay, etc.) were recorded on the Patient Description Form; the extremities in which the catheters were administered, whether or not PVC care was performed, insertion and removal dates of the catheter, dates when culture samples were obtained, and culture results were recorded on the Catheter Follow-up Form.

***Experimental Group*:** 10% poviodine was administered on the PVC insertion areas of patients in the experimental group by two researchers (G.A, B.Ç) every 24 hours. 10% poviodine from solution was used due to recommendations in the literature and relevant guidelines and for its good antiseptic properties (Purohit, Saluja & Kakranı 2003; Jayaraja, Kumar et all. 2009,). For the cleaning, plaster was removed from the catheter and the catheter entry site was cleaned in a circular motion using the 10% poviodine. After cleaning, the catheter was fixed again with anti-allergenic plaster. This process was repeated 2 additional times during the 72 hours. During each application, the routine medical treatment of patients via PVC continued throughout.

Control Group: The PVC areas of patients in the control group were not treated with any solution during the 72 hours.During all these application, the routine medical treatment of patients via PVCcontinued throughout.

Microbiological Culture Testing in PVC: Since PVCs have a risk of infection after 72-96 hours (CDC, 2002; Cicolini, Bonghi, Labio & Mascio 2009; Kaya & Pallos 2013; PIVC, 2013), PVCs of patients in both groups were removed at the end of 72 hours by researchers (G.A, B.Ç) wearing sterile gloves. The catheter tip was cut with sterile lancet from the very end and transferred to a sterile petri dish before being sent out at once for microbiological culture testing. Samples sent to the laboratory were inseminated to Blood Agar and EMB (Eosin Methylene Blue) medium through semi-quantitative culture method within 2 hours (at the latest) to prevent the microorganisms from drying. The medium was incubated at 37ºC for 24 hours and, in case of no reproduction within the first 24 hours, for 48 hours, and the reproduced colonies were processed by the researchers (H.U, M.V.C) for bacteriological typology. The assessment of 'reproduction

detected' in isolates was based on the detection of an at least 15 cfu (Colony Forming Unit) reproduction among inseminated plaques (Öztürk, 2005). All cultures were examined by the same specialist physicians (H.U, M.V.C) in the microbiology laboratory of the same hospital where data were collected. A double blinding method was used in the study.

Analysis of results: A package program in electronic environment was used to analyze the data. The data were assessed by using percentage analyses, Chi-Square test, and Fisher's Exact Test.

Ethical Consideration: Required permissions were granted by the relevant institutions to conduct the study. Furthermore, the research proposal was submitted to the Ethics Committee was approved (Number: 2012/2/43). To conduct the study, permission was granted by the university hospital and the clinics where the study was conducted. Before administration, the purpose and benefits of the study were explained to the patients and their relatives. Their verbal consents were received. During the study, the questions asked by the participants were answered.

Results

Table 1 illustrates the distribution of the patients' descriptive characteristics. While the average age of patients in the experimental group included in the study was 48.3±14.8, the average age of patients in the control group was 45.9±19.0. The average hospitalization duration of patients in the experimental group was 3.38±3.64, whereas the average hospitalization duration of patients in the control group was 5.35±4.6. 55.6% of patients in the experimental group and 47.1% of patients in the control group were males. Additionally, 55.6% of patients in the experimental group and 52.9% of patients in the control group were primary school graduates. The difference between the groups was not statistically significant. Patients in the experimental and control groups were similarly distributed.

Table 2 illustrates the distribution of the treatment-related characteristics of patients. 22.2% of individuals in the experimental group and 41.2% of patients in the control group stated that they were in the middle of taking antibiotics regimens. 77.8% of patients in the experimental group and 76.5% of patients in the control group did not receive IV liquid treatment. 22.2% of patients in the study group and 70.6% of patients in the control group were found to be receiving analgesic treatments. In addition, 55.6% of patients in the experimental group and 35.3% of patients in the control group had contact with PVC 2 times a day due to their treatments. The differences between the groups in these parameters were not statistically significant. Patients in the experimental and control groups were similarly distributed.

Table 3 compares the bacteria reproduction in the experimental and control groups. While colony reproduction was observed in 58.8% of patients in the control group of the study (n=17), colony reproduction was not observed in 41.2%. However, colony reproduction was not observed in PVCs of the patients in the experimental group (n=18); the difference between these groups of patients was statistically significant ($p<0.01$).

Discussion

With the development of treatment opportunities and invasive methods in the healthcare field, the use of catheterization has gradually increased. This development has led to many treatment-related complications. Peripheral intravenous catheters, which are one of these catheters, may cause many complications (Hall, 2004; Akça Ay, 2011). These complications cause longer hospital stays for patients, unnecessary diagnostic processes and treatments, stress for patients and their relatives, an increased work load for medical personnel, and economic losses. In this study, conducted with the idea that PVC care may be a solution for the prevention of these problems, catheters which received / did not receive 24-hour PVC care / were left to clinical routine were microbiologically examined, and the results were discussed according to the relevant literature.Characteristics of experimental and control groups were compared in this study (Tables 1-2). No difference was found in terms of demographic characteristics and treatment-related characteristics of the patients in the experimental and control groups. Report in the literature state that factors such as the patient's age, whether the patient received antibiotic treatments, IV liquid receiving status, number of PVC contacts, IV liquid flow rate, and other similar factors may have an impact on the occurrence of phlebitis and other infections (Akça Ay 2011; Potter & Perry 2011). Therefore, it is important that the groups are similar in terms of these characteristics.

Figure 1:Study's Diagram

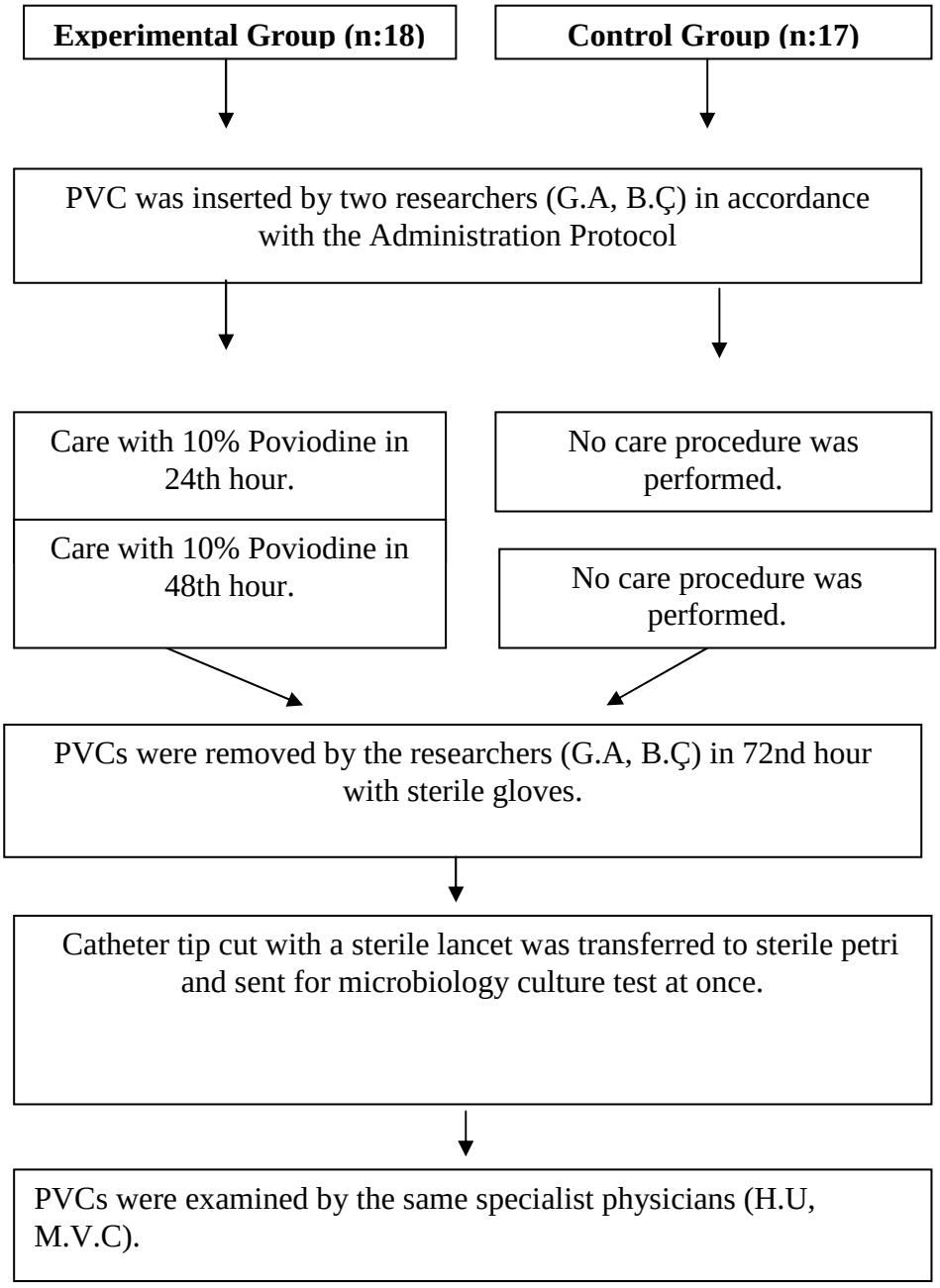

Figure 2: Administration Protocol

Standard PVC Administration Method (CDC 2002, Sabuncu et al., 2008, Uzun 2013, PIVC 2013).

Tools and Instruments	**Cannula in the right size (22G), alcohol, tourniquet, cotton pad, waste bin, medicine tray, protective cloth, gloves, hypafix 10cm*10 m anti-allergic plaster**
Method:	Hands were washed. Medicine tray was prepared and materials were checked.
	Suitable patient was identified and the informed about the procedure. Patient's verbal permission was received for the administration.
	The patient to receive the PVC administration was instructed for the correct position. Patient had supine or fawler positions. The area was opened with the veins being visible.
	Suitability of vein was checked. The extremity determined through the selection of the suitable vein was supported. Protective cloth was laid under the determined area.
	The tourniquet was fastened approximately 10 cm above the area in a way that it would not prevent arterial circulation and would be removed easily.
	The distal of the vein has been palpated and insertion point was determined. Gloves were worn.
	The area was cleaned by applying pressure with a cotton pad containing alcohol starting from the determined insertion point from top to down through the vein and 1 minute passed for the alcohol to dry. A cannula in the right size was selected. (number 22 G)
	Cannula's protector was removed and it was held between index and middle fingers with its sharp edge facing upwards. The skin was stretched with thumb and index fingers holding from beneath and behind the administration area with a passive hand.
	Skin was stretched. Tissue was inserted with an angle of 15^{o}. Blood control was performed. Cannula's angle was reduced and it was pushed forward for approximately 2 mm. Cannula was pushed forward inside the vein by pulling its plunger slowly for 1-2 mm.
	Tourniquet was removed and pressure was applied inside the cannula's tip in order to prevent the blood from flowing outside. The white cannula lid at the tip of the plunger was removed and plunger was thrown into the waste bin. Lid was reunited with PVC.
	It was fastened with Hypafix 10cm*10 m Anti-allergic Plaster'. Its insertion date, time and the name and surname of the person who inserted it were written on it. Materials were collected.
	Help was provided for the patient to return to a comfortable position. Hands were washed. The procedure was recorded in accordance with the institution's policy.

Table 1. Distribution of Descriptive Characteristics of Patients

Descriptive Characteristics	Experimental Group		Control Group		Test Value / Statistics
Age	48.3 ±14.8		45.9±19.0		X^2:15.851 p: 0.603
Period of Hospital Stay	3.38±3.64		5.35±4.6		X^2:12.417 p: 0.258
	S	**%**	**S**	**%**	
Gender					
Female	8	44.4	9	52.9	X^2:0.253
Male	10	55.6	8	47.1	p: 0.615
Educational Status					
Illiterate	2	11.1	4	23.5	X^2:1.092
Primary school	10	55.6	9	52.9	p: 0.579
High school	6	33.3	4	23.5	
Service					
Neurology	8	44.4	5	29.4	X^2:0.846
Neurosurgery	10	55.6	12	70.6	p: 0.358
Total	18	100.0	17	100.0	

Table 2. Distribution of Treatment-Related Characteristics of Patients

Descriptive Characteristics	Experimental Group		Control Group		Test Value / Statistics
	S	**%**	**S**	**%**	
Use of Antibiotics					
Yes	4	22.2	7	41.2	X^2:1.457
No	14	77.8	10	58.8	p: 0.227
IV Liquid Treatment Status					
Yes	4	22.2	4	23.5	X^2:0.008
No	14	77.8	13	76.5	p: 0.927
Use of Analgesics					
Yes	4	22.2	12	70.6	X^2:0.237
No	14	77.8	5	29.4	p: 0.627
Number of Contact with PVC					
1	2	11.1	4	23.5	X^2:1.716
2	10	55.6	6	35.3	p: 0.424
4	6	33.3	7	41.2	
Total	18	100.0	17	100.0	

Table 3. Comparison of Bacteria Reproduction in Experimental and Control Groups

	Experimental Group		Control Group		Total		Test Value
	S	**%**	**S**	**%**	**S**	**%**	
There is reproduction *	0	0.0	10	58.8	10	28.6	X^2: 14.824 **p: 0.000**
There is no reproduction	18	100.0	7	41.2	25	71.4	
Total	18	100.0	17	100.0	35	100.0	

* CNS developed in 10 patients; whereas α both streptococcus and CNS developed in 1 patient.

In this study, while no reproduction was observed among the catheters that received 24-hour PVC care, colonization was detected in 58.8% of catheters in patients who did not receive care outside of that typically specific by the clinical protocol. The difference in colonization between PVCs that did versus did not receive care was statistically significant (Table 3).

No PVC-related colonization study in which infection risk rates are given was found in the literature. Infection risk has been reported to be 1.3% for plastic PVCs and 0.2-0.5% for teflon/ polyurethane PVCs. It has been emphasized that PVC-related infections are lower in frequency than are infections related to use of peripheral artery catheters, and the infection risk for peripheral artery catheters is reported to be 1.9% (Aygün, 2008). However, it should be taken into consideration that PVCs are more commonly used in hospitals compared to other catheters. In addition, the fact that care has been provided, especially at the catheter insertion site, during the study is thought to help effectively ensure reduction of infection rates since catheterization-related infections generally occur at the catheter insertion site and in the mouth of the catheter. The literature reports that 65% of catheter infections originate from the catheter insertion site, 30% from the mouth of the catheter, and 5% from other areas (Bouza, Burillo & Munoz 2002). To elaborate further, while the insertion site often creates the source of infection in temporary catheters, the source of infection in permanent catheters is often the mouth of the catheter (Öncü, 2012). In light of this information, both the care provided at the insertion point of the PVC and the use of a strong antiseptic during this care are thought to be effective in reducing colonization.

This study determined that the microorganisms most commonly reproduced on the catheters in the control group were coagulase-negative staphylococci (CNS) (Table 3). Staphylococci are the most frequently identified causative factors of catheter infections, with coagulase-negative staphylococci holding a primary position among the different staphylococci with respect to frequency of occurrence (Öncü, 2012). CNSs, which are present in the normal flora of skin and mucosa and are generally assessed to be contaminant when isolated from cultures, are among the most significant factors in nosocomial sepsis and bacteremia. According to the National Nosocomial Infection Surveillance (NNIS) data, CNSs are responsible for approximately one fourth of nosocomial bacteremia (NNIS, 2004). Therefore, PVC care is a potential solution for reducing catheter colonization by a hospital infection agent. In addition, it is known that a significant amount of the microorganisms that cause catheter infections produce a substance (biofilm) that makes it easier for them to stick to foreign bodies (such as catheters) and enables them to protect themselves during host defense (Pascual, 2002). Therefore, PVC care is thought to create such a protection and be effective even against microorganisms that defend themselves. If this biofilm layer gets broken somewhere in the PVC channel, it joins the systematic circulation and may cause blood circulation infections, bacteremia, and sepsis (HPS, 2012; McCallum & Higgins, 2012). Due to all of these reasons, it is thought that PVC is applied too much; accordingly, PVC care becomes even more important since catheters are a risk factor for development of hospital-borne infections.

Conclusion and Recommendations: In this study, colonization was identified in slightly more than half of the control group (58.8%) in

whom no PVC care beyond the standard protocol was provided. No colonization was detected in the group where PVC care was provided with 10% poviodine (the experimental group). The study's results suggest the following recommendations:

- PVC care should be provide, because PVC is the most common type of catheter used in hospitals
- Conduct numerous studies with larger sample groups on this subject
- It is suggested that studies done about care of PVC with different antiseptics
- Service training programs may be advisable to raise awareness about the effectiveness of PVC care in preventing infections

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