

Nurses' peripheral intravenous catheter-related practices: a descriptive study

Práticas dos enfermeiros na cateterização intravenosa periférica: um estudo descritivo
Prácticas de los enfermeros relacionadas con el cateterismo intravenoso periférico: un estudio descriptivo

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Abstract

Background: Peripheral intravenous catheter (PIVC) insertion and maintenance are the procedures most commonly performed by nurses in clinical settings. However, current catheter failure rates are high, thus compromising the patient's therapeutic plan and well-being.

Objective: To understand nurses' practices during PIVC insertion and maintenance.

Methodology: A transversal and descriptive study was conducted in a cardiology ward in central Portugal. Nurses' ($n = 26$) practices during PIVC management were observed and recorded by a research nurse during the morning shift, using a checklist based on transnational standard of care (SoC) recommendations.

Results: During PIVC insertion ($n = 38$) the main digressive areas included glove usage (55.2%), use of the aseptic non-touch technique (44.7%), hand hygiene (18.4%-84.2%), and patient education (28.9%). Regarding PIVC maintenance ($n = 66$), catheter hub disinfection (78.8%), catheter flushing (53.3%-78.8%), and patient education (24.2%) were the main deviating areas found. Significant PIVC failure rates were found (25.8%).

Conclusion: Overall, a substantial number of PIVC-related practices does not comply with current SoC recommendations, which may pose a risk to patient safety and care quality.

Keywords: catheterization, peripheral; nurses; professional practice; standard of care

Resumo

Enquadramento: A inserção e a manutenção do cateter venoso periférico (CVP) são os procedimentos mais comumente realizados por enfermeiros em contexto clínico. Todavia, as atuais taxas de insucesso no cateterismo são elevadas, comprometendo o plano terapêutico e o bem-estar do doente.

Objetivo: Conhecer as práticas dos enfermeiros durante a inserção e a manutenção de CVPs.

Metodologia: Foi realizado um estudo transversal e descritivo num serviço de cardiologia no centro de Portugal. As práticas profissionais dos enfermeiros ($n = 26$) durante a gestão do CVP foram observadas e registadas, durante o turno da manhã, utilizando uma *checklist* baseada em recomendações de padrões de cuidados transnacionais.

Resultados: Durante a inserção de CVP ($n = 38$), as principais áreas digressivas corresponderam ao uso de luvas (55,2%), à utilização de técnica asséptica (44,7%), à higienização das mãos (18,4%-84,2%), e ao ensino do doente (28,9%). Relativamente à manutenção do CVP ($n = 66$), a desinfeção do obturador (78,8%), o *flushing* do cateter (53,3%-78,8%) e a educação do doente (24,2%) foram as principais áreas desviantes. Observaram-se taxas significativas de insucesso no cateterismo (25,8%).

Conclusão: Um número substancial de práticas relacionadas com o CVP não segue as recomendações de padrões de cuidados internacionais, o que pode colocar em risco a segurança do doente e a qualidade dos cuidados.

Palavras-chave: cateterismo periférico; enfermeiras e enfermeiros; prática profissional; padrão de cuidado

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Resumen

Marco contextual: La inserción y el mantenimiento del catéter intravenoso periférico (CIVP) son los procedimientos que los enfermeros realizan con mayor frecuencia en entornos clínicos. Sin embargo, las tasas de fallo del catéter actuales son altas, lo que compromete el plan terapéutico y el bienestar del paciente.

Objetivo: Entender las prácticas de los enfermeros durante la inserción y el mantenimiento del CIVP.

Metodología: Se realizó un estudio transversal y descriptivo en una sala de cardiología en el centro de Portugal. Un enfermero investigador observó y registró las prácticas de los enfermeros ($n = 26$) durante el manejo del CIVP en el turno de la mañana, para lo cual utilizó una lista de verificación basada en las recomendaciones del estándar transnacional de atención (SoC, en inglés).

Resultados: Durante la inserción del CIVP ($n = 38$), las principales áreas divergentes se refirieron al uso de guantes (55,2%), al uso de la técnica aséptica no táctil (44,7%), a la higiene de las manos (18,4%-84,2%) y a la educación del paciente (28,9%). En cuanto al mantenimiento del CIVP ($n = 66$), la desinfección del conector del catéter (78,8%), el lavado del catéter (53,3%-78,8%) y la educación del paciente (24,2%) fueron las principales áreas desviadas encontradas. Se encontraron tasas significativas de fallo del CIVP (25,8%).

Conclusión: En general, un número considerable de prácticas relacionadas con el CIVP no están en conformidad con las recomendaciones actuales del SoC, lo que puede representar un riesgo para la seguridad del paciente y la calidad de la atención.

Palabras clave: cateterismo periférico; enfermeros; práctica profesional; nivel de atención

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Introduction

In a progressively challenging clinical environment, the quality and safety of healthcare depend on integrating the best evidence in regular nursing practice (Ray-Barruel & Rickard, 2018). This reality gains new implications when discussing the need for inserting a peripheral intravenous catheter (PIVC) during hospitalization, since the majority of patients worldwide requires at least one to fulfill the prescribed therapeutic plan (Alexandrou et al., 2018). Nevertheless, current data from international point prevalence studies have shown that PIVCs are associated with high rates of complications known to increase morbidity and mortality risks (Alexandrou et al., 2015, 2018; Marsh, Webster, Mihala, & Rickard, 2017). In fact, there is evidence that up to 69% of PIVCs fail due to a wide range of reasons such as phlebitis, occlusion, infiltration, dislodgment, and infection (Marsh et al., 2018).

Therefore, to lower the incidence of catheter failure and avoid preventable repercussions, it is necessary to understand why PIVCs fail (Marsh et al., 2018). Recent major studies have focused on PIVC-related outcomes such as first-attempt success, incidence of complications, and costs (Alexandrou et al., 2015, 2018; Marsh et al., 2018).

Nonetheless, a significant number of authors highlighted that the professional practices observed do not always comply with the recommended standards of care (SoC) in this thematic area (Bernatchez, 2014; Braga et al., 2018; Fiorini et al., 2018; Kampf et al., 2013), such as the guidelines from the Centers for Disease Control and Prevention (CDC; O'Grady et al., 2011), the Royal College of Nursing (RCN, 2016), and the Infusion Nurses Society (INS, 2016).

This scenario is disturbing, since SoC establish the expected levels of performance for clinicians and provide criteria for accountability, supported by graded research evidence and updated by clinical experts regularly, striving for a more efficient, safer, and more patient-centered care (Ray-Barruel & Rickard, 2018).

In Portugal, PIVC-related practices and outcomes are still an understudied area. To answer this need, the TecPrevInf project (funded by the Portugal2020) was created. With an ac-

tion-research approach, the TecPrevInf project aims to transfer innovative technologies into nursing practice and identify their impact on PVC-related repercussions. As part of its action-research approach, it is essential to first describe the current nursing practices related to PIVC management to identify key areas for future improvement.

Research question

What are the nurses' practices during PIVC insertion and maintenance in a cardiology ward in central Portugal?

Methodology

Between April and August 2018, a transversal and descriptive study was conducted in the cardiology ward of a large tertiary hospital in central Portugal. The approval from an Ethics committee was delivered by the chosen hospital (authorization number 115-17) and by the Portuguese Data Protection Authority (authorization number 14037/2017).

Phase I – Checklist creation

Data were collected using a checklist based on SoC recommendations from the CDC (O'Grady et al., 2011), the RCN (2016), and the INS (2016) for all details relevant to catheter insertion and maintenance care. Additionally, to include national sources of information, the research team also reviewed the SoC recommendations from the Portuguese Central Administration of the Health System, I.P (Veiga et al., 2011). Consequently, a comprehensive list of items was delineated and cross-checked it with the different recommendations. Recommendations in categories IA/IB were considered essential for patient safety and included in the checklist. After this initial sorting, items consistent with, at least, two of the consulted guidelines were promptly included in the checklist, while singular recommendations were saved for further expert analysis.

The checklist was presented for discussion to a panel composed by clinical ($n = 6$) and academic experts ($n = 4$), with a previous background in nursing and microbiology. After this process,

all experts agreed upon a final version of the checklist, composed of a section with 35 items for PIVC insertion and another section with 28 items for PIVC maintenance. For both sections, the checklist items range from the preparation of the necessary material for PIVCs insertion/maintenance to a final moment of patient education about catheter care and prevention of associated complications. The assessment of each step follows a *yes*, *no*, and *not applicable* logic, including a comments section.

Phase II – Study conduction

All registered nurses ($n = 26$) who provided direct patient care were approached by the principal investigator, who described the research and its main purpose, as well as its voluntary nature, consequently obtaining their informed consent for participation. Student nurses and nurses absent due to annual, medical, or parental leave were excluded from this study. Data were collected by a single research nurse, with previous experience in PIVCs management and no connection to the chosen clinical setting and nursing team. During the morning shift (between 9 a.m. and 2 p.m.), nurses whose patients required a PIVC insertion or maintenance were accompanied by the research nurse, who observed the congruence between nurses' practices and the previously memorized checklist items. When necessary, the research nurse would request further oral clarification to characterize nurses' PIVC-related practices. After the procedure, the research nurse would thank the professional for collaborating and fill in the checklist in a separate private room. Simple calculations were used for the statisti-

cal analysis. Relative frequencies were used to describe the characteristics of nurses, as well as PIVC-related practices during catheter insertion and maintenance. IBM SPSS Statistics, version 23.0 was used for statistical analyses.

Results

Of the 26 participants, the majority was female (65.4%), with a mean age of 41.4 ± 9.4 years, and an average professional experience of 18.1 ± 8.5 years, of which 10.3 ± 8.6 were in the cardiology ward. Overall, 3.8% of the nurses held a bachelor's degree, 80.8% had a nursing degree (*licenciatura*), and 15.4% had a master's degree.

Forty two point three percent of the nurses were specialists in broad nursing areas such as medical-surgical (15.4%), rehabilitation (15.4%), community (7.7%), and maternal/obstetric (3.8%).

PIVC insertion

In total, 38 PIVC insertion moments were observed. Overall, 92.1% of the participants consulted the patient's prescription chart and substantiated the need for a new PIVC.

The majority of the nurses checked the patient's peripheral veins (73.7%) and also asked about the patient's previous peripheral catheterization experiences (15.8%), although only 63.2% asked for the patient's informed consent before PIVC insertion. When preparing the necessary material for PIVC insertion, 65.8% of all nurses did not follow national recommendations regarding essential material for PIVC insertion (Table 1).

Table 1
Overlooked items during the preparation of material for PIVC insertion

Items	Occurrences (%)
Sharps container	55.3
Protective field	44.7
Syringe with sodium chloride 0.9% for flushing	7.9
Disposable gloves	7.9
Tray	5.3
Occlusive dressing	2.6

Before starting the procedure, 47.4% prepared the surrounding environment by, for instance, adjusting the available light (18.4%), and ensured patient comfort. Generally, 71.1% confirmed the patient's identity before starting the procedure, although in one case they only checked the patient's name. However, nurses recurrently involved the patient throughout the procedure (84.2%). In total, 81.6% of the participants selected the puncture site in a preferred anatomical location (forearms or hands), avoiding bony areas, areas near infected, inflamed, or broken skin, as well as flexion areas. During data collection, all PIVCs were inserted in an upper extremity (100%). However, in two particular

observations, and before PIVC insertion, the excess of skin hair was not trimmed.

In all observations, reusable tourniquets were applied without a previous attempt to clean/disinfect them. In 94.7% of all observations, nurses applied the tourniquet 5 to 10 centimeters above the desired puncture site and selected a proper peripheral vein using palpation and observation (100%). However, between the selection of the desired puncture site and the preparation of the material, only 34.2% of the nurses relieved the tourniquet. To enhance vein distension, nurses employed other complementary strategies (Table 2) in 34.2% of the observed insertions.

Table 2

Nurses' complementary strategies for vein distension (after tourniquet application)

Complementary strategies for vein distension	Occurrences (%)
Asking the patient to open and close his/her hand repeatedly	13.2%
Applying direct heat	2.6%
Massaging and rubbing the puncture site	7.9%

In 92.1% of the observations, the selected PIVC was a 20-gauge. After vein selection, 55.2% of the participants wore gloves. For site antisepsis, the majority preferred 70% isopropyl alcohol (60.5%), followed by 2% chlorhexidine gluconate in 70% isopropyl alcohol (39.5%); yet, 21.1% of the observed nurses did not fulfill the expected drying time of the antiseptic. Moreover, the aseptic non-touch technique was observed in 21 of the 38 moments, since 44.7% of the nurses manipulated the insertion site after applying the antiseptic and did not perform it again.

During PIVC insertion, 81.6% of the nurses warned the patient before inserting the needle. All nurses complied with a 10° to 30° angle with the skin during the initial puncture. PIVC insertion was successful on the first-attempt in 76.3% of the moments; however, in some cases, PIVC insertion was only successful on the second

(7.9%), third (7.9%), fourth (5.3%), and sixth (2.6%) attempt.

In the majority of cases (94.7%), PIVCs were fixated with a transparent film dressing, though the puncture site was not visible in nine patients due to the use of adhesive strips in the insertion site. Dressings were identified with date and time of PIVC insertion in 18 cases, although in two instances only the date was recorded. After the procedure, 86.8% of the nurses questioned the patient about his/her comfort, and 28.9% informed the patient about potential complications, associated signs and symptoms, and preventive strategies.

Overall, during PIVC insertion, nurses' hand hygiene compliance rates were documented following international recommendations for procedure duration, solution, and technique. Results can be found in Table 3.

Table 3

Nurses' compliance with stipulated moments for hand hygiene (PIVC insertion)

Hand hygiene compliance rates		Occurrences (%)
PIVC insertion	Before contact with the patient	50%
	After leaving the patient's surroundings and before preparing the material for PIVC insertion	50%
	After preparing the patient's surroundings	57.9%
	Before donning gloves and selecting the puncture site	42.1%
	After vein selection (if done without gloves)	18.4%
	After finishing the procedure and touching the patient's surroundings	84.2%

PIVC maintenance

In total, 66 moments of PIVC maintenance were followed, mostly during the administration of intravenous medication (61%). The majority of the ward's nurses (51.5%) asked for patient consent before starting to prepare all the necessary material. Forty-one moments of medication administration were recorded. After analyzing the prescription chart, and when preparing medication, none of the included nurses recorded all the necessary criteria to identify the five rights of medication administration. Most participants (78%) only recorded the patient's name or bed number on the syringes. While preparing the necessary material, only half the nurses followed the current recommendations, frequently overlooking items such as the protective field (37.9%), the sharps container (34.8%), or a pair of disposable gloves (16.7%). Overall, 36.4% arranged the surrounding environment before PIVC maintenance. At the bedside, the patient's identity was confirmed again in 78.8% of the observed moments. All the nurses showed concern about the integrity of the catheter dressing (100%). Overall, 27.3% changed the PIVC dressing due to loose borders (18.2%), blood soiling (3%), or both (3%). However, at two different moments, the dressing was changed as part of the nurse's PIVC care routine.

Insertion site integrity was observed by all participants (100%), and it was necessary to remove PIVCs in 25.8% of the observed moments, mainly due to the presence of warning signs such as heat and edema, as well as complications such as infiltration and obstruction.

Nevertheless, before PIVC use, 78.8% of nur-

ses disinfected the catheter hub, commonly using 70% isopropyl alcohol (68.2%) and 2% chlorhexidine gluconate in 70% isopropyl alcohol (7.6%) for this purpose. In two separate moments, nurses used both alcohol and chlorhexidine to disinfect the hub.

Overall, nurses tested catheter patency using a standard saline flush (78.8%), although the volume and technique employed varied greatly, such as using a solution composed of 1% heparin diluted in 100 milliliters of sodium chloride 0.9% (3%). Nevertheless, 21.2% of the participants did not check catheter patency before administering intravenous medication. In 35 cases, PIVCs were used for intravenous medication administration, with multiple 412 administrations occurring with 15 patients. Overall, in 53.3% of the cases, nurses performed flushing between each administration, while in one-fifth of the cases there was no final saline flush. In 17.1% of the cases, nurses used a pump to calculate the adequate infusion rate, while the remaining participants administered it as a bolus.

In general, the majority of the nurses (68.2%) detected immediate effects after administration of therapy, such as pain (57.7%), infiltration (19.2%), redness (11.5%), and extravasation (7.7%). However, 24.2% of the participants provided patient education regarding possible complications and preventive strategies.

Overall, during PIVC maintenance, nurses' hand hygiene compliance rates were documented following international recommendations for procedure duration, solution, and technique. Results can be found in Table 4.

Table 4

Nurses' compliance with stipulated moments for hand hygiene (PIVC maintenance)

Hand hygiene compliance rates		Occurrences (%)
PIVC maintenance	Before contacting the patient's surroundings	72.7%
	After leaving the patient's surroundings and before preparing the material for PIVC maintenance	97%
	After preparing the patient's surroundings	77.3%
	Before contact with the patient for PIVC maintenance	75.8%
	After finishing the procedure and contact with the patient's surroundings	100%

Discussion

The observed practices during PIVC insertion and maintenance varied greatly between the ward nurses and differ, in some instances, from the consulted SoC recommendations. According to the RCN (2016, p. 9), "infusion therapies may be required as a result of emergency or planned episodes of care and will be dependent upon a patient's clinical needs". In this sense, in cases where infusion therapy is considered for long term use, patients and their caregivers/family members will be well enough to participate in decisions that support or value their care delivery (RCN, 2016).

Therefore, patients should be able to make informed decisions in partnership with their nurses and the nurses must obtain their consent (RCN, 2016). However, in our study, more than one-third of nurses (36.8%) did not ask for patient's consent before PIVC insertion, and 48.8% did not ask for patient's consent before maintenance care. Furthermore, previous PIVC-related experiences were explored in only 15.8% of the observed moments. These results are disheartening since increased patient involvement in decisions affecting their care can support the nurses' decisions in approaching PIVC based on the patients' lifestyle and therapeutic needs (RCN, 2016).

Additionally, moments of patient education varied between 24.2% (maintenance) and 28.9% (insertion) of the observations made. These results are less than expected, demonstrating that nurses should educate patients (or caregivers/family members) about their care plan including, but not limited to, the goals of intravenous treatment, potential adverse effects, and PIVC management instructions (INS, 2016). These moments should be substantiated

by personalized elements such as the patient's literacy levels, cultural congruence, and primary language, in an understandable and actionable approach (INS, 2016).

Regarding the medical devices used during PIVCs insertion and maintenance, full compliance with the SoC recommendations was not observed. In fact, nurses did not always comply with the recommended principles of quality and safety, especially in what concerns the use of a sharps container. According to the RCN (2016), all used needles should be disposed of in a non-permeable, puncture-resistant, tamper-proof container (located in a safe environment in the ward or a near patient location).

This situation is worrisome, mainly because of the inherent occupational health risk for nurses due to potential needlestick and sharps injuries during PIVC insertion. Furthermore, potentiating this risk, all catheters used during PIVC insertion did not possess a safety mechanism that allows capping the entire needle (Sossai et al., 2016).

The results obtained depict an international reality, where nurses constitute the most significant risk group for needlestick injuries with a severe clinical, economic, and humanistic burden (Cooke & Stephens, 2017). In addition to the excessive working hours, understaffing, and poor care environments, inadequate practices of needle disposal (e.g., recapping) and understock of essential material (sharps containers) are considered modifiable factors (Cooke & Stephens, 2017). Nonetheless, there is evidence that specific training reduces this risk exponentially (Abebe, Kassaw, & Shewangashaw, 2018). Overall, different observed practices potentiate the risk of PIVC-related contamination, contradicting the need for aseptic technique

adherence during all aspects of PIVC management. During vein selection, all nurses applied a reusable tourniquet with no prior moment for decontamination. This reality is alarming, since all additional equipment must be cleaned routinely before and following patient use according to the manufacturer's recommendations (INS, 2016). Reusable tourniquets can harbor pathogenic microorganisms and pose a risk of puncture site contamination (Costa et al., 2018). Antiseptics should be allowed to dry before PIVC placement, according to the manufacturer's recommendation (INS, 2016; O'Grady et al., 2011). In our study, drying times were respected in 21.1% of the observed moments, evidencing a gap in this domain. Furthermore, after skin disinfection, 44.7% of the nurses touched the insertion site and did not disinfect it again, thus not complying with recommendations for maintaining aseptic technique throughout PIVC management (O'Grady et al., 2011). Notably, this result is more significant than in other contemporary studies (Kampf et al., 2013). In 23.7% of the moments observed, the same nurse attempted PIVC insertion 3 to 6 times. Similar results were found by Marsh et al. (2018), where multiple insertion attempts were necessary to place 23% of the analyzed PIVCs. Interestingly, supporting our findings, the authors also found that no vascular visualization technologies (e.g., ultrasound or near-infrared light) were used to assist nurses in complex cases, as this method is rarely used in the selected hospital setting. This reality must be taken into consideration by hospital managers, since vascular visualization technologies "should be used in patients with difficult venous access and after failed venipuncture attempts" (INS, 2016, p. 44). Vein visualization technology is proven to reduce the number of PIVC insertion attempts and mechanical complications in complex cases (RCN, 2016), thus reducing patients' anxiety and pain levels and improving overall patient and carer satisfaction. Acquiring these technologies and training professionals in their use may be an alternative to the traditional technique and its limitations, given the significant number of patients with difficult venous access as a result from structural vessel changes caused by disease processes, history of frequent venipuncture, lengthy cycles of infusion therapy, skin alterations, or even variations in color and hair (INS, 2016).

In this study, regarding PIVC securement, 94.7% of the nurses used transparent film dressings, as recommended by most international SoC guidelines (Bernatchez, 2014), allowing visual inspection of the catheter site without dressing removal and protecting against external pathogens. However, 23.7% of the dressings performed covered the catheter site, diminishing any attempts of continuous clinical supervision of the device and preventive measures in early cases of complications such as phlebitis. Moreover, most nurses did not record the time and date of the dressing change. Although the latest guidelines advocate clinically indicated replacement of PIVC as an alternative to routine replacement (Bernatchez, 2014), recording the date and time of dressing replacement may assist nurses in monitoring eventual early stage symptoms in the endovascular segment, such as heat, tenderness, erythema, or palpable cord (Capdevila et al., 2016).

Additionally, while the catheter site dressing must be replaced when it becomes damp, loose, or visibly soiled (O'Grady et al., 2011), 18.2% of the dressings in our study were poorly fixated. This result is clinically significant since effective catheter stabilization reduces the incidence of PIVC failure and prevents complications associated with catheter re-siting (Marsh, et al., 2017). Although no linear conclusions can be drawn in this respect given our study design, poor PIVC fixation may partly explain the high incidence of PIVC replacement found (25.8%). Surprisingly, similar results were found in recent prevalence studies also conducted in Western Europe, where 11-21.8% of PIVC dressings were loose or lifting (Alexandrou et al., 2015, 2018).

Notably, during the phase of medication preparation, it was observed that no nurses recorded all the necessary information to confirm the five rights of medication administration afterward at the patient's bedside (the right patient, the right medication, the right dose, the right route, and the right time). However, the absence of necessary safety measures in medication administration can be harmful to patients. Although individual carelessness can play a role in medication errors, there is evidence that both human variables and system failures are accountable for them. For instance, multiple studies show that factors such as communication failures, technology issues, interruptions, distractions,

heavy workload, and physical exhaustion can contribute to nurses' medication errors (Jones & Treiber, 2018). This result changes its face when confronted with international SoC that point to the need to expand these safety and quality assurance rights beyond five, such as the right to refuse, the right education, the right preparation, the right frequency, the right drug-drug interaction, the right evaluation, and the right information (Jones & Treiber, 2018).

According to the RCN (2016), PIVC patency should be maintained using pulsatile flushing between the various medication administrations and positive pressure afterward. In this study, flushing was performed in 78.8% of the observed moments, although nurses' compliance with current recommendations decreased between and after multiple administrations. Furthermore, flushing technique and volume varied greatly between professionals, mirroring contemporary studies such as that by Braga et al. (2018), where flush volume ranged between 3 and 10 mL.

The non-standardization of flushing practices may result from the absence of sustained evidence pointing to the correct volume (Braga et al., 2018). Indeed, SoC recommendations may be vague in this respect, noting that the volume of the flush solution may vary due to factors such as PIVC type and size, patient's age, and type of infusion therapy (INS, 2016; RCN, 2016). Nevertheless, the INS (2016, p. 77) advocates the use of a minimum flush volume "equal to twice the internal volume of the catheter system (e.g., catheter plus add-on devices)", indicating a volume between 5 and 10 mL of preservative-free 0.9% sodium chloride to promote the removal of fibrin deposits and drug precipitates from the PIVC lumen.

Given its significance in the prevention of healthcare-associated infections (HAIs), nurses' compliance with hand hygiene during PIVC insertion and maintenance was analyzed with hand hygiene during PIVC insertion and maintenance. During PIVC insertion, compliance rates varied between 18.4% (after vein selection) and 84.2% (after finishing the procedure and touching the patient's surrounding). However, during PIVC maintenance, hand hygiene compliance rates increased substantially, ranging between 72.7% (before touching the patient) and 100% (after finishing the procedure and touching the patient's surroundings). In both

instances, nurses achieved higher compliance rates in specific moments designed to protect themselves when in contact with the patient.

In this study, the lack of hand hygiene compliance before vein selection (42.1%) and antiseptis of the puncture site (18.4%) poses a risk of exogenous infection. Similarly, Kampf et al. (2013) found that nurses' hand hygiene compliance rates during PIVC insertion were equally underwhelming, specifically before initial patient contact (9.2%) and before catheter insertion (0%). These results belie the indications of the CDC (O'Grady et al., 2011), which stipulate that hand hygiene must be performed before and after palpating catheter insertion sites as well as before and after inserting, replacing, accessing, repairing, or dressing an intravascular catheter. Moreover, although gloves should not be used as an alternative to hand hygiene (RCN, 2016), every manipulation of the PIVC must be performed with single-use clean gloves (Capdevila et al., 2016). This practice is essential to protect nurses whenever there is potential contact with blood (e.g., during PIVC insertion), body fluids, mucous membranes, non-intact skin, or contaminated equipment (INS, 2016). However, in this study, nurses wore gloves in 55.2% of the observed moments. This situation constitutes an occupational risk, especially when associated with the underwhelming hand hygiene compliance rates witnessed, the non-existence of PIVC with needle retraction system, and non-recurrent use of a sharps container.

Overall, it was observed that several nurses PIVC-related practices did not comply with current national and international SoC recommendations. Interestingly, some of the non-conformant practices found in this study matched other national and international findings, such as: multiple puncture attempts through traditional technique; mismatched preparation of essential material (e.g., sharps container); variations in PIVC flushing (technique, volume, and timings) and aseptic non-touch technique; hand hygiene compliance and glove use.

These findings highlight the need for continuous staff education on PIVC SoC recommendations, since the lack thereof can lead to the "relaxation of the norm, abandonment of good clinical practices, and increase in infection and complication rates" (Capdevila et al., 2016, p. 196). However, our findings need to be analyzed within the

context of some limitations. The study design prevented the follow-up of PIVCs until their removal with the purpose of collecting specific clinical outcomes. Although efforts, from the research team, to involve nurses in our study were exhaustive, our sample is not representative of global professional practices.

Moreover, this study did not focus on nurses' knowledge of PIVC management and did not take into consideration internal and external factors that potentially influence nurses' daily practices. For instance, in this study, the vast majority of the nurses used a 20-gauge PIVC (92.1%), while current SoC recommendations advocate the lowest caliber possible according to patients' veins and therapeutic plan. Future studies should consider this aspect since numerous studies have shown there is an evident lack of knowledge of PIVC management by clinical staff and of possible favorable opportunities to improve it (Capdevila et al., 2016). However, these results are significant for nursing practice, since PIVC insertion and maintenance are considered essential skills for all practicing nurses (Ho, Liew, & Tang, 2016).

Integrating the best available evidence into PIVC management is a complex and time-consuming process (Ray-Barruel & Rickard, 2018), especially for healthcare professionals such as nurses, whose workload and spectrum of professional activity require constant dedication. In this sense, health managers should "incorporate decision supports at the point of care that contribute to meaningful patient outcomes without increasing workload and paperwork" (Ray-Barruel & Rickard, 2018, p. 17), especially for nurses, since they are the professionals who deal primarily with PIVCs (Fiorini et al., 2018).

SoC recommendations constitute a consistent, reliable, and valid approach to PIVC management (Ray-Barruel & Rickard, 2018) and can be used as a consultation resource in clinical settings, mainly in the form of a clinical guideline. However, clinical guidelines should be regularly updated, involving the active participation of stakeholders from the different organizational levels to allow their replication regardless of the clinical context (Ray-Barruel & Rickard, 2018). Additionally, there is evidence supporting the importance of disclosing periodically to staff PIVC-related complication rates as a positive reinforcement for guideline follow-up and as

a warning if deviations occur (Capdevila et al., 2016). Nevertheless, SoC recommendations must be used as a sustained foundation in the development of institutional, educational programmes and policies on PIVC management, setting the benchmark for professional performance during catheter insertion and maintenance.

Conclusion

The findings of this study evidenced that nursing practices during PIVC insertion and maintenance are not consistent and do not always comply with current SoC recommendations, namely regarding patient involvement and education as well as infection prevention and control related practices such as: hand hygiene, glove usage, use of non-touch aseptic technique, catheter hub disinfection, and flushing.

Given the outlined results, and as part of the action-research methodology employed in the TecPrevInf project, there is an evident need to proceed to its next phase, which includes reflexive sessions with the nursing team and educational programmes based on SoC recommendations, providing an optimal environment for achieving high-quality PIVC-related patient outcomes, safety, and satisfaction.

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