









Incidence of obstruction in peripheral intravenous catheters in adults and related factors

Incidência de obstrução em cateteres periféricos intravenosos em adultos e fatores relacionados

Incidencia de obstrucción en catéteres intravenosos periféricos en adultos y factores relacionados

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ABSTRACT

Objective: to analyze the incidence and factors related to peripheral intravenous catheter obstruction in hospitalized adults. **Method:** a prospective cohort, based on the observation of 203 catheters, between February 2019 and May 2020, in a Brazilian public teaching hospital. Clinical and catheter variables were taken into account. The data was analyzed descriptively and using inferential statistics. **Results:** the length of stay ranged from one to 15 days and obstruction occurred in 7.5% of the observations. There was an increased obstruction risk in relation to gender (RR=0.49 / p=0.186), age (RR=1.20 / p=0.732), larger catheters (RR=0.53 / p=0.250), insertion in the back of the hand up to the forearm (RR=2.33 / p=0.114) and the time length the catheter was *in situ* (RR=0.33 / p=0.433). **Conclusion:** Daily care and observation of the peripheral intravenous catheter is important to minimize the appearance of local and systemic complications and maintain the patency of the device.

Descriptors: Nursing; Patient Safety; Catheterization, Peripheral; Residence Time; Catheter Obstruction.

RESUMO

Objetivo: analisar a incidência e os fatores relacionados à obstrução de cateter intravenoso periférico em adultos hospitalizados. **Método:** uma coorte prospectiva, realizada a partir da observação de 203 cateteres, entre fevereiro de 2019 e maio de 2020, em hospital público e de ensino brasileiro. Foram consideradas variáveis clínicas e do cateter. Os dados foram analisados descritivamente e por estatística inferencial. **Resultados:** o tempo de permanência variou entre um a 15 dias e a obstrução ocorreu em 7,5% das observações. Houve aumento do risco de obstrução em relação ao sexo (RR=0,49 / p=0,186), à idade (RR=1,20 / p=0,732), aos cateteres de maior calibre (RR=0,53 / p=0,250), à inserção no dorso da mão até antebraço (RR=2,33 / p=0,114) e ao tempo do cateter *in situ* (RR=0,33 / p=0,433). **Conclusão:** O cuidado diário e observação do cateter intravenoso periférico são importantes para minimizar o surgimento de complicações locais e sistêmicas e manter a patência do dispositivo.

Descritores: Enfermagem; Segurança do Paciente; Cateterismo Periférico; Tempo de Permanência; Obstrução do Cateter.

RESUMEN

Objetivo: analizar la incidencia y los factores relacionados con la obstrucción del catéter intravenoso periférico en adultos hospitalizados. **Método:** cohorte prospectiva, realizada mediante la observación de 203 catéteres, entre febrero de 2019 y mayo de 2020, en un hospital escuela público brasileño. Se consideraron variables clínicas y del catéter. Los datos se analizaron de forma descriptiva y mediante estadística inferencial. **Resultados:** el tiempo de permanencia varió entre uno y 15 días y la obstrucción ocurrió en el 7,5% de las observaciones. Hubo mayor riesgo de obstrucción en relación con el sexo (RR=0,49 / p=0,186), la edad (RR=1,20 / p=0,732), los catéteres de mayor calibre (RR=0,53 / p=0,250), la inserción en el dorso de la mano hasta el antebrazo (RR=2,33 / p=0,114) y el tiempo del catéter *in situ* (RR=0,33 / p=0,433). **Conclusión:** el cuidado diario y la observación del catéter intravenoso periférico son importantes para minimizar la aparición de complicaciones locales y sistémicas y mantener la permeabilidad del dispositivo.

Descriptores: Enfermería; Seguridad del Paciente; Cateterismo Periférico; Tiempo de Permanencia; Obstrucción del Catéter.

INTRODUCTION

The insertion of a peripheral intravenous catheter (PIVC) is common practice for nursing staff to administer medications, intravenous solutions, blood products and blood components, as well as parenteral nutrition¹. Depending on the solution infused and other factors, such as the insertion site, caliber and material of the catheter, adverse events such as phlebitis, infiltration, obstruction, and extravasation can occur, as well as leading to the loss of the device¹⁻⁴.

Some studies have shown that the majority of hospitalized patients require a PIVC, and local complications are frequently identified¹⁻⁶. Researchers in a study of 40,620 PIVCs and 38,161 patients, observed in 406 hospitals in 51 countries, identified some type of non-compliance in relation to the use of PIVCs, including signs and symptoms of phlebitis, infiltration, obstruction and other events⁵.

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Editor in chief: Cristiane Helena Gallasch; Associate Editor: Thelma Spíndola

Data from a systematic review of more than 70,000 PIVCs showed phlebitis (with definition) in 19.3%, phlebitis (without definition) in 4.5%, infiltration/extravasation in 13.7%, occlusion in 8%, leakage in 7.3%, pain in 6.4% and displacement in 6.0% of the more than 70,000 PIVCs observed³.

In this context, PIVC obstruction can have a significant impact on intravenous therapy due to loss of patency or the need for a new puncture^{1,5-7}. Such situations require time-consuming nursing care, increased hospital costs and discomfort for the patient^{1,3,5}.

Obstruction is defined as the inability to infuse or inject solutions or medication into a patent catheter, aspirate blood from the catheter or both¹. Among the risk factors for obstruction are the type of PIVC material, the caliber, the type of medication, the infusion flow and factors related to blood coagulation⁸.

As for obstruction mechanisms, these can be due to thrombotic, chemical, or mechanical causes. The latter is related to the positioning of the catheter tip or to kinks in the cannula that impede the flow of infusion⁹.

The nursing professional detects obstruction by observing the interruption of the infusion, slow drip, absence of blood reflux, difficulty in administering the medication or by means of infusion pump alarms¹.

In relation to maintenance, the use of bundles is recommended, which should include specific measures to prevent obstruction. These include flushing, which consists of applying 0.9% saline solution before and after the administration of medication^{1,10}. This practice is recommended for all types of catheters; however, it varies according to type, caliber and length, infusion volume and daily frequency^{1,11}.

Identifying points for improvement in the processes involving intravenous therapy (IVT) contributes to health care indicators, and the nursing team stands out in the care of patients with PIVC in clinical practice because it is responsible for the routine assessment of the insertion site, the cover and the accessories used in intravenous infusion, as well as applying care protocols¹¹. In this way, specific measures can be adopted to prevent the loss of PIVCs, thus improving the quality of care and reducing hospital costs.

Considering the complexity and severity of adults admitted to public and teaching hospitals who require a PIVC for diagnosis and treatment, this study aimed to analyze the incidence of PIVC obstruction in hospitalized adults and the related factors.

METHOD

This is a prospective, observational cohort, carried out between February 2019 and May 2020, in a public teaching hospital with 302 beds, located in the interior of Minas Gerais, a reference for high and medium complexity.

The sample consisted of adults aged 18 or over, admitted to the Internal Medicine, Surgery and Neurology units and with a PIVC for their treatment. Those with two catheters were excluded.

To calculate the sample of 196 participants, we considered a 53.9% incidence of loss of PIVC¹², a finite population of 400 participants, a 5% margin of error and a 95% confidence interval (CI). Considering a 20% loss rate, the maximum number of participants was 245. A non-probabilistic strategy was adopted for patient selection.

The primary outcome (dependent variable) of the study was PIVC obstruction, considering total or partial interruption of PIVC flow. Only short peripheral intravenous catheters between 14 and 24 gauge were considered as PIVCs. Other types of peripherally inserted catheters were excluded.

Participants were invited to take part in the study according to their admission to the sectors selected for the study. The researchers and research assistants took turns assessing the PIVC every 24 hours. As a result of the COVID-19 pandemic, participants who were diagnosed with the virus and had to be transferred to isolation units were excluded from the study, as these places were not open to researchers.

Data for each PIVC was observed and recorded according to the research protocol: 1. First observation after admission to the ward and after peripheral venipuncture (PVP); 2. New observations every 24 hours and until the day the PIVC was removed from the vein.

According to institutional protocol, PIVC should be removed when there are signs or symptoms of adverse events, such as phlebitis, infiltration, extravasation, obstruction and when there is no longer any need to use it.

In relation to the obstruction outcome, the perception of slow infusion flow, infusion pump alarms, the presence of blood in the extender or the equipment and difficulty in flushing were considered. For this purpose, the medical records and the reports of care professionals were taken into account. In situations where the obstruction was observed by the care professionals, a PVP was performed, as there were no specific protocols for unblocking PIVCs at the study institution.

According to the institutional standard operating protocol (SOP), in order to prevent obstruction, nursing staff should flush saline solution with a swirling technique into a 10ml syringe. The SOP follows ANVISA recommendations and so flushing should be administered intermittently, as well as before and after the administration of medication¹¹.

In relation to the daily assessment of the PIVCs, which includes assessing the insertion site and accessories, this should be carried out daily. If there are signs and symptoms of phlebitis, obstruction, infiltration, or extravasation, the PIVC should be changed.

The institution used adhesive plaster or microporous tape (non-sterile) as covers, as well as sterile transparent film. As a measure to prevent infection, the sterile cover should be changed every seven days or if necessary, and the others daily after bathing.

In relation to the obstruction of PIVCs or other catheters, there were no specific medications available at the institution for unblocking them. If an obstruction occurs, the catheter should be removed.

An instrument adapted for this investigation was used to collect the data, excluding variables related to preparation for elective surgery, which was not the subject of this investigation¹³. Independent variables were gender, age, medical specialty, length of current hospitalization, anticoagulant use, previous chemotherapy, hospitalizations or surgeries in the last six months and history of morbidities such as Systemic Arterial Hypertension (SAH), Diabetes Mellitus (DM) and others. Variables related to PIVC included catheter caliber, topography, and length of stay.

The variables were coded in a dictionary and double-entered into a Microsoft Excel® spreadsheet. After validation, the data was exported and analyzed using IBM® SPSS® software, version 20, using descriptive and inferential statistics. PIVC obstruction was considered the dependent variable and the independent variables, gender, age, anticoagulant use, caliber, and length of PIVC stay were dichotomized for bivariate analysis using the Chi-square test. Cox regression was used to assess the influence of the independent variables in relation to obstruction.

This investigation complied with the guidelines for observational studies (STROBE)¹⁴ and the Equator Network's Recommendations for Quality and Transparency in Health Research. Data collection was carried out after the participant or their guardian understood and agreed to it and signed an informed consent form.

The research protocol was approved by the local Research Ethics Committee and all ethical aspects were complied with.

RESULTS

Peripheral intravenous catheters observed in 199 adult inpatients were included, and their characterization is shown in Table 1.

A total of 203 PIVCs were observed in adults, most of them male, with a mean age of 59.7 years (SD±15.8), a minimum of 18 and a maximum of 89 years, with different morbidities and health histories. There were four losses due to Sars-CoV-2 infection and the need for care in isolation units, which prevented daily PIVC observation.

The comorbidities reported by the participants included SAH (n=107/53, 8%), DM (n=51/25, 6%), thrombosis (n=09/4, 5%), coagulation disorders (n=02/1, 0%) and chronic renal failure (08/4, 0%). Among the neurology participants, 17 (8.5%) had plegia in at least one arm and, according to institutional protocol, PVP could not be performed on this limb.

As for the PIVCs observed, 154 (77.4%) had intravenous medication in a continuous infusion pump; 45 (22.6%), intermittent. It was not possible to identify the type of obstruction (mechanical, chemical, or thrombotic) as the analysis of the catheter lumen after removal from the vein was not included in this investigation.

Table 1: Characterization of adults hospitalized with a peripheral intravenous catheter (n=199). Uberaba, MG, Brazil, 2020.

Variable	n	f(%)
Gender	Female	87 43.7
	Male	112 56.3
Specialty	Medical Clinic	97 48.7
	Neurology	54 27.1
	Others	48 24.2
Age group	≤ 20	06 3.0
	21 – 30	05 2.5
	31 – 40	17 8.5
	41 – 50	21 10.6
	51 – 60	42 21.1
	≥ 61	107 53.8
Anticoagulant use	Absent	01 0.5
	Yes	54 27.1
Previous hospitalizations history (last 90 days)	No	144 72.4
	Yes	37 18.6
Previous surgery history (last six months)	No	162 81.4
	Yes	26 13.1
Intravenous chemotherapy history	No	173 86.9
	Yes	04 2.0
	No	195 98.0

Table 2 shows data related to the obstruction of the peripheral intravenous catheters observed.

Table 2: Variables related to peripheral venous catheter obstruction in hospitalized adults (n=199). Uberaba, MG, Brasil, 2020.

Variables	Peripheral venous catheter obstruction		Adjusted RR (CI 95%)	p-value*
	No n (%)	Yes n (%)		
Gender				0.186
Male	106 (57.6)	06 (40.0)	0.49	
Female	78 (42.4)	09 (60.0)	(0.16 -1.43)	
Age (years old)				0.732
≤ 60	102 (55.4)	09 (60.0)	1.20	
≥ 61	82 (44.6)	06 (40.0)	(0.41-3.52)	
Anticoagulant use**				0.250
No	135 (73.8)	09 (60.0)	0.53	
Yes	48 (26.2)	06 (40.0)	(0.18-1.57)	
Caliber (Gauge)				0.114
14, 16 and 18	72 (39.1)	09 (60.0)	2.33	
20, 22 and 24	112 (60.9)	06 (40.0)	(0.79-6.83)	
Topography				0.823
Back of hand to forearm	163 (88.6)	13 (86.7)	0.83	
Arm up to jugular	21 (11.4)	02 (13.3)	(0.17-3.97)	
Time length the catheter stays <i>in situ</i> (in days)				0.433
≤ 05	170 (92.4)	13 (86.7)	0.53	
≥ 06	14 (7.6)	02 (13.3)	(0.11-2.61)	

Notes: *Chi-square test. p=significance level: p<0.01 **Missing data (n=1).

The time length the PIVC remained in the vein ranged from one to fifteen days and obstruction occurred in 7.5% of cases. In relation to the variables that could be associated with the obstruction risk, the results showed an increase in gender (female), age (60 years or older), larger calibers (14, 16 and 18), insertion in the back of the hand or forearm, and the time length the catheter remained *in situ* (up to five days). However, there was no significance in relation to these variables and obstruction. The results obtained using Cox regression are shown in Table 3.

Table 3: Peripheral venous catheter obstruction and association with clinical and catheter-related variables in adults. Uberaba, MG, Brazil, 2020.

Variable	Adjusted RR (CI 95%)	p-value*
Gender	1.31 (0.46 – 3.78)	<1.413
Age group	0.79 (0.26 – 2.37)	1.723
Topography	0.60 (0.21 – 1.73)	1.576
Anticoagulant use	1.23 (0.41 – 3.67)	1.549
Caliber	1.87 (0.40 – 8.72)	0.875

Notes: *Cox Regression, significance level: $p < 0.01$.

The regression data showed that the risk seemed to be greater in relation to gender, caliber and the anticoagulants use than in relation to the other variables (Table 3); however, there was no statistical significance.

DISCUSSION

This study identified the factors associated with PIVC obstruction in hospitalized adults. Most of the participants were male, between 51 and 60 years old, admitted to the investigation sectors for diagnosis and treatment of cardiovascular, neurological, and infectious diseases. In 2018, a study carried out at the same institution also obtained similar results¹³.

In relation to gender, the obstruction risk was 1.35 times higher in men than in women; however, there was no significant association between gender and PIVC obstruction in this study.

Among the participants, 27% were using anticoagulants, either because they were bedridden or for clinical reasons, and had less PIVC obstruction; however, there was no statistical significance between this variable in the bivariate and regression analysis. Despite this, the anticoagulants use should be considered by nursing staff for PVP, as it helps to identify early factors that could lead to catheter loss or to identify signs and symptoms of complications^{1,6,11}.

In this respect, a multicenter study of 9,620 PIVCs (86% in adults) in 132 hospitals in Latin America showed situations that can lead to obstruction and loss of the catheter¹⁵. Among the 2,741 PIVCs observed in Brazilian hospitals, in 6% there was blood in the extensor or connection, 5% pain on palpation, 3% dried blood at the insertion site and 1% edema greater than one centimeter around the insertion site¹⁵.

As for the puncture site in this investigation, the majority of PIVCs were in veins from the hand to the forearm. Considering the complexity and long period of hospitalization of the patients observed, the use of smaller-caliber PIVCs can be justified by the difficulty of PVP during hospitalization and also by the lack of other catheter options in the institution that could meet the demand for long-term IVT, in addition to the short-term central catheter.

In relation to topography, the evidence available in the literature suggests that there is no significant difference between inserting the PIVC in the forearm and the back of the hand in terms of complications, making both approaches suitable¹⁶. However, it is worth noting that insertion in these places can reduce the patient's mobility for their daily needs during hospitalization.

A survey carried out in 51 countries found that a third of the 40,620 PIVCs inserted were placed in veins in the forearm and the rest in the hand, or forearm and wrist. The authors highlighted the need for training and the use of technology to visualize larger caliber veins to meet the need for IVT and early loss⁵.

In relation to obstruction, 7.5% of the devices observed in this investigation were obstructed, mainly in larger caliber PIVCs. In this respect, the results were lower than in other countries, where the rates were 50%¹⁷, 7.6%, 12.2% and 3.1%, respectively¹⁹. The results of a systematic review of 70 observational studies and 33 randomized clinical trials (76,977 PIVCs) showed a 13.7% occlusion rate⁷.

The choice of PIVC caliber and diameter depends on the professional's experience, as well as the patient's previous history, such as a history of difficult PVP^{1,6,11}. Larger caliber PIVCs are associated with thrombophlebitis and smaller caliber PIVCs with obstruction, infiltration, extravasation and displacement^{1,3,11}.

A Brazilian study showed that nursing staff preferred smaller PIVC for administering solutions in general and larger calibers for antibiotics²⁰. Other studies have reported that smaller calibers are more likely to develop flaws^{1,7,11}. On the other hand, they can reduce the likelihood of vascular trauma and complications such as phlebitis^{1,3}. The use of intravenous antibiotics can also lead to PIVC obstruction, depending on the caliber and medication²¹.

In this study, the mean PIVC length of stay ranged from one to 15 days. This result differs from two studies, whose mean length of stay ranged from two to 11 days^{8,17}. According to current recommendations, PIVCs should be removed in situations of malfunction, suspected contamination, or signs of complications, or when they have not been used in the last 24 or 48 hours¹¹. 24 hours after insertion, a fibrin coating forms in the lumen and at the tip of the catheter, which can result in the formation of a thrombus and obstruction²².

Daily assessment of the PIVC insertion site, the cover, accessories, as well as observation of the medications administered and patency contributes to preventing complications and losses^{3,11,23}. Protocols combined with health education, continuous infusion, and flushing help to prevent obstruction and other complications^{11, 22}. In this way, they can minimize losses and costs related to health care.

Study limitations

This study observed PIVC from the puncture to the removal of the device; however, convenience sampling is a limitation of the study. Due to the COVID-19 pandemic, the researchers followed the recommendations for personal protection and isolation rules, and in some situations, it was not possible to follow the participants in their entirety.

CONCLUSION

PIVC obstruction occurred in 7.5% of the devices. Among the risk factors, the most notable were larger-caliber PIVCs, those inserted in the back of the hand up to the forearm and catheters that remained *in situ* for five days or less. Observing the PIVCs from puncture to removal of the device allowed for a more detailed assessment of the work process and opportunities for improvement. PIVC maintenance protocols are important to minimize complications and device loss, and the gaps reinforce the need for further studies.

REFERENCES

1. Gorski LA, Hadaway L, Hagle ME, Broadhurst D, Clare S, Kleidon T, et al. Infusion Therapy Standards of Practice, 8th edition. J Infus Nurs. 2021 [cited 2023 Mar 02]; 44(1S Suppl 1):S1-224. DOI: <https://doi.org/10.1097/nan.0000000000000396>.
2. Marsh N, Larsen E, Genzel J, Mihala G, Ullman AJ, Kleidon T, et al. A novel integrated dressing to secure peripheral intravenous catheters in an adult acute hospital: a pilot randomised controlled trial. Trials. 2018 [cited 2023 Mar 02]; 19(1):596. DOI: <https://doi.org/10.1186/s13063-018-2985-9>.
3. Marsh N, Webster J, Ullman AJ, Mihala G, Cooke M, Chopra V, et al. Peripheral intravenous catheter non-infectious complications in adults: a systematic review and meta-analysis. J Adv Nurs. 2020 [cited 2023 Mar 02]; 76(12):3346-62. DOI: <https://doi.org/10.1111/jan.14565>.
4. Milliani K, Taravella R, Thillard D, Chauvin V, Martin E, Edouard S, et al. Peripheral venous catheter-related adverse events: evaluation from a multicentre epidemiological study in France (the CATHEVALProject). PLoS One. 2017 [cited 2023 Mar 02]; 12(1):e0168637. DOI: <https://doi.org/10.1371/journal.pone.0168637>.
5. Alexandrou E, Ray-Barruel G, Carr PJ, Frost SA, Inwood S, Higgins N, et al. Use of short peripheral intravenous catheters: characteristics, management, and outcomes worldwide. J Hosp Med. 2018 [cited 2023 Mar 02]; 13(5). DOI: <https://doi.org/10.12788/jhm.3039>.
6. Helm RE, Klausner JD, Klemperer JD, Flint L, Huang EBA. Accepted but unacceptable: peripheral IV catheter failure. J Infus Nurs. 2019 [cited 2023 Apr 05]; 42(3):151-64. DOI: <https://doi.org/10.1097/NAN.0000000000000326>.
7. Coventry L, Jacob A, Davies H, Stoneman L, Keogh S, Jacob E. Drawing blood from peripheral intravenous cannula compared with venepuncture: a systematic review and meta-analysis. J Adv Nurs. 2019 [cited 2023 Apr 01]; 75(11):2313-39. DOI: <https://doi.org/10.1111/jan.14078>.
8. Simin D, Milutinović D, Turkulov V, Brkić S. Incidence, severity and risk factors of peripheral intravenous cannula-induced complications: an observational prospective study. J Clin Nurs. 2019 [cited 2023 Mar 28]; 28(10):1585-99. DOI: <https://doi.org/10.1111/jocn.14760>.

9. Canadian Vascular Access Association. CCAA Occlusion Management Guideline for Central Venous Access Devices (CVADs) 2019 Second Edition. 2019; 13(Suppl 1):1-32. Available from: <https://www.gavecelt.it/nuovo/sites/default/files/uploads/CVAA%20occlusion%20guidelines%202019.pdf>.
10. Patterson T, Dunsdon J, Slater K, McDougall D, Fullerton F. Evaluation of intravenous administration practices, patient safety and expenditure on saline products in a tertiary hospital. *J Vasc Access*. 2017 [cited 2023 Jan 06]; 3(1):1-7. DOI: <https://doi.org/10.12659/MSM.913182>.
11. Ministério da Saúde (Br). Agência Nacional de Vigilância Sanitária-ANVISA. Medidas de prevenção de infecção relacionada à assistência à saúde. Brasília: 2017 [cited 2023 Jan 06], 199p. Available from: <https://www.gov.br/anvisa/pt-br/centraisdeconteudo/publicacoes/servicosdesaude/publicacoes/caderno-4-medidas-de-prevencao-de-infeccao-relacionada-a-assistencia-a-saude.pdf/view>
12. Piper R, Carr PJ, Kelsey LJ, Bulmer AC, Keogh S, Doyle SJ. The mechanistic causes of peripheral intravenous catheter failure based on a parametric computational study. *Sci Rep*. 2018 [cited 2023 Jan 06]; 8(1):3441. DOI: <https://doi.org/10.1038/s41598-018-21617-1>.
13. Monteiro DAT, De La Torre-Montero JC, Nicolussi AC, Reis RK, Barbosa MH, Toffano SEM. Prevalence of and factors associated with difficult peripheral venipuncture in adult surgical patients. *J Vasc Access*. 2020 [cited 2023 Jan 10]; 22(3):404-10. DOI: <https://doi.org/10.1177%2F1129729820939335>
14. Cuschieri S. The STROBE guidelines. *Saudi J Anaesth*. 2019 [cited 2023 Jan 10]; 13(Suppl 1):S31-4. DOI: https://doi.org/10.4103/sja.SJA_543_18.
15. Walker RM, Pires MPO, Ray-Barruel G, Cooke M, Mihala G, Azevedo SS, et al. Peripheral vascular catheter use in Latin America (the vascular study): a multinational cross-sectional study. *Front Med (Lausanne)*. 2022 [cited 2023 Jan 10]; 9:1039232. DOI: <https://doi.org/10.3389/fmed.2022.1039232>.
16. Fan XW, Xu L, Wei WS, Chen YM, Yang YQ. Relationship between indwelling site and peripheral venous catheter-related complications in adult hospitalized patients: a systematic review and meta-analysis. *J Clin Nurs*. 2023 [cited 2023 Jan 16]; 32(7-8):1014-24. DOI: <http://doi.org/10.1111/jocn.16241>.
17. Braga LM, Parreira PMSD, Arreguy-Sena C, Carlos DM, Mónico LSM, Henriques MAP. Incidence rate and the use of flushing in the prevention of obstructions of the peripheral venous catheter. *Texto Contexto Enferm*. 2018 [cited 2023 Jan 20]; 27(4):e2810017. DOI: <https://doi.org/10.1590/0104-07072018002810017>.
18. Chen YM, Fan XW, Liu MH, Wang J, Yang YQ, Su YF. Risk factors for peripheral venous catheter failure: A prospective cohort study of 5345 patients. *J Vasc Access*. 2022 [cited 2023 Jan 19]; 23(6):911-21. DOI: <https://doi.org/10.1177/11297298211015035>.
19. Murayama R, Uchida M, Oe M, Takahashi T, Oya M, Komiya C, et al. Removal of Peripheral Intravenous Catheters Due to Catheter Failures Among Adult Patients. *J Infus Nurs*. 2017 [cited 2023 Dec 06]; 40(4):224-31. DOI: <https://doi.org/10.1097/nan.000000000000168>.
20. Santana RCB, Pedreira LC, Guimarães FEO, Almeida LPB, Reis LA, Menezes TMO, et al. Nursing team care actions for safe peripheral intravenous puncture in hospitalized elderly people. *REME rev. min. enferm*. 2019 [cited 2023 Dec 28]; 40(4):e-1182. Available from: http://www.revenf.bvs.br/scielo.php?script=sci_arttext&pid=S1415-27622019000100229&lng=pt&nrm=iso&tlng=pt
21. Larsen EN, Marsh N, Mihala G, King M, Zunk M, Ullman AJ, et al. Intravenous antimicrobial administration through peripheral venous catheters - establishing risk profiles from an analysis of 5252 devices. *Int J Antimicrob Agents*. 2022 [cited 2023 Jan 06]; 59(4):106552. DOI: <https://doi.org/10.1016/j.ijantimicag.2022.106552>.
22. Keogh S, Shelverton C, Flynn J, Davies K, Marsh N, Rickard, CM. An observational study of nurse's intravenous flush and medication practice in the clinical setting. *JVAD*. 2017 [cited 2023 Mar 06]; 3(1):3-10. Available from: <https://search.informit.org/doi/abs/10.3316/informit.629496319613481>.
23. Estequi JG, Roseira CE, Jesus JB, Figueiredo RM. Boas práticas na manutenção do cateter intravenoso periférico. *Enferm Foco*. 2020 [cited 2023 Jan 22]; 11(1):10-14. DOI: <https://doi.org/10.21675/2357-707X.2020.v11.n1.2246>.

Author's contributions

Conceptualization, M.M.B. and S.M.E.T.; methodology, M.M.B. and S.M.E.T.; software, M.M.B. and S.M.E.T.; validation, S.M.E.T.; formal analysis, M.M.B.; investigation, M.M.B. and S.M.E.T.; resources, M.M.B.; data curation, M.M.B. and S.M.E.T.; manuscript writing, M.M.B. and L.R.S.A.; writing – review and editing, M.M.B., L.R.S.A., V.S.A.F., T.F.A.F., R.K.R., M.A.S., D.C. and S.E.M.T.; visualization, M.M.B., L.R.S.A., V.S.A.F., T.F.A.F., R.K.R., M.A.S., D.C. and S.E.M.T.; supervision, S.M.E.T.; project administration, S.M.E.T. All authors read and agreed with the published version of the manuscript.