Survey of Complications of Peripheral Venous Catheterization at an Intensive Care Unit of (ICU) of Susa City

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Abstract

Background: Peripheral catheters are the most common invasive procedures in patients, and have several therapeutic uses, yet result in infectious and non-infectious complications as well as problems such as pain and bruising, drug and fluid leakage out of the vessels, ecchymosis, hematoma, thrombosis, embolism, infection and phlebitis.

Objectives: The aim of this study was to evaluate the complications of peripheral veins catheterization and some related factors at an intensive care unit (ICU) of Susa city.

Methods: This descriptive cross sectional study was conducted on 224 catheters in patients, who were hospitalized for at least 48 hours at the intensive care unit. Data was collected through a questionnaire (demographic information, medications, catheter number, catheter site and placement) and a checklist of catheter mechanical complications and phlebitis checklist. Review of the catheter site was done as well (at first, second, third and fourth, twelfth hour). To analyze the data, descriptive and analytical statistics (chi-square and Mann-Whitney) were used, and the significance level was considered as P < 0.05.

Results: The highest frequency was found in the age group of 30 to 60 years old. Results showed no significant correlation between age and incidence of complications and phlebitis, the insertion of catheter, and catheter assembly site (P > 0.05). A significant correlation was reported between variables such as type of drugs, catheter survival time, and work shift (P < 0.05).

Conclusions: Due to mechanical problems and phlebitis caused by peripheral catheters, choosing the right location and proper care and management of catheters can reduce the risk of complications and prevent overload to the patient and system due to increased skills by using educational programs.

Keywords: Peripheral Venous Catheterization, Complications, Phlebitis

1. Background

Peripheral venous catheter (PVC) is made of flexible plastic hollow tubes that are placed inside peripheral vessels, are mainly placed in the hand metacarpal vein, cephalic and basilica veins of the forearm (1). It is the most common invasive procedure in hospitalized patients (2). It is applied in a wide range of clinical procedures including intravenous administration of drugs, intravenous hydration and transfusion of blood and blood products as well as during surgery, emergency care, and in other situations in which direct access to the blood flow is needed (3). More than 80% of patients receive intravenous treatments via peripheral venous catheter and prescribing intravenous drugs is an integral part of nursing care (4). In the United States of America about 200 million venous catheters are annually inserted, which are estimated up to 450 million. It is reported up to 5 million annually in Sweden (5). In Great Britain, one out of three patients has a venous catheter (6). Also, according to one research in Yazd 50% and Tehran 55% of the hospitalized patients received intravenous treatment, indicating the extent of using these therapeutic methods in the country (7). These values are 15 times more than central venous catheters, so they are worth paying attention, but are far less considered compared to central venous catheters (8).

Peripheral catheters have several therapeutic uses, but they result in infectious and non-infectious complications and problems such as pain and bruising, extravasation, ecchymosis, hematoma, thrombosis, embolism, infection

and phlebitis. The most common complication is phlebitis (9). Phlebitis is affected by various factors such as catheter size, thickness and length, combination of catheter components, duration of catheter insertion, the number of catheterization, insertion site, drug and solvent concentration, flow rate of drug, sterilization method, type of coating used to fix the catheter and catheter infusion rate and catheter substitution (10). Rickard et al. (2012) reported that the prevalence of phlebitis was 2.6% to 67.2% (11). Iranian studies reported phlebitis rate as 54.8% in Tabriz, 67% in Kurdistan, and 85.7 to 98.1% in Tehran (7, 12, 13).

In addition to infection and phlebitis of peripheral catheters, non-infectious complications such as pain and bruising, patient anxiety, infiltration, inadvertent arterial puncture and injuring a nerve as well as extravasation, ecchymosis, hematoma, thrombosis and embolism are also common (9). Peripheral catheters often fail or break before the end of treatment, which, according to studies, this rate reaches 33% to 69%, which is often due to accidental extravasation from the main vein or part of the angiocatheter from the vessel (14). A study by Fletcher (2011) showed that the incidence of thrombosis related to major vascular resulted from peripheral catheter at the ICU in 8.4% and 15% of cases caused pulmonary embolism (15). It is the catheterization complications that lead to prolongation of hospitalization for on to three weeks and subsequently increase in the cost of treatment from 30,000 to 50,000 dollars. The costs are three to five times more than the cost of hospitalization in public wards and prevalence of deaths is 12 to 25% (16).

At the ICU, due to the complexity of the patient's condition and treatment process, many electronic devices and equipment, lack of awareness of patients and their dependence on others, increased use of high-risk and life-saving medicines and other medical procedures, peripheral veins catheterization is very important and prescribing intravenous drugs is an integral part of nursing care (4). From all catheters used in hospitals, 80000 are used at the ICU (16).

The aim of this study was to evaluate the complications of peripheral venous catheters in intensive care units of Shush Nezam Mafihospital. By presenting the results of this research to health care and education authorities and managers, it is hoped that steps are taken to address problems.

2. Methods

This was a descriptive cross-sectional study with the sample size calculated as 224 after a pilot study with 95% confidence and accuracy of 5%, which included patients at the Intensive care unit (ICU) and coronary care unit (CCU) of NezamMafi hospital. The total sample size was determined by the following formula: P = 0.3, α = 0.05, q = 0.70, z = 1/96, n = pqz - (1-α/2)/[(0.15 + p)]^2.

Data was collected from April to June 2015, during a four-month period. The aim was to determine the effect of catheter indwell time on the development of phlebitis during PVC. Samples were observed on admission and establishing intravenous line and for the next 48 hours. Inclusion criteria included underlying diseases such as leukemia, vascular diseases, immunodeficiency, hemodialysis and dermatitis, having healthy upper limb, the same catheter (angiocatheter) in all patients in terms of the same manufacturer, using alcohol as a disinfectant prior to using catheter, lack of sensitivity to drugs and adhesive. Data were collected using a questionnaire consisting of three parts, namely, 1. Demographic data (age and type of illness), 2. Information related to intravenous therapy, including the type of drugs (antibiotics, serum therapy, anticoagulants, etc.), number of venous catheters (16-19), the catheter place (back of the hand, forearm, antecubital, on feet and knees), the venous catheter placement (emergency and non-emergency), 3. A checklist of catheterization complications (bleeding, leakage, ecchymosis, obstruction and extravasation) and signs and symptoms of phlebitis based on visual infusion phlebitis assessment scale (VIPAS), with four grades. Zero indicates the absence of phlebitis signs and symptoms (pain, redness and swelling), score 1 means swelling, rigidity and redness (erythema), untouchable but dangerous vein, score 2 means untouchable but dangerous and red vein, score 3 means red, swollen, painful and palpable vein with rigidity tangible up to around 7.5 cm above the injection site and score 4 means swollen, palpable and painful vein with more than 7.5 cm above the injection site being rigid (20); the creation time of phlebitis was also recorded on paper. Patients who were discharged before two day were excluded. The authors developed an Information form on peripheral venous catheter and treatment after review of relevant literature. The form collected data on the number of catheters; anatomical site and frequency of catheter administration per site; use of antibiotics and fluids; duration of catheter use; phlebitis development; phlebitis level; and whether the catheter had instruments like triple taps, vein valve, and Dosi-flow. The SPSS was used for analysis. Descriptive statistics (frequency distribution and mean) and inferential statistics (Mann-Whitney test and the chi-square) were used. For the questionnaire validity, the corrective comments of ten faculty members of the School of Nursing - Midwifery were used, and also for reliability, Cronbach's alpha test and scientific reliability coefficient were used. Code of the ethical approval was No. U-93186. The study was approved by the ethics committee of the Jundishapur

University of Medical Sciences.

3. Results

The results showed that the mean age of patients was 51.09 with a standard deviation of 21.742, and 17% were younger than 30 years while 33.9% were over 60 years old in CCU and ICU wards.

The most common diagnosis was related to ACS and MI (11.6%), CHF (10.7%) and AF (9.8%) and the least (1.8%) was reported for DKA.

The most common catheterization time was in the morning (45.5%), and the highest incidence of phlebitis 2 (18.85%). In other working shifts, catheterization was done equally at different times, probably due to being busy in the morning and routine replacement of catheters that according to chi-square test, statistical values showed no significant correlation between these two (P = 0.30) (Table 1).

The most common location of the catheter insertion was in the back of the hand (41.1%) and the least (2.7%) was the knee; 25% was reported in the forearm and antecubital site and 6.3% on foot, and the most common catheter used was size 20 (pink) (19.6%), size 18 (24.1%), size 22 (6.3%) and size 16. Overall, 39.35% of catheters were replaced before 24 hours, which showed a significant relationship with phlebitis (P = 0.001) (Table 1).

In this study, 34.8% received antibiotics and the most frequently used antibiotic was ceftriaxone, vancomycin and meropenem (6.3%) that were significantly associated with the incidence of phlebitis (P = 0.029). Overall, 19.6% of patients, who did not take antibiotics had phlebitis 1 and 2. Furthermore, 24.9% of patients received serum and 25% received anticoagulant drugs, such as heparin, streptokinase and cerebrolysin. For 23.3% of patients, maintenance medication like Lasix serum, nitroglycerin serum and insulin serum were used, and 9% of patients were infused amiodarone serum.

Table 2 shows the frequency distribution of venous catheters complications. Most complications (68.8%) were related to infiltration and least (5.4%) to thrombus formation and catheter blockage. In total, 96.42% of catheters with complications showed levels of phlebitis and statistical values showed significant correlation (P = 0.013). Infiltration complications, extravasation and bleeding, thrombus formation and blockage were significantly correlated with phlebitis, but ecchymosis had no significant relationship with phlebitis (P = 0.52). According to chi-square test, no significant correlation was reported between age and incidence of complications (P = 0.36).

Table 3 shows the frequency of phlebitis and grading and its relationship with patient's age, which was not significant (P = 0.20).

Table 4 shows the phlebitis grading and complication incidence during different hours. More signs of phlebitis were reported in fourth 12 hours. The relationship between complications and some catheter demographic characteristics are shown in Table 1.

The findings showed that according to chi-square test, statistical values showed no significant relationship between phlebitis and catheter placement method (emergency and non-emergency), (P = 0.79). The highest incidence of phlebitis was reported in the emergency stage and for grade 2 phlebitis.

4. Discussion

The findings showed that most common time of inserting peripheral venous catheter was in the morning and the average shelf life was two days. The incidence of infectious complications (phlebitis) and noninfectious (leakage, extravasation, ecchymosis and bleeding, blockage) are relatively high. It is remarkable that no significant relationship was found between complications and shelf life of catheter, medications, patient's age and phlebitis degree.

A study showed that more than half of the catheter insertions occur during night shifts and (35%) in the morning, and there was a significant relationship between infiltration and morning shift (p = 0.006), while it was also reported that infiltration during the night shift was 22.5% and phlebitis in the morning shift was 2.6% (39). In this study, in morning shift, the incidence of infiltration was higher than other side effects, and the relationship was significant in terms of statistical values (P = 0.05). The amount of ecchymosis (P = 0.01) and occlusion (P = 0.02) in the morning is more than other complications and was reported as significant. In this study, the catheter insertion time was more in the morning and infiltration, which is consistent with the mentioned study but there was no statistically significant association, which is probably because of differences in size and location of sampling (Table 1).

Previous studies showed a significant relationship between old age and incidence of complications, and symptoms of phlebitis and infiltration, where with increasing age, the risk of complications increases, with a significant association (18, 19, 21-23). Studies have shown that aging affects the complication rate, which is due to the fragility of patients' vessels (24). Some studies showed that no significant relationship exists between different age groups and complications (P = 0.79) (25, 26). In the present study, no significant relationship was found between age and incidence of side effects, which was consistent with other studies; this is probably due to the sample size and study area as well as age group of 30 to 60 years old (middle age), which

Table 1. The Incidence of Peripheral Venous Catheter Complications and its Relationship With Different Variables (Working Shift, Anatomic Location and Catheter Size) at the Intensive Care Unit

Complications/Variables	Bleeding and Leaving vessels	P-Value Chi-Square	Infiltration	P Value (Chi-Square)	Ecchymosis	P Value (Chi-Square)	Obstruction and Thrombosis	P Value (Chi-Square)
Morning shift	38 (54.3)		68 (47.9)		32 (55.2)		26 (34.2)	
Evening Shift	18 (25.7)	0.89	28 (19.7)	0.05	18 (31)	0.01	26 (34.2)	0.02
Night shift	14 (20)		46 (32.4)		8 (13.8)		24 (31.6)	
Back of the hand	30 (13.39)		64 (28.57)		20 (8.92)		34 (15.17)	
Forearm	16 (7.14)		28 (12.5)		16 (7.14)		12 (5.35)	
Antecubital	18 (8.03)	0.42	36 (16.07)	0.18	14 (6.25)	0.50	24 (10.71)	0.16
Top of feet	6 (2.67)		10 (4.46)		6 (2.67)		41 (1.78)	
Place of knee	0		40 (4.46)		2 (0.89)		2 (0.89)	
Gray 16 G	4 (1.78)		12 (5.35)		0		6 (2.67)	
Green 18 G	18 (8.03)	0.09	28 (12.5)	0.23	14 (6.25)	0.12	16 (7.14)	0.78
Pink 20 G	38 (16.96)		66 (29.46)		30 (13.39)		38 (16.96)	
Blue 22 G	10 (4.46)		36 (16.07)		14 (6.25)		16 (7.14)	

Table 2. Frequency Distribution of Peripheral Venous Catheter Complications and Relationship With Age and Phlebitis at the Intensive Care Unit[a]

Complications	No. (%)	MEAN AGE	Chi-Square P-Value	With Phlebitis	No Phlebitis	Mann-Whitney Test P Value
Bleeding and leaving vessels	28 (12.5)	49.6	56.31	31.255	68.755	0.068
Infiltration	152 (68.8)	47.67	0.31	63.39	36.60	0.001
Thrombosis and blockage	12 (5.4)	55.00	0.35	32.92	66.07	0.001
Ecchymosis	18 (8)	56.31	0.48	25.89	74.1	0.52
Uncomplicated	24 (10.71)	52.64	0.32	-	-	-

[a]Values are expressed as %.

Table 3. Frequency and Relationship Between Age and Phlebitis in Patients With Peripheral Venous Catheters at the Intensive Care Unit[a]

Phlebitis/Age, y	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4	P Value
Less than 30	0	8 (3.57)	14 (6.25)	6 (2.67)	10 (4.46)	
30 to 60	0	30 (13.36)	36 (16.07)	34 (15.17)	10 (4.46)	0.20
Over 60	4 (1.78)	18 (8.03)	30 (13.39)	58 (25.89)	6 (2.67)	

[a]Values are expressed as No. (%).

had the highest frequency, while age was not a risk factor in this study.

In 60.7% of patients, catheter was replaced after completion of this study; hospital's instructions on replacement of the catheter are 48 hours. Infiltration and obstruction has dedicated the highest percentage. In a study by Unbeck, examining the peripheral catheters' complications in 2015, most cases showed obstruction and fluid leakage (20). Another study in 2011 showed less incidence of obstruction (27). However, according to a study, infiltration detection is easier than other side effects and is considered in 36% of catheter removals (18). This difference can be attributed to drugs, type and size of the catheter and personnel skills.

In this study, angiocath replacement time was more in the first 24 hours and was indicative of a greater incidence of complications in the second 12 hours. This study is not in line with the study by Unbeck; catheter survival time was

Table 4. Frequency Distribution of Grading Phlebitis and Symptoms Incidence Time[a]

Phlebitis	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4		Total
Frequency percentage	1.8	25	35.7	25.9	11.6		100
Time of incidence of signs and symptoms	Pain	Sensitivity	Redness	Heat	Inflation	Vessel rigidity	Serum level reduction
12 hours	32.1	21.099	25.3	30.4	20.5	34.8	28.6
Second 12 hour	17.9	16.1	18.9	19.8	5.4	23.2	13.4
Third 12 hour	19.6	25.9	23.2	18.8	7.1	29.5	18.8
Fourth 12 hour	15.20	14.3	15.2	14.4	6.3	17	21.4

[a]Values are expressed as %.

less in infants until removal (fourth 12 hours) due to significant complications in children (20). The difference in the incidence of complications can be due to lower sample size and studied age group. Studies showed that clinical skill and competency in PVC could reduce the rate of complications (28). The study of Jackson showed that catheters that require removal before 72 hours have complications such as leakage, infiltration and extravasation (17). A study by Abolfotouh et al. (2014) reported that from the first 24 to 30 hours complications included extravasation and leakage and on the third day after insertion, all complications were involved (P = 0.0001) (29). In the present study, type of medication and complying with the standards had some effects on the shelf life of angiocath.

In a study by Tripathi et al. (2008), it was shown that catheter installation near the joint has a direct relationship with short shelf life and complications (30). In a study by Pasalioglu, the most common catheter installation area was reported in the forearm (59.9%) and wrist (25.1%). The shelf life of the catheter in this study (42.4%) was less than 48 hours (P < 0.0001), and 31.9% had a shelf life of between 49 and 96 hours (4) that is in line with this study. In a study by Johansson, Webster and Cicolini et al. it was shown that the most common location of the catheter was reported to be the back of the hand and forearm (10, 31, 32) and the antecubital had the highest frequency risk of thrombophlebitis. Akbari showed that there was no difference between the insertion place of catheter and complications (7). In a study by Nasiryani, the most common catheters used in the study were size 20 (42.72%) and most common insertion place (68.79%) was the forearm (33). In this study, the most prevalent catheter installation was in the back of the hand and most complications were related to infiltration and phlebitis 2 (35/7%), and no significant correlation was found between the location of the catheter installation and complications according to the chi-square test (P > 0.05) (Table 1).

A study showed that the most frequently used catheters were size 20 (37.8%), size 22 (36.6%) and size 18 (22.8%). This study showed that smaller catheters have complications two times more than other sizes (32). In this study, most side effects were related to catheter size 20 and no difference as in the size of catheter and complications (P > 0.05) due to the use of this type of catheter in the present study.

A survey conducted by Uslusoy (2006) reported that phlebitis rates were very low in the first 24 hours (34, 35). Pasalioglu (2014) reported a phlebitis rate of 41.2%, and 90.1% had phlebitis grade 2 and 9.9% had grade 3, and it was noted that there is a relationship between shelf life of catheter and antibiotics, gender, anatomical location of catheter and results in phlebitis development (4). Another study reported the frequency of phlebitis as 1% to 79% (33). In a study by Nasiryani (2004), on the incidence of phlebitis in 159 patients, the following complication rates were reported, 16.29% redness, 22.22% tenderness and 44.8% stiffness of the arteries (33). In this study, the incidence of phlebitis was reported more in the second 24 hours, and the most common type was grade 2 (35.7%). There are various reports of phlebitis incidence and low grades of phlebitis in some studies and the length of incidence time may be a sign of more attention and better training than previous years and staff skills.

Nasiryani reported that the prevalence of superficial phlebitis is increased by taking intravenous antibiotics and decreased with using heparin (33). Another study reported that direct heparin injection into a vein has a potential impact on thrombophlebitis creation (21). A study showed that catheters that have anticoagulant (heparin and Urokinase) prevent complications (36). In another study on examining venous catheters in children, it was suggested that washing the catheter route with diluted heparin once every two weeks prevents complications (37). In this study, 24% of the catheters with heparin, streptokinase and cerebrolysin were complicated by phlebitis, with statistical values indicating a significant relationship (P <

0.05). In this study, no significant relationship was found between the use of antibiotics and anticoagulant (P = 0.62). Nonetheless, a significant relationship was found among the maintenance drugs (Lasix serum, amiodarone, nitrates and pantoprazole) (P < 0.05). Due to the difference in the results of various studies, other factors may affect the complication incidence that can result in bias.

Inserting a catheter in emergencies is associated with infections due to non-compliance with the conditions for sterilization (1). In this study, 53.5% of the catheters were associated with complications, which comply with the study by Qorbani that emergency insertion of catheters increases the risk of phlebitis by 2.5 times (38). Also infectious diseases is one of the factors of suffering phlebitis that may be due to the nature of the disease and antibiotics. In the study by Qorbani, infected patients (74.6%) had phlebitis that matched another study (38). Given the high prevalence of phlebitis, it is recommended to do further training on how to inset and take care of intravenous catheters (39). However, no significant relationship exists between catheter placement and complications of phlebitis (P = 0.79), which may be due to less catheterization in an emergency condition.

Phlebitis and its other complications are potential dangerous source for systemic infections and with the presence of phlebitis, the risk of developing these infections increases by 18 times (12). The high rate of complications is likely due to absence of a proper standard protocol in vein puncture and critical situations and needs for immediate interventions, which can affect the quality of catheterizations and its subsequent care (31).

The limitations of this study were the low sample size, not reviewing the personnel performance and how standards were observed. It is recommended to conduct studies in this regard in the most prolific hospitals and with higher number of beds, to perform effective and affordable interventions to address these problems.

4.1. Conclusions

The results showed that the proper selection and management of peripheral venous catheterization could allow longer use of the available catheter for antibiotic therapy and anti coagulant and maintenance treatment, without the lethal complications. To reduce the complications of these procedures, the nurses' clinical skills and standards should be considered to prevent dangerous complications and additional costs to the system and the patient.

Acknowledgments

Footnotes

References

1. O'Grady NP, Alexander M, Burns LA, Dellinger EP, Garland J, Heard SO, et al. Guidelines for the prevention of intravascular catheter-related infections. *Am J Infect Control.* 2011;**39**(4 Suppl 1):S1–34. doi: 10.1016/j.ajic.2011.01.003. [PubMed: 21511081].

2. Gonzalez Lopez JL, Arribi Vilela A, Fernandez del Palacio E, Olivares Corral J, Benedicto Marti C, Herrera Portal P. Indwell times, complications and costs of open vs closed safety peripheral intravenous catheters: a randomized study. *J Hosp Infect.* 2014;**86**(2):117–26. doi: 10.1016/j.jhin.2013.10.008. [PubMed: 24373830].

3. Ortega R, Sekhar P, Song M, Hansen CJ, Peterson L. Peripheral intravenous cannulation. *N Eng J Med.* 2008;**359**(21):ee26. .

4. Pasalioglu KB, Kaya H. Catheter indwell time and phlebitis development during peripheral intravenous catheter administration. *Pak J Med Sci.* 2014;**30**(4):725–30. [PubMed: 25097505].

5. Zingg W, Pittet D. Peripheral venous catheters: an under-evaluated problem. *Int J Antimicrob Agents.* 2009;**34 Suppl 4**:S38–42. doi: 10.1016/S0924-8579(09)70565-5. [PubMed: 19931816].

6. Boyd S, Aggarwal I, Davey P, Logan M, Nathwani D. Peripheral intravenous catheters: the road to quality improvement and safer patient care. *J Hosp Infect.* 2011;**77**(1):37–41. doi: 10.1016/j.jhin.2010.09.011. [PubMed: 21130520].

7. Akbari H, Raufi S, Anbari K. Comparaing the effect of Nitroglycerin and Clobetazol Ointments on Prevention of Superficial Intravenous Catheter Induced Phlebitis. *Evid Base Care.* 2014;**4**(1):71–80.

8. Dudeck MA, Horan TC, Peterson KD, Allen-Bridson K, Morrell G, Pollock DA, et al. National Healthcare Safety Network (NHSN) Report, data summary for 2010, device-associated module. *Am J Infect Control.* 2011;**39**(10):798–816. doi: 10.1016/j.ajic.2011.10.001. [PubMed: 22133532].

9. Dougherty L, Braver K, Gabrie J, Kayle J. Standarts for infusion therapy. London: Royal collage of nursing; 2010.

10. Webster J, Clarke S, Paterson D, Hutton A, van Dyk S, Gale C, et al. Routine care of peripheral intravenous catheters versus clinically indicated replacement: randomised controlled trial. *BMJ.* 2008;**337**:a339. doi: 10.1136/bmj.a339. [PubMed: 18614482].

11. Rickard CM, Webster J, Wallis MC, Marsh N, McGrail MR, French V, et al. Routine versus clinically indicated replacement of peripheral intravenous catheters: a randomised controlled equivalence trial. *Lancet.* 2012;**380**(9847):1066–74. doi: 10.1016/S0140-6736(12)61082-4. [PubMed: 22998716].

12. Aliromaei N. Evaluation of intravenous catheter-related phlebitis in hospitalized patients ICU. *J Nurs Midwifery.* 2008;**6**(3):127–34.

13. Shabanloie R. An audit of access prepheral catheter.first confferance of clinical audit. *Tabriz Univ Med Sci.* 2012;**2**.

14. Bolton D. Improving peripheral cannulation practice at an NHS Trust. *Br J Nurs.* 2010;**19**(21):1346. doi: 10.12968/bjon.2010.19.21.79998. [PubMed: 21355359] 1348-50.

15. Fletcher JJ, Stetler W, Wilson TJ. The clinical significance of peripherally inserted central venous catheter-related deep vein thrombosis. *Neurocrit Care.* 2011;**15**(3):454–60. doi: 10.1007/s12028-011-9554-3. [PubMed: 21541826].

16. Sk T. Quality Indicators in Critical Care: Patient safety. *Indian J Crit Care Me.* 2009:31–3.

17. Jackson A. Retrospective comparative audit of two peripheral IV securement dressings. *Br J Nurs.* 2012;**21**(2):10.

18. Wienbeck S, Fischbach R, Kloska SP, Seidensticker P, Osada N, Heindel W, et al. Prospective study of access site complications of automated contrast injection with peripheral venous access in MDCT. *AJR Am J Roentgenol.* 2010;**195**(4):825–9. doi: 10.2214/AJR.09.3739. [PubMed: 20858804].

19. Saini R, Agnihotri M, Gupta A, Walia I. Epidemiology of infiltration and phlebitis. *Nurs Midwifery Res J.* 2011;**1**(7):22–33.

20. Unbeck M, Forberg U, Ygge BM, Ehrenberg A, Petzold M, Johansson E. Peripheral venous catheter related complications are common among paediatric and neonatal patients. *Acta Paediatr.* 2015;**104**(6):566–74. doi: 10.1111/apa.12963. [PubMed: 25655941].

21. Hirschmann H, Fux L, Podusel J, Schindler K, Kundi M, Rotter M, et al. The influence of hand hygiene prior to insertion of peripheral venous catheters on the frequency of complications. *J Hosp Infect.* 2001;**49**(3):199–203. doi: 10.1053/jhin.2001.1077. [PubMed: 11716637].

22. Lanbeck P, Odenholt I, Paulsen O. Dicloxacillin: a higher risk than cloxacillin for infusion phlebitis. *Scand J Infect Dis.* 2003;**35**(6-7):397–400. [PubMed: 12953952].

23. Rego Furtado LC. Incidence and predisposing factors of phlebitis in a surgery department. *Br J Nurs.* 2011;**20**(14):S16-8–S22 passim. [PubMed: 21841668].

24. Forberg U, Johansson E, Ygge BM, Wallin L, Ehrenberg A. Accuracy in documentation of peripheral venous catheters in paediatric care: an intervention study in electronic patient records. *J Clin Nurs.* 2012;**21**(9-10):1339–44. doi: 10.1111/j.1365-2702.2011.03949.x. [PubMed: 22243530].

25. Salgueiro-Oliveira A, Parreira P, Veiga P. Incidence of phlebitis in patients with peripheral intravenous catheters: The influence of some risk factors. *Aust J Adv Nurs.* 2012;**30**(2):32.

26. Kethireddy S, Safdar N. Urokinase lock or flush solution for prevention of bloodstream infections associated with central venous catheters for chemotherapy: a meta-analysis of prospective randomized trials. *J Vasc Access.* 2007;**9**(1):51–7.

27. McCallum L, Higgins D. Care of peripheral venous cannula sites. *Nurs Times.* 2012;**108**(34-35):12. [PubMed: 22953419] 14-5.

28. Dillon PW, Jones GR, Bagnall-Reeb HA, Buckley JD, Wiener ES, Haase GM, et al. Prophylactic urokinase in the management of long-term venous access devices in children: a Children's Oncology Group study. *J Clin Oncol.* 2004;**22**(13):2718–23. doi: 10.1200/JCO.2004.07.019. [PubMed: 15226339].

29. Abolfotouh MA, Salam M, Bani-Mustafa A, White D, Balkhy HH. Prospective study of incidence and predictors of peripheral intravenous catheter-induced complications. *Ther Clin Risk Manag.* 2014;**10**:993–1001. doi: 10.2147/TCRM.S74685. [PubMed: 25525365].

30. Tripathi S, Kaushik V, Singh V. Peripheral IVs: factors affecting complications and patency–a randomized controlled trial. *J Infus Nurs.* 2008;**31**(3):182–8. doi: 10.1097/01.NAN.0000317704.03415.b9. [PubMed: 18496062].

31. Johansson ME, Pilhammar E, Khalaf A, Willman A. Registered nurses' adherence to clinical guidelines regarding peripheral venous catheters: a structured observational study. *Worldviews Evid Based Nurs.* 2008;**5**(3):148–59. doi: 10.1111/j.1741-6787.2008.00105.x. [PubMed: 18373638].

32. Cicolini G, Bonghi AP, Di Labio L, Di Mascio R. Position of peripheral venous cannulae and the incidence of thrombophlebitis: an observational study. *J Adv Nurs.* 2009;**65**(6):1268–73. doi: 10.1111/j.1365-2648.2009.04980.x. [PubMed: 19374679].

33. Nasiryani K. Prevalence of preipheral vein catheter infection in hospital in 2004. 13th disease congress. Tehran. Pasteur institute iran; .

34. Uslusoy E, Mete S. Predisposing factors to phlebitis in patients with peripheral intravenous catheters: a descriptive study. *J Am Acad Nurse Pract.* 2008;**20**(4):172–80. doi: 10.1111/j.1745-7599.2008.00305.x. [PubMed: 18387013].

35. Sum W, Ridley LJ. Recognition and management of contrast media extravasation. *Australas Radiol.* 2006;**50**(6):549–52. doi: 10.1111/j.1440-1673.2006.01626.x. [PubMed: 17107526].

36. Ulusoy S. The prevention of intravasculer catheter infections guides. *J Hosp Infect.* 2005;**9**(1):15–26.

37. Tohid HB, Sim NK, Lin LM. Extending the use of peripheral intravenous catheter and administration sets from 72 hours to 96 hours. *Singapore Nurs J.* 2005;**32**(2).

38. Gorbani R, Nasajizavare MGG. The incidence of thrombophlebitis associated with peripheral venous catheters in adult patients hospitalized in teaching hospitals in Semnan. *J Q Monitor.* 2005;**4**(3):175–80.

39. Hadaway L. Short peripheral intravenous catheters and infections. *J Infus Nurs.* 2012;**35**(4):230–40. doi: 10.1097/NAN.0b013e31825af099. [PubMed: 22759827].