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Routine Replacement or Clinically Indicated Replacement of Peripheral Intravenous Catheters

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SAF and EP designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors EKL and AGK managed the analyses of the study. Author SAF managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Intravenous catheter replacement time is still one of the challenges before care systems. Replacement of the catheter after 72 hours is now implemented in many treatment centers.
Aim: The aim of this study was to determine the complications of peripheral intravenous catheters 72 and 96 hours after indwelling.
Methods: This clinical trial study was conducted on 123 patients with the inclusion criteria and the subjects were chosen by block randomization. The catheter insertion site was assessed by the nurses of the surgery ward using Infusion Nurses Society scales on assessment of leaking, infiltration and phlebitis, and assessing the signs of obstruction. If the signs of complication were

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not observed, the catheters were assessed up to 72 hours in the control group and up to 96 hours in the intervention group. The data were analyzed using descriptive and inferential statistics such as the Chi-square, Mann Whitney, Fisher's exact test, Kruskal Wallis and logistic regression.
Results: There was no significant difference in the complications (phlebitis, infiltration, leakage and obstruction) of the two groups of catheter for 72 hours and up to 96 hours. But comparing the complications in the two groups of control and intervention before and after 72 hours showed significant statistical differences (phlebitis p=0.0001, infiltration and leakage p=0.014, obstruction p=0.002). These complications were less in catheters in the intervention group during 72-96 hours.
Conclusion: The results of this study indicate that the catheters can keep in the site to 96 hours if they do not have complications after 72 hours. It seems that by assessing intravenous lines using standard scales for assessing the catheter insertion site, unnecessary catheter changes can be prevented. Therefore, patients experience less pain and nurses' time and equipment will be saved.

Keywords: Peripheral catheterization; nursing; inpatients.

1. INTRODUCTION

Peripheral venous catheter care is an important component of nursing care [1]. Intravenous care is done for millions of patients all around the world for delivering fluids, medicines and nutrients [2]. Approximately 70% of all patients need intravenous catheters and nearly 200 million intravenous catheters are used annually only in the US [3]. Using intravenous catheters may have serious complications for patients [4]. Phlebitis, with symptoms including pain, swelling, redness and occlusion, are common complications of peripheral intravenous catheters [5]. Phlebitis is the most common complication of intravenous catheters and occurs in 2.5% to 70% of all intravenous catheters [6,7]. Different ranges of complications concerning intravenous catheters were reported in studies with different designs [8], therefore, estimations of complication rates are different [9]. Infection of the bloodstream and in-situ infection are seen in 0.08% and 2.3%, respectively, as the complications of intravenous catheters [7].

There is great controversy over the main causes of complications in intravenous catheters [10]. Catheter indwelling time is believed to be the main cause of complications in intravenous catheters [4]. It is recommended that all intravenous catheters must be changed routinely to increase their complications [3]. The guideline of Center for Disease Control and prevention (CDC) in 2011, recommended that there was no need to replace peripheral catheters more frequently than every 72-96 hours to reduce the risk of infection and phlebitis in adults. This guideline did not change in the last update in 2017 [11]. Infusion Nurses Society (INS) emphasized changing intravenous catheters based on clinical signs of complications in 2016 [12].

Changing catheters regularly when there is no serious complications may lead to unwanted complications for patients, such as unnecessary needling and an increase in the workload of staffs [3]. In the US, 330 million catheters are sold annually and if changing catheters is not done routinely in 15% of all patients who need catheters for more than 3 days, it can prevent 6 million unnecessary inserting of catheters, 2 million hours of staff's workload and 60 million dollars decrease in costs [13]. If we try to keep the uncomplicated catheters for more than 72 hours, it will help calm patients [14].

The results of some studies in Australia have shown no significant difference between the complications of catheters that remain below or over 72 hours [15,16]. The results of a retrospective study showed that there was no significant difference between complications of intravenous catheters in 72 and more than 96 hours duration [17], but the results of an Italian study showed that a 24-hour increase in the indwelling time of a catheter can increase the risk of phlebitis by 5% [18].

It seems clinical evidence is not enough to determine the exact time needed to change peripheral intravenous devices. This study tries to find out what complications the difference of catheters lasting longer and/or less than 72 hours can make.

2. METHODS AND MATERIALS

2.1 Aim

The aim of this study was to detect the complications of peripheral intravenous catheters 72 and 96 hours after indwelling.

2.2 Design

This is a randomized clinical trial study. In order to be consistent with the received drugs, the duration of receiving drugs and the coincidence of the disease was executed in patients after coronary artery bypass grafting surgery in the heart surgery ward.

2.3 Samples

123 patients who had the inclusion criteria participated in the study. The inclusion criteria of the study were: needing an intravenous catheter for more than 72 hours, without any history of peripheral vascular diseases, without any history of immunosuppressive drug use, and without sepsis and valvular heart disease (all based on medical records). All subjects had to be ordered for one type of sensitivity to intravenous antibiotics. Signing of the consent form was the other criteria to participate in the study.

Exclusion criteria were prescribed drugs including antibiotics change - because all subjects receive only one type antibiotic by intravenous catheters, sensitivity to intravenous device dressing, blood transfusion, and the removal of the catheter by accident.

2.4 Validity and Reliability

Standard phlebitis and intravenous site infiltration checklist was used. This tool was designed based on the signs of phlebitis on the entry site of the intravenous device that have scores from 0 to 4. Score 0 meant 'without signs of phlebitis and infiltration' and score 4 meant 'severe signs' consisting of patients' reported pain or tenderness, erythema, swelling, and the cord beyond the intravenous catheter tip more than 2.5 cm.

The checklist tool for detecting the leakage had scoring from 0 to 4. Score 0 meant 'without signs of infiltration' and score 4 meant pale skin color in the site of the indwelling catheter, swelling and color changing to blue, edema more than 15 cm around the site, deep pitting edema, skin sensitivity, and the blockage of the intravenous route that is characterized by a lack of forward movement of the injectable fluid, even after the aspiration of the intravenous line for one time.

The checklist of phlebitis and leakage of the inserting site of intravenous catheter was validated by Groll et al. in 2010 [19], and was subsequently entered in the nursing reference books, therefore, we did not need to confirm the validity and reliability of these tools.

2.5 Sample Size Estimation and Sampling Method

Sample size estimation was done by the results of Barker et al's study [20] with two tailed $\alpha=0.01$, 95% power. Based on this study, 48 samples were considered for each group. But in view of Rickard et al's findings [17], approximately 36% attrition rate was reported of patients during 72 hours, 75 samples were estimated for the intervention group (by having more than 72 hours of the intravenous catheter) and overall, the study was done on 123 subjects. Sampling was done using the random block sampling method and by a computer-generated random block list.

2.6 Data Collection

This study was done in the heart surgery wards on patients after they had undergone coronary artery bypass grafting surgery and after they were transferred from the intensive care unit to the ward. In these wards, all patients are given one type of antibiotics. These wards were selected because all patients were ordered one type of crystalloids and antibiotics (cefazolin was the antibiotic that was prescribed for all patients after the surgery). Similarly, crystalloids and antibiotics were also the inclusion criteria of the study. In these wards, all catheters are changed routinely after 72 hours even without reports of any complications. This protocol is set by the Ministry of Health and Medical Education (MOHME) for all therapeutic centers to reduce infection by peripheral catheters. In the control group, replacing catheters was done routinely in 72^{nd} hour even without complications. In the intervention group, if the patient's catheter did not have any complications it was not replaced up to 96 hours and, in that time, if any complications were reported the intravenous device was replaced.

Complications in each of the shifts were assessed by the nurses in the wards who were trained by one of the members of the research team and all observations were recorded by them. For all samples, a demographic data form was filled by the researchers. This form included the age and sex of the patient and his/her diagnosis, use of anticoagulant drugs,

BMI, underlying diseases, and the history of smoking and drug abuse. The type and amount of crystalloids, date and hour of placing the intravenous device, inserting site, catheter indwelling time and reason of replacing were documented.

For all of the patients in the intensive care unit, an intravenous catheter was inserted before entering the surgical wards. To insert the catheter, first, the skin of the site was cleaned using ethanol 70%. For all samples, a specific type of catheter, a brand with a French 20, was used. In this step, an identification code was written on the dressing of the intravenous catheter. All of the steps are shown in Fig. 1.

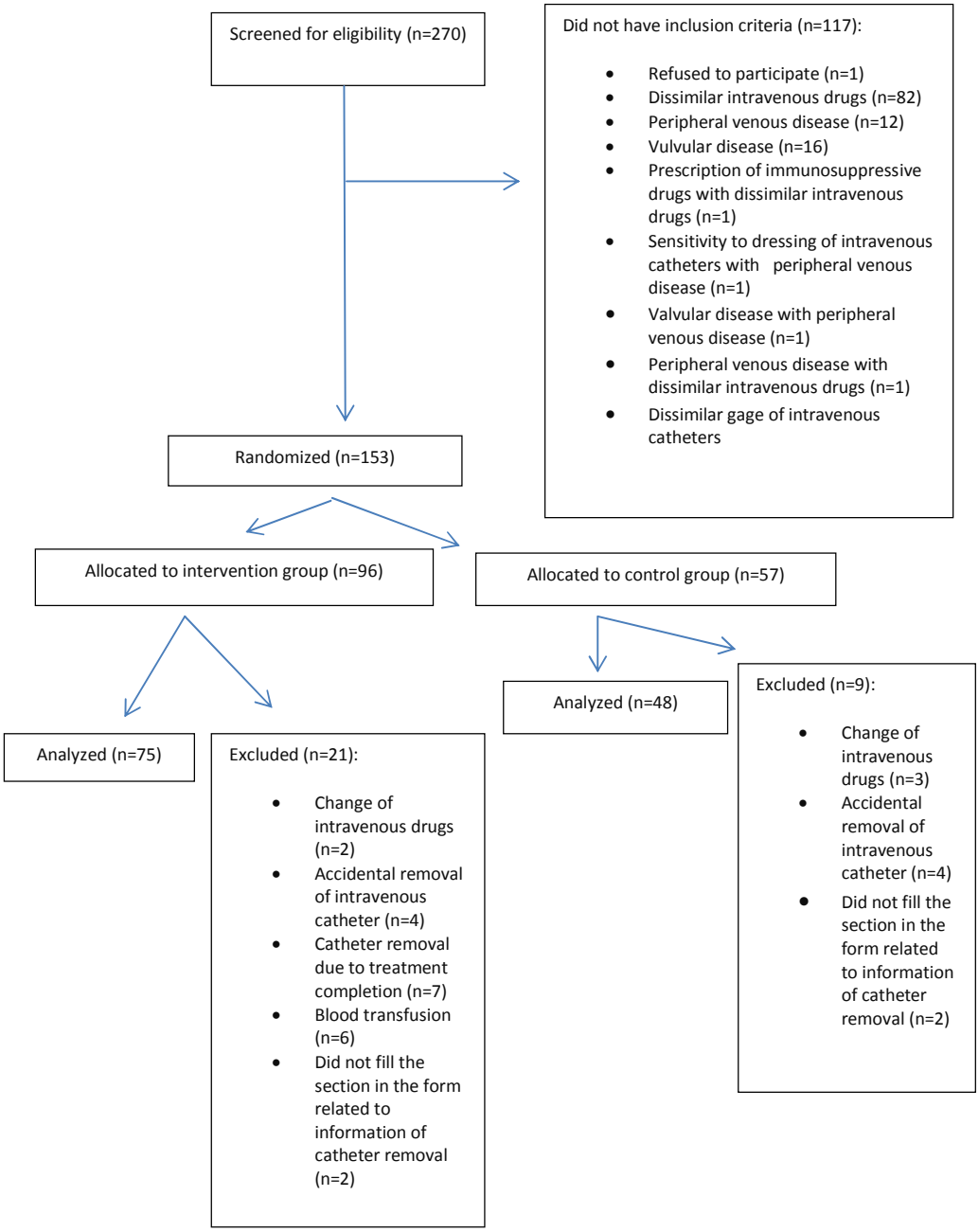

Fig. 1. Participant flowchart

3. RESULTS

The results of this study showed that the majority of samples in the control and intervention groups were males with ages over 60. Other demographic variables and the variables related to the illness are shown in Table 1. The Chi-square and independent T tests showed that demographic and illness-related factors did not have a significant difference in the two study groups.

The inserting site in the two groups was similar and in the majority of samples in the two groups it was in their forearm. Mean time duration in the intervention group was 66.33±28.88 and in the control group it was 58.38±18.80. The difference between them was not significant (p=0.093). Occurrences of occlusion, leakage and phlebitis were similar in the two groups, though the difference on phlebitis was near the level of significance (p=0.052). The sum of occurrences of complications in the two groups was significant based on the Chi-square test (p=0.047). The difference of complication numbers in the two groups was significant (p<0.07). The Chi-square test showed a significant difference (p=0.001) between complication occurrence in the control group and the intervention group with changing before 72 and after 72 hours. In the intervention group who were assessed with 96 hours, 14.3% of catheters were changed due to complications and 85.7% were changed without complications (Table 2). In the other words of the 75 intravenous catheters that were supposed to be replaced for up to 96 hours in the absence of a complication, 40 catheters were changed due to complications before 72 hours. Only 35 catheters remained uncomplicated until 96 hours. Of these 35 catheters, only 5 catheters had phlebitis and 30 catheters were uncomplicated at the time of the change at 96 hours.

Catheter changing time in all of the subjects had a significant relationship with sex (p=0.041), BMI (p=0.004), catheter insertion site (p=0.022) and history of diabetes (p=0.015). Logistic regression showed women vs men (p=0.009, OR=3.37, CI 95% for OR=1.347-8.171) and catheter insertion site are significant predictors of catheter complications. In addition, hand vs antecubital (p=0.025, OR=12.291, CI 95% for OR=1.367-110.513), and forearm vs antecubital (p=0.017, OR=2.99, CI 95% for OR=1.214-7.409) had more risk for intravenous catheter complications. Logistic regression showed an unexpected result about complications in diabetic patients. This result showed no diabetic patients had more risk for complication compared to diabetic patients (p=0.006, OR=3.202, CI 95% for OR=1.403-7.304) (Table 3).

4. DISCUSSION

In this study, complications of intravenous catheters were evaluated. Phlebitis is a common complication of the intravenous catheter insertion site. The severity of phlebitis in the subjects in this study was in grades 1 and 2. Our findings were consistent with the results of Pasalioglu and Kaya's study, in which the majority of phlebitis were grade [4]. These findings were in accordance with the findings of numerous studies [18,21]. In the studies of Powell et al. [14] and Uslusoy and Mate [22], who used a phlebitis assessment tool similar to the one used in this study, the findings were similar to the findings of this study on the phlebitis grade. It should, however, be noted that the phlebitis assessment tools were different in different studies, and thus comparing different studies is difficult.

In this study, there were no significant differences on the frequency of phlebitis, leakage, infiltration and occlusion between the two groups. This finding shows that increasing catheter indwelling time to 96 hours cannot have an effect on the frequency of complications. In many studies, similar findings were reported. In these studies, catheter changing was done only after the occurrence of complications, and in many studies even after more than 96 hours, no complications occurred. In Rickard et al.'s study, complications did not have a significant difference in the two groups of study (routine change and changing clinically, indicated) [3]. In another study of Rickard et al, similar results were reported [15]. On the frequency of phlebitis, Webster et al.'s study showed no significant difference between phlebitis in the two study groups (routine catheter change group and changing based on complication occurrence) [16]. Many studies, on the other hand, showed different results, such as Nishanth et al. [23] and Barker et al.'s studies [20]. The difference in the findings of the studies may be due to the different methods used in them because, in these two studies, catheters were changed when signs of thrombophlebitis were reported. Our findings showed that the frequency of complication (each of the complications) did not have a significant difference in the two study groups. In Pasalioglu and Kaya's study [4], in which catheters without complications remain up to 120 hours, more catheters were changed after 48 hours due to

Table 1. Characteristics of study participants in two groups

Groups		Control group		Intervention group		Sig.
	Variables	Number	Percent	Number	Percent	
gender	male	36	75	46	61.33	P=0.117*
	female	12	25	29	38.66	
	total	48	100	75	100	
age	Mean ±SD	59.06±9.62		60.33±8.47		P=0.443**
	38-59 years	22	45.83	28	37.33	
	60-84 years	26	54.16	47	62.66	
	total	48	100	75	100	
BMI (kg/m2)	Mean ±SD	27.27±4.13		26.95±4.34		P=0.687**
	BMI≤25	16	33.33	30	40	
	25<BMI≤30	24	50	23	30.66	
	BMI>30	8	16.66	22	29.33	
	total	48	100	75	100	
Smoking history	yes	12	25	14	18.66	P=0.401*
	no	36	75	61	81.33	
	total	48	100	75	100	
Diabetes Mellitus	yes	25	52.08	35	46.66	P=0.558*
	no	23	47.91	40	53.33	
	total	48	100	75	100	
hypertension	yes	32	66.66	55	73.33	P=0.428*
	no	16	33.33	20	26.66	
	total	48	100	۷۵	100	
hyperlipidemia	yes	31	64.58	49	65.33	
	no	17	35.41	26	34.66	P=0.932*
	total	48	100	75	100	
hypothyroidism	yes	5	10.41	4	5.3	P=0.292*
	no	43	89.58	71	94.66	
	total	48	100	75	100	
Opium addict history	yes	7	14.58	13	17.33	P=0.687*
	no	41	85.41	62	82.66	
	total	48	100	75	100	
Using of anticoagulant agent	yes	47	97.91	75	100	P=0.209*
	no	1	2.08	0	0	
	total	48	100	75	100	

**Chi 2 test, ** Independent t test*

Table 2. Comparison of complications rate in two groups

Groups		Control group (change in 72 hours)		Intervention group				Total		Sig.
				change before 72 hours		Change between 72-96 hours				
Complications		Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Complications	no	28	58.3	0	0	30	85.7	58	47.2	P=0.001*
	yes	20	41.7	40	100	5	14.3	65	52.8	
	total	48	100	40	100	35	100	123	100	

** Chi2 test*

Table 3. Complications occurrences base on personal and clinical and catheter related variables

Variable	B	SE	P value	Odds ratio	95% CI for OR	
					Lower	Upper
Female vs male	1.199	0.460	0.009	3.371	1.347	8.171
Catheter insertion site			0.033			
Wrist vs antecubital	1.320	0.806	0.101	3.743	0.772	18.154
Hand vs antecubital	2.509	1.121	0.025	12.291	1.367	110.513
Forearm vs antecubital	1.098	0.461	0.017	2.999	1.214	7.409
Arm vs antecubital	0.079	0.757	0.917	1.083	0.245	4.777
No diabetics vs diabetics	1.164	0.421	0.006	3.202	1.403	7.304
constant	-2.692	0.795	0.001	0.068		

phlebitis. In Powell et al.'s study, a significant relationship between dwell times of intravenous catheters and phlebitis frequency was reported. Phlebitis was increased as dwell times increased, however, the phlebitis rate was reduced when catheters were maintained for more than 4 days [14]. This finding is consistent with our results which show that the number of catheters that remain to 96 hours had lower complications versus the number of catheters that were changed before 72 hours due to complications. In our study, according to the policies of the health system, we had to maintain catheters up to 72 hours even when they did not have any complications. But in many studies, a routine change was done in 96 hours dwell times.

In our study, the patients in the two groups did not have significant differences in variables that could affect catheter complications such as age, sex, BMI, and underlying diseases. In addition, the needle gage of catheters and the prescribed drugs were the same for all subjects. Thus complication occurrences may be due to the dwell time. Based on our findings, it could be said that in patients with better veins and without catheter complications, the catheter may be maintained after 72 hours.

Based on the regression model, the insertion site was a relevant factor in catheter complications and the use of antecubital was accompanied by lower complications in comparison to other sites of hands. Wallis et al showed that the lowest danger of catheter complications was in the forearm [5]. Cicolini et al. showed that the hand, compared to antecubital, increased complications [21]. Different findings in different studies may be related to their different subjects and the different settings of their studies. Skin pathogens of patients and poor hygiene of the inserter can also affect complications and reduce indwelling time. In our study, all of the subjects were admitted to the cardiac surgery ward due to the similarity of the intravenous antibiotics and fluids that were administered to them. All of these factors can influence catheter complications. Our findings were able to answer this question: if catheters do not show any complications and the intravenous line is opened, do we have to change catheters after 72 hours due to our health system policy? It seems we need to do more research to show it is necessary to reconsider our policies about it.

In this study, signs of complications were assessed in all shifts and as doing it singlehandedly and by one person was not possible, we trained all the nurses in the ward and put checklists in the medical documents of all patients. We asked all nurses to fill this checklist if they saw any signs of complications and change the catheters. This situation may have affected our findings since we were not able to observe all complications ourselves.

In this study, the intravenous devices were inserted by different nurses and it may have influenced our findings. Based on our findings, it seems we need to do more research on this topic to bring about suitable policies about it.

5. CONCLUSION

The results of this study indicate that the catheters can keep in the site to 96 hours if they do not have complications after 72 hours. It seems that by assessing intravenous lines using standard scales for assessing the catheter insertion site, unnecessary catheter changes can be prevented. Therefore, patients experience less pain and nurses' time and equipment will be saved.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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