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Clinical nurses' knowledge and practices on routine care related to the prevention of complications of peripheral intravenous therapy: A cross-sectional study

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Abstract

Aim: The aim of this descriptive and cross-sectional study was to determine the knowledge and practices of nurses related to the prevention of peripheral intravenous therapy (PIT) complications, and to identify the influencing factors.

Methods: The study adopted a cross-sectional and descriptive design and was conducted between April and August of 2018 with a total of 214 clinical nurses. The data collection tools employed were a 12-item sociodemographic questionnaire and a 16-item questionnaire on knowledge and practices related to the prevention of peripheral intravenous therapy complications.

Results: The mean knowledge scores of the nurses were found to be 81.54 ± 12.06 (min: 50, max: 100). No statistically significant difference was found to exist between the scores, and the variables of the nurses' gender, length of employment in the health profession, type of work, training received related to PIT complications, and self-competence level in PIT complications.

Conclusion: The nurses were found to have high knowledge levels; however, their practices for preventing PIT complications differed. Standardized practice procedures and workplace training are needed in order to transform nurses' knowledge into practice with regard to the prevention of PIT complications.

Keywords

Intravenous catheter, nurse, nursing practices, peripheral intravenous therapy, peripheral intravenous therapy complications

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Introduction

Peripheral intravenous therapy (PIT) is a common procedure in today's clinical setting.[1] In order to manage fluid, electrolyte, and acid–base imbalances, PIT is frequently used for the administration of different solutions, medications, blood, or blood products.[1,2] In North America and in the UK, it was reported that more than 300 million intravenous catheter interventions are performed annually, and that 80% of hospitalized patients receive at least one PIT during their hospitalization.[3] Since PIT is considered an invasive procedure, serious and life-threatening complications can potentially occur if an incorrect amount of intravenous fluid or medication is administered.[4–6] While the localized complications of PIT are hematoma, ecchymosis, thrombosis, thrombophlebitis, non-thrombotic blockage, infiltration, and extravasation, the systemic complications of PIT are excessive fluid or electrolyte load, pulmonary edema, air embolism, catheter embolism, and anaphylaxis. Local or systemic infection is another potential complication of PIT.[7–10] Studies have reported that

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PIT complications mostly occur from administering incorrect fluid amounts, fluid type, or rate of application.[11,12] Nurses are responsible for the insertion of an intravenous (IV) catheter, the administration of a wide variety of infusion solutions or medications, assessments to classify complications according to the Infusion Nursing Society (INS) Infusion Therapy Standards of Practice and practices aimed at the prevention of complications.[7,8,13,14] Among the practices for the prevention of PIT complications are selecting an appropriate IV site, avoiding IV areas of flexion, using proper venipuncture technique, assessing the IV site in terms of pain, edema, or inflammation, and for openness of the vein.[15,16] The practice focus is on preventing PIT complications; however, if complications develop, nurses must recognize, report, and intervene appropriately in order to ensure positive patient outcomes.[7] Therefore, it is essential to determine the knowledge and practices of nurses in terms of patient care related to the prevention of PIT complications, as nurses have a key role in assuring safe, quality patient care. Studies have shown that the knowledge of nurses regarding the prevention of PIT differs in relation to their professional characteristics such as the education they received, their length of employment within the health profession, and in which department they work.[1,13–15] A recent scoping review conducted by Raynak et al.[16] concluded that nurses' knowledge related to vascular access devices was varied. Their study highlighted a knowledge gap in nurses with regards to the best practices for vascular access device routine care. Similarly, a study conducted by Osti et al.[14] found that whilst most nurses had good knowledge of caring and maintaining IV cannulation, others had inadequate knowledge and/or poor practices.[14] The Infusion Nurses Society pointed out that nurses' knowledge and practices toward the recognition of risk factors for the development of PIT could reduce complications.[17]

In order to define key areas for future improvement, it is important to first explain current nursing knowledge and practices related to preventing PIT complications. Therefore, the aim of the current study is to determine clinical nurses' knowledge and practices with regards to routine care related to the prevention of PIT complications, and to identify the influencing factors.

Methods

Study design and settings

This descriptive cross-sectional design study was conducted between April and August 2018. The study was conducted within internal medicine and surgical units of hospitals in the Aegean region of Turkey.

Study sample

The population of the study was 242 clinical nurses employed in the surgical and internal medicine wards of a large hospital in the Aegean region of Turkey. The research sample consisted of 214 nurses who were actively working in these units and who were willing to participate in the current study (Participation rate: 88.4%).

Data collection tools

Data were collected using three different forms: (1) "Nurses' Description Form," (2) "Form for Nurses' Encountering and Assessing Status of PIT Complications," and (3) "Assessment Form for Nurses' Knowledge Level on Prevention of PIT Complications." Three faculty members specialized in the Fundamentals of Nursing evaluated the forms and accompanying checklists in order to ensure content validity prior to the intervention. The necessary adjustments related to the specific context of the study were applied based on the faculty members' recommendations.

Nurses' description form

The Nurses' Description Form was prepared by the researchers and consisted of 12 questions aimed at determining the participant nurses' sociodemographic and professional characteristics. In addition, the form included five questions regarding the nurses' education about PIT complications.

Form for nurses' encountering and assessing status of PIT complications

The researchers designed the form based on the most current INS Infusion Therapy Standards of Practice, which were available during the research planning stage.[17] The form comprises six questions regarding encounters with and the assessment of PIT complications. The form included details such as nurses most frequently encountered PIT complications, documenting the status of PIT complications, and the assessment of PIT complications by nurses.

Assessment form for nurses' knowledge level on prevention of PIT complications

The researchers designed the form based on the most current INS Infusion Therapy Standards of Practice, which were available during the research planning stage.[17] The form comprises 10 questions. The participants were asked to respond to each statement by choosing "*True*," "*False*," or "*I have no opinion*." Correct answers given by the nurses were assigned 10 points, while incorrect answers or those with "*I have no opinion*" were assigned 0 points. The highest possible score was 100, whist the lowest was 0. Nurses' knowledge levels were then assessed according to their total score. A total score of between 0 and 40 indicated the nurses' knowledge level as being weak, whilst a total score between 41 and 70 indicated a medium level of

knowledge, and a total score between 71 and 100 indicated a high level of knowledge. The Cronbach's alpha value of the form was found to be 0.88.

Data collection

After consenting to participate in the current study, data were collected through face-to-face interviews conducted with the participant nurses in their clinics. This process was taken into consideration in order to ensure that the duration of the research did not negatively impact upon the participants' working hours. The time taken to complete each questionnaire was approximately 30 min.

Data analysis

In evaluating the collected research data, IBM's Statistical Package for Social Science (SPSS, Version 22.0) was employed. There was no data found to be missing from the current study. Continuous variables are presented as median (min–max), whilst categorical variables are described using frequencies and percentages. Shapiro–Wilk normality test was applied in order to examine whether or not the numerical data were distributed normally. Since the data were found to be normally distributed, independent *t*-test and analysis of variance (ANOVA) test were used to compare the total scores of the sociodemographic information of the nurses.

Ethical considerations

The necessary legal permission was obtained from the Hospital Ethics Committee (Decision: 21.02.2018/95) and from each of the nurses who voluntarily participated in the research. All of the participants were provided verbal information about the study, and written informed consent was obtained from each participant.

Results

The mean age of the nurses participating in the current study was 35.91 ± 5.54 years old, with 86.4% being female, and 89.7% having a bachelor's degree. It was determined that the nurses' weekly work hour total was 60.30 ± 7.96 h, and that 52.8% of them worked within internal medicine units. Of the participants, 36% had been employed within the health profession for between 10 and 15 years, and 73.8% of them worked both daytime and shifts (Table 1).

When the status of the training the participant nurses had received related to PIT complications was examined, it was seen that 89.3% of the nurses had received training on the complications of PIT during their undergraduate training, whilst 73.8% of the nurses had received some form of PIT-related training since their graduation. As to the nurses' PIT training, 77.2% of them had received in-service training. In total, 81.3% of the participant nurses self-rated their procedural knowledge regarding PIT complications as "good."

Table 1. Various descriptive characteristics of the nurses (*N* = 214).

Characteristic	*n*	%
Age (Mean ± SD) 35.91 ± 5.54 years		
Weekly work time (Mean ± SD) 60.30 ± 7.96 h		
Gender		
Female	185	86.4
Male	29	13.6
Length of employment in health profession		
0–5 years	27	12.6
5–10 years	61	28.5
10–15 years	77	36.0
15 years or more	49	22.9
Highest educational qualification		
Bachelor's degree	192	89.7
Postgraduate degree	22	10.3
Clinic of employment		
Surgical unit	101	47.2
Internal medicine unit	113	52.8
Type of work		
Daytime	30	14.1
Daytime and shift	158	73.8
Shift	26	12.1
Received PIT training before graduation		
Yes	191	89.3
No	23	10.7
Received PIT training after graduation		
Yes	158	73.8
No	56	26.2
Training type		
Inservice	122	77.2
Web sources	11	6.9
Books/Articles	11	6.9
Congresses/Symposia	14	8.8
Self-competence level: IV therapy complications		
Low	23	10.7
Good	174	81.3
Very good	17	7.9
Standardized practice procedures to prevent PIT complications within clinic		
Available	36	16.8
Unavailable	147	68.7
No idea	31	14.5
Total	214	100

PIT: peripheral intravenous therapy.

Also, 68.7% of the nurses mentioned there being no standardized practice procedures for the prevention of PIT complications within their clinic (Table 1).

The PIT complication which the nurses reportedly encountered the most frequently was ecchymosis (43%). All of the nurses stated that they report any PIT complications, and 87.4% stated that they performed risk assessments regarding PIT complications after stabilizing an intravenous catheter. More than half of the nurses (61.7%) reported having performed a risk assessment prior to the

Table 2. Nurses' status regarding encountering PIT complications and nurses' practices on prevention of PIT complications ($N = 214$).

Characteristic	*n*	%
Nurses most frequently encountered PIT complications		
Ecchymosis	92	43.0
Infiltration	61	28.5
Phlebitis	61	28.5
I report the PIT complications		
Yes	214	100
No	0	0
I perform a risk assessment after stabilizing an IV catheter		
Yes	187	87.4
No	27	12.6
I perform a risk assessment prior to PIT administration		
Yes	132	61.7
No	82	38.3
I perform a risk assessment after PIT administration		
Yes	173	80.8
No	41	18.2
Most frequently used risk assessment method/s*		
Use of a scale	47	22.0
Flushing the vein with normal saline	191	89.3
Assessing the IV catheter area toward inflammation or edema	201	93.9
Assessing the IV catheter area toward pain/comfort	114	53.3
Total	214	100

PIT: peripheral intravenous therapy; IV: intravenous.
*More than one response could be given.

PIT administration, and 80.8% stated that performed one after (Table 2).

Among the risk assessment methods for PIT complications employed by the nurses; 22% stated that they used a scale, 89.3% of them stated that they flushed the vein with normal saline, the vast majority (93.9%) reported that they assessed the skin around the IV catheter toward edema or inflammation. Finally, a little more than half of the participant nurses (53.3%) assessed the intravenous catheter area toward pain/comfort (Table 2).

The nurses gave a high proportion of correct responses to the statements concerning PIT complication preventative practices. The nurses' mean score was 81.54 ± 12.06 (min: 50, max: 100) (Table 3), and no statistically significant difference was found to exist between the scores and the variables of gender, length of employment in the health profession, type of work, training received related to PIT complications, and level of self-competence in PIT complications (Table 4).

Discussion

The current study determined the level of clinical nurses' knowledge and practices concerned with routine care related to the prevention of PIT complications and identified the pertinent influencing factors. Overall, the participant nurses achieved a high score (81.54 ± 12.06; min: 50, max: 100) from the 10 questions concerning practices for the prevention of PIT complications, which shows that their information on routine care related to the prevention of PIT complications was cognizant. As most of the participant nurses stated having received training on PIT complications after their graduation, it is likely that education played a role in the obtained results. Cicolini et al.[18] pointed out that this finding should represent a starting point for nurse managers to reflect on the importance of continuous professional education. The Centers for Disease Control and Prevention (CDC) guidelines to IV interventions[19] reported on the relationship between higher levels of nursing education and a reduction in the prevalence of PIT complications. The current study revealed that nurses with a postgraduate educational achieved higher mean score in terms of their knowledge. In the studies of Aydin and Arslan[6] and also Ho et al.,[15] it was concluded that higher levels of nurses' education created a positive effect on the prevention of PIT complications. In a study by Lee et al.,[20] it was reported that nurses with a higher level of education showed a higher readiness to being trained according to the latest literature regarding nursing practices, including the prevention of PIT complications.

In the current study, no statistically significant difference was found to exist between the scores and the variables of nurses' gender, their length of employment in the health profession, type of work, their having received training related to PIT complications, and their self-assessed level of competence in PIT complications. Thus, it was seen that the nurses' independent variables did not affect their mean scores of knowledges regarding PIT complications. Studies have shown that the knowledge of nurses regarding the prevention of PIT differs in relation to their personal and professional characteristics.[1,13–15]

Accurate documentation provides guidance which outlines nurses' professional accountability in recordkeeping for all nursing routine practices.[14] From examining the practices of the participant in the current study, it was seen that all of the nurses documented PIT complications. According to the INS Infusion Therapy Standards of Practice,[17] nurses should document PIT complications in order to ensure the continuity and safety of infusion care. This finding emphasized that continuous assessment of nurses helps to prevent PIT complications.

Studies have reported that the most frequent PIT-related complications are phlebitis, infiltration, and infections.[2,18,21] Among these complications, the most common is phlebitis, which is defined as the inflammation of the intima layer of the vein.[3,22,23] A recent meta-analysis conducted by Lv and Zhang[24] reported that the risk of phlebitis development can be reduced by adapting appropriate practices. Nurse practices (e.g., venipuncture technique) are central to the development of PIT-related complications,[24] and

Table 3. Distribution of nurses' responses regarding prevention of PIT complications ($N = 214$).

Items	Correct		Incorrect		No opinion	
	n	%	*n*	%	*n*	%
Prior to assessing a patient for potential venipuncture sites, type of IV fluids or medications administrated should be considered.	195	91.1	0	0	19	8.9
After selecting a suitable vein, appropriate choices for IV catheter size selection should be considered.	184	86.0	13	6.1	17	7.9
IV site selection should be initiated routinely in the nondominant arm.	181	84.6	24	11.2	9	4.2
In order to reduce movement of the IV catheter, stabilization of the catheter hub should be ensured.	177	82.7	10	4.7	27	177
Primary intermittent administration sets should be changed every 24 h.	178	83.2	16	7.5	20	9.3
When PIT is administered consecutively, the IV catheter area should be assessed toward pain, swelling, or inflammation prior to the administration.	196	91.6	10	4.7	8	3.7
IV catheters should be removed if signs of pain, swelling, or inflammation are seen.	190	88.8	9	4.2	15	7.0
Prior to every PIT administration, the catheter should first be flushed with saline.	160	74.8	47	22.0	7	3.3
Prior to every PIT administration, the catheter patency/clot should be checked.	144	67.3	50	23.4	20	9.3
After every PIT administration, the catheter should be flushed with saline.	139	65.0	55	25.7	20	9.3

PIT: peripheral intravenous therapy.

Table 4. Comparison of nurses' mean knowledge scores and independent variables.

Characteristics	Min	Max	Mean ± SD	Statistical test	*p*
Gender					
Female	50	100	81.67 ± 11.97	$t = 0.389$	0.700
Male	50	100	80.68 ± 12.79		
Length of health profession employment					
0–5 years	50	100	79.62 ± 14.53	$F = 0.471$	0.798
5–10 years	50	100	82.04 ± 11.74		
10–15 years	50	100	81.29 ± 11.73		
15 years or more	50	100	82.29 ± 11.74		
Highest educational qualification					
Bachelor's degree	50	100	76.81 ± 13.23	$t = 1.786$	0.086
Postgraduate degree	60	100	82.08 ± 11.83		
Clinic of employment					
Surgical unit	50	100	82.67 ± 12.23	$t = 1.297$	0.196
Internal medicine unit	50	100	80.53 ± 11.86		
Type of work					
Daytime	60	100	81.00 ± 10.28	$F = 0.250$	0.940
Daytime and shift	50	100	81.96 ± 12.48		
Shift	50	100	79.61 ± 11.48		
Received PIT training before graduation					
Yes	60	100	83.47 ± 10.70	$t = -0.903$	0.374
No	50	100	81.30 ± 12.22		
Received PIT training after graduation					
Yes	50	100	82.85 ± 11.55	$t = -0.976$	0.331
No	50	100	81.07 ± 12.23		
Self-competence level: IV therapy complications					
Low	70	100	83.04 ± 8.75	$F = 0.570$	0.723
Good	70	100	82.94 ± 9.19		
Very good	50	100	81.20 ± 12.68		
Total score	50	100	81.54 ± 12.06		

PIT: peripheral intravenous therapy.
F: ANOVA (one-way) test, *t*: Independent *t*-test.

previous studies have shown various risk factors related to PIT complications according to the demographic features of patients (e.g., age, gender, vascular structure) and pharmacological procedures (e.g., drug irritation, infusion rate).[2,17–19,22,23] In conclusion of the current study, the results showed that the PIT complication most frequently encountered by nurses was ecchymosis (43%), which is a trauma-based vessel injury related more often to the venipuncture technique.[23] Education on the correct IV catheter insertion techniques could help to further reduce the prevalence of ecchymosis.

Most prevention practices such as assessing an IV catheter site all form part of routine nursing care.[14] Assessment of the IV site and the venous pathway up to the extremity is essential to identifying PIT complications.[17,18] The INS Infusion Therapy Standards of Practice[17] pointed out that the risk for PIT complications is reduced when there is continuous assessment of the site. While 87.4% of the participant nurses performed risk assessment after stabilizing an intravenous catheter, 80.8% of nurses did so following the administration of PIT. Among the methods most frequently used was an assessment of the skin around the IV site toward edema or inflammation. The current study found that the least used method for the prevention of PIT complications was the use of scales (22%), which is a result possibly linked to a lack of knowledge or lack of policies and procedures toward implementing guidelines. The international updated vascular access framework[25] and guideline[17] recommended that using structured and evidence-based tools such as the I-DECIDED clinical decision-making tool for assessment of IV devices[26] to prompt early detection of complications. Nevertheless, more than half of the participant nurses (68.7%) stated there being no standardized practice procedures to prevent PIT complications within their clinic. The practice procedures for the prevention and assessment of PIT complications guide nursing care that is consistent with the latest evidence-based guidelines.[16] Whilst the nurses in the current study were found to have high knowledge levels, their practices for the prevention of PIT complications differed. It should be noted that the lack of standardized practice procedures in the clinical settings where the participant nurses worked may have influenced the variability seen in their nursing practices.

Conclusion

The results of the current study found that the participant nurses' knowledge scores regarding the prevention to PIT complications were high, but that their independent variables did not significantly affect their knowledge scores. However, the nurses' practices toward the prevention of PIT complications were found to differ, which highlights the need for the transference of acquired knowledge into clinical practice. The current study aimed to highlight the variability in nurses' knowledge and practices with regards to routine patient care related to the prevention of PIT complications, and to demonstrate the need for continued education so as to ensure high-quality patient care and improved patient outcomes. Nursing and healthcare managers should consider the training and education of nurses with respect to evidence-based practices for the prevention of PIT complications, and nurses should apply the recommended changes to their clinical practices. In addition, updating the knowledge and practices of nurses through a supportive practice environment is advisable, and which includes the planned implementation of standardized practice procedures. In line with these results, it is recommended that future studies be conducted with a larger sample, and to include nurses working in other clinical fields so as to potentially elicit results that consider a different perspective.

Limitations

The current study was conducted with clinical nurses working at a single health institution. Therefore, these conclusions cannot be generalized, although the current study's findings could be retested according to other contexts.

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Authorship statement

All listed authors meet the authorship criteria, and all authors are in agreement with the content of the manuscript. All authors have contributed significantly. Study conception and design: DUY; Data collection: DUY, DY; Data analysis and interpretation: DUY, DY, DK; Drafting of the article: DUY, DY; Critical revision of the article: DY, DK.

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References

1. Arpa Y and Cengiz A. Determining of the knowledge levels of healthcare staff in the diagnosis and prevention of development of phlebitis and thrombophlebitis associated with intravenous infusion therapy. *Educ Res Nurs* 2016; 13: 21–26.

2. Kuş B and Büyükyilmaz F. Current guidelines recommendations in peripheral intravenous catheter administration. *Gümüşhane J Health Sci* 2019; 8: 326–332.
3. Wallis M, McGrail M, Webster J, et al. Risk factors for peripheral intravenous catheter failure: A multivariate analysis of data from a randomized controlled trial. *Infect Control Hosp Epidemiol* 2014; 35: 63–67.
4. Abadi P, Etemadi S and Abed Saeedi ZH. Investigating role of mechanical and chemical factors in the creation of peripheral vein in Flammarion in hospitalization patients in hospital in Zahedan, Iran. *Life Sci J* 2013; 10: 379–383.
5. Keleekai N, Schuster C, Murray C, et al. Improving nurses' peripheral intravenous catheter insertion knowledge, confidence, and skills using a simulation-based blended learning program. *Simul Healthc* 2016; 11: 376–384.
6. Aydin S and Arslan GG. Hemşirelerin periferal intravenöz kateter girişimlerine ilişkin bilgi düzeylerinin incelenmesi. *Dokuz Eylül Üniversitesi Hemşirelik Fakültesi Elektronik Dergisi* 2018; 11: 290–299.
7. Doherty L, Bravery K, Gabriel, et al. *Standards for infusion therapy*. 3rd ed. London: Royal College of Nursing, 2012.
8. Craven FR, Hirnle JC and Jensen S. *Fundamentals of nursing: human health and function*. China: Wolters Kluwer Health/Lippincott Williams & Wilkins, 2013.
9. Cura ŞÜ, Atay S and Efil S. Investigation of nurses' level of skills in peripheral venous catheter application. *J Ankara Health Sci* 2019; 8: 30–38.
10. Potter AP, Perry GA, Stockert AP, et al. *Fundamentals of nursing*. Elsevier Mosby, 2019.
11. Momken M, Mohammadpour A, Elahifard H, et al. Evaluation of parenteral electrolyte solution utilization and fluid therapy in surgical department of Imam Reza, Mashhad, Iran. *J Pharm Care* 2018; 6: 58–61.
12. Mousavi M, Khalili M and Dashti-Khavidaki S. Errors in fluid therapy in medical wards. *Int J Clin Pharm* 2012; 34: 374–381.
13. Chung SA, Choi EH, Lee KS, et al. Nurses' knowledge and performance for prevention of extravasation at peripheral intravenous therapy. *J Korea Acad Ind Coop Soc* 2016; 17(8): 183–191.
14. Osti C, Khadka M, Wosti D, et al. Knowledge and practice towards care and maintenance of peripheral intravenous cannula among nurses in Chitwan Medical College Teaching Hospital, Nepal. *Nurs Open* 2019; 6(3): 1006–1012.
15. Ho S, Liaw LS and Tang WM. Nurses' knowledge and practice in relation to peripheral intravenous catheter care. *Med Health* 2016; 11(2): 181–188.
16. Raynak A, Paquet F, Marchionni C, et al. Nurses' knowledge on routine care and maintenance of adult vascular access devices: a scoping review. *J Clin Nurs* 2020; 29(21–22): 3905–3921.
17. Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice, 8th edition. *J Infus Nurs* 2021; 44(suppl. 1): S1–S224.
18. Cicolini G, Simonetti V, Comparcini D, et al. Nurses' knowledge of evidence-based guidelines on the prevention of peripheral venous catheter-related infections: a multicentre survey. *J Clin Nurs* 2013; 23(17): 2578–2588.
19. Centers for Disease Control and Prevention. Guidelines for the prevention of intravascular catheter-related infections, https://www.cdc.gov/infectioncontrol/pdf/guidelines/bsi-guidelines-H.pdf (2011). (accessed July 18, 2020).
20. Lee WL, Chen HL, Tsai, et al. Risk factors for peripheral intravenous catheter infection in hospitalized patients: a prospective study of 3165 patients. *Am J Infect Control* 2009; 37: 683–696.
21. Keogh S, Shelverton C, Flynn J, et al. An observational study of nurses' intravenous flush and medication practice in the clinical setting. *Vasc Access* 2017; 3: 1–18.
22. Erdogan BC and Denat Y. The development of phlebitis and infiltration in patients with peripheral intravenous catheters in the neurosurgery clinic and affecting factors. *J Care Sci* 2016; 9: 619–629.
23. Akpınar RB, Polat HT, Yaman S, et al. The precautions taken by the nurses to prevent the bruise haematoma and pain associated with subcutaneous heparin. *J Anatolian Nurs Health Sci* 2010; 13: 19–25.
24. Lv L and Zhang J. The incidence and risk of infusion phlebitis with peripheral intravenous catheters: a meta-analysis. *Vasc Access* 2020; 21(3): 342–439.
25. Hallam C, Weston V, Denton A, et al. Development of the UK Vessel Health and Preservation (VHP) framework: a multi-organizational collaborative. *J Infect Prev* 2016: 17: 65–72.
26. Ray-Barruel G, Cooke M, Mitchell M, et al. Implementing the I- DECIDED clinical decision-making tool for peripheral intravenous catheter assessment and safe removal: protocol for an interrupted time-series study. *BMJ Open* 2018; 8(6): e021290.