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## **PERIPHERAL VENIPUNCTURE: COMPREHENSION AND EVALUATION OF NURSING PRACTICES**

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### **ABSTRACT**

**Objective:** to understand the nursing practices related to peripheral venipuncture and to analyze the incidence of complications in patients with venous catheters.

**Method:** mixed design, involving: case study, sectional study, cohort study and focus group. The sample consisted of nurses and patients from a medical clinic in Portugal. Thematic analysis and descriptive statistics were performed.

**Results:** stressors capable of influencing nursing practices were identified, including: the decisions of the medical team, the age and characteristics of the venous network of the patient, the availability of other catheters in the institution, the low level of knowledge of nurses regarding the care of patients in the insertion, maintenance and removal of the peripherally inserted central venous catheter. The following complications and their respective incidences were documented in patients with peripheral venous catheters: phlebitis (22.2%), obstruction (27.7%), fluid exiting through insertion site (36.1%), infiltration (38.8%) and accidental catheter removal (47.2%). Catheter obstruction with an incidence of 22.2% was only observed in those who used the peripherally inserted central venous catheter. The following benefits were observed with the use of the peripherally inserted central venous catheter: safe administration of drugs; pain reduction, number of venous punctures and complications.

**Conclusions:** the peripherally inserted central venous catheter is presented as a valid and viable alternative that can improve the quality of nursing care and the safety and well-being of patients.

**DESCRIPTORS:** Peripheral catheterization. Vascular access devices. Nursing. Patient safety. Technology.

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# CATETERISMO VENOSO PERIFÉRICO: COMPREENSÃO E AVALIAÇÃO DAS PRÁTICAS DE ENFERMAGEM

## RESUMO

**Objetivo:** compreender as práticas de enfermagem relacionadas com o cateterismo venoso periférico e analisar a incidência de complicações durante a permanência do cateter venoso no paciente.

**Método:** delineamento misto, envolvendo: estudo de caso, estudo seccional, estudo de coorte e grupo focal. A amostra foi constituída por enfermeiros e pacientes de um serviço de clínica médica de Portugal. Efetuada análise temática e estatística descritiva.

**Resultados:** identificou-se estressores capazes de influenciar as práticas de enfermagem, sendo eles: as decisões da equipe médica, a idade e as características da rede venosa do paciente, a disponibilização de outros cateteres pela instituição e o baixo nível de conhecimento dos enfermeiros sobre os cuidados aos pacientes na inserção, manutenção e remoção do cateter venoso central de inserção periférica. Nos pacientes portadores de cateter venoso periférico, documentou-se as seguintes complicações e suas respectivas incidências: flebite (22,2%), obstrução (27,7%), saída de fluido pela inserção (36,1%), infiltração (38,8%) e remoção acidental do cateter (47,2%). Naqueles que usaram o cateter venoso central de inserção periférica, identificou-se apenas a obstrução desse cateter, com incidência de 22,2%. Verificou-se os seguintes benefícios com a utilização do cateter venoso central de inserção periférica: administração segura de medicamentos e redução da dor, do número de punções venosas e de complicações.

**Conclusão:** o cateter venoso central de inserção periférica apresenta-se como alternativa válida e viável para melhorar a qualidade da assistência de enfermagem, a segurança e o bem-estar dos pacientes.

**DESCRITORES:** Cateterismo periférico. Dispositivos de acesso vascular. Enfermagem. Segurança do paciente. Tecnologia.

# CATETERISMO VENOSO PERIFÉRICO: COMPRENSIÓN Y EVALUACIÓN DE LAS PRÁCTICAS DE ENFERMERÍA

## RESUMEN

**Objetivo:** comprender las prácticas de enfermería relacionadas con el cateterismo venoso periférico y analizar la incidencia de complicaciones durante la permanencia del catéter venoso en el paciente.

**Método:** delineamiento mixto, involucrando: estudio de caso, estudio seccional, estudio de cohorte y grupo focal. La muestra está formada por las enfermeras y los pacientes en un servicio de clínica médica de Portugal. Se realizó un análisis temático y estadístico descriptivo.

**Resultados:** se identificaron estresores capaces de influenciar las prácticas de enfermería, siendo ellos: las decisiones del equipo médico, la edad y las características de la red venosa del paciente, la disponibilidad de otros catéteres por la institución y el bajo nivel de conocimiento de los enfermeros sobre los cuidados a los pacientes en la inserción, mantenimiento y remoción del catéter venoso central de inserción periférica. En los pacientes portadores de catéter venoso periférico, se documentó las siguientes complicaciones y sus respectivas incidencias: flebitis (22,2%), obstrucción (27,7%), salida de fluido por la inserción (36,1%), infiltración (38,8%) y eliminación accidental del catéter (47,2%). En aquellos que usaron el catéter venoso central de inserción periférica, se identificó sólo la obstrucción de ese catéter, con incidencia del 22,2%. Se verificaron los siguientes beneficios con la utilización del catéter venoso central de inserción periférica: administración segura de medicamentos y reducción del dolor, del número de punciones venosas y de complicaciones.

**Conclusión:** el catéter venoso central de inserción periférica se presenta como alternativa válida y viable para mejorar la calidad de la asistencia de enfermería, la seguridad y el bienestar de los pacientes.

**DESCRIPTORES:** Cateterismo periférico. Dispositivos de acceso vascular. Enfermería. Seguridad del paciente. Tecnología.

## INTRODUCTION

In the field of nursing, technology is understood as the use of knowledge and materials (equipment or medication) used in the nurse-patient therapeutic relationship, to investigate objective and subjective data in order to identify nursing diagnoses capable of supporting care planning and nursing interventions.<sup>1-2</sup>

By relating the process of peripheral venipuncture<sup>3</sup> and the administration of intravenous therapy with health technologies, it is possible to understand intravenous catheters as a hard technology; the structured knowledge that supports care as a soft-hard technology; and nurse-patient interactions during care as a soft technology.<sup>4</sup>

Venous catheters are technological resources used to care for people who need intravenous drug therapy for the treatment of several pathologies, in different contexts, with the peripheral venous catheter (PVC) being the most used type. It enables the administration of solutions and/or medicines, parenteral nutrition, blood products and the collection of blood for diagnostic purposes.<sup>5-7</sup> However, the evidence indicates high incidence of local complications with PVC after insertion, principally phlebitis and infiltration, as well as associated risk factors, such as irritant medications.<sup>7-12</sup>

The peripherally inserted central venous catheter (PICC) presents as an alternative to the PVC, as it allows the administration of any type of medication, including irritants and/or vesicants,<sup>13-14</sup> due to the final location of its tip in a central vein. Such positioning contributes to low rates of local complications compared to PVCs and midlines.<sup>14-18</sup>

PICC have a high insertion success rate (up to 95%), especially when guided by ultrasound,<sup>14</sup> are cost-effective in relation to the other central venous catheters, mainly in the insertion, and have lower incidences of complications.<sup>19</sup> In addition, they meet patients' intravenous therapy needs, who express satisfaction and comfort during its use, particularly when the PICC is compared to the PVC, as it reduces pain related to successive venipuncture attempts.<sup>13,19-20</sup>

Despite the benefits, PICC limit some of the patient's daily life activities, such as the practice of water sports, and requires particular care during personal hygiene as to avoid wetting the dressing, in addition to weekly dressing changes.<sup>13</sup>

The nurse is responsible for the clinical and holistic evaluation of the patient with a PVC, in a dynamic energy system perspective and interaction of intra, inter and extrapersonal variables. Its performance, according to the Neuman Systems Model, which aims to identify the possible stressors and their effects when a break in the defense line occurs. The nurse also aims to help the patient to stabilize his/her energy system through nursing interventions at the primary, secondary or tertiary level,<sup>21</sup> in order to prevent, reduce and treat complications so that the patient reaches their maximum well-being.

Considering that nurses are responsible for the selection, insertion and maintenance of PVCs in patients requiring intravenous therapy, their position allows them to provide care in the monitoring and evaluation of human responses, in order to prevent failures, report errors promote the safety and well-being of patients requiring intravenous infusion.

Thus, considering the work that the nurse performs in the peripheral venipuncture process, an investigation was performed to understand the nursing practices related to peripheral venous catheterization and to analyze the incidence of complications in patients with venous catheters.

## METHOD

From a conceptual point of view, orientation from the Medical Research Council (MRC) was chosen to implement and evaluate complex interventions.<sup>22</sup> Therefore, the mixed method was used

because it allows to join different approaches and helps to understand the phenomenon under study: nursing practices in the peripheral venipuncture process. In Step 1 - Development:<sup>22</sup> an institutional case study with nurses was implemented on the premise that nursing practices are influenced by several factors that are capable of influencing patient safety. In Step 2 - Feasibility/piloting:<sup>22</sup> was performed sequentially: a) sectional study to obtain information on nurses' knowledge regarding care for patients with PICC; b) educational intervention with nurses on PICC care; c) pilot study outlined in a cohort to analyze the incidence of complications in patients with PVC and PICC, and to analyze the feasibility of a study in a larger sample; and d) focus group with nurses to understand the changes that occurred in nursing practices.

The setting was a medical clinic service in Portugal. The choice was intentional, due to the high incidence of phlebitis evidenced in a previous study<sup>9</sup> and the motivation of the nursing team.

The Development Stage (July/2015 to February/2016): a case study was carried out,<sup>23</sup> using participant observation techniques and individual interviews. The inclusion criteria were to be a nurse and to provide care to the patients in the service for a minimum of three months. Among the 30 eligible nurses, two were excluded due to being on maternity leave, one due to prior management activities and five due to being transferred to other services. There were 22 nurses in total. There was no refusal to participate.

A previously elaborated data collection instrument based on the scientific evidence on the subject guided the content in the participant observation. The criterion adopted for the beginning and end of each observation was the knowledge of the activities of the principal investigator and related to nursing care in peripheral venipuncture process and/or the preparation and administration of drugs via the peripheral intravenous route, or invitation from the nurses to accompany them during this treatment. In general, the observation began during the nurses' shift and continued until the end of the medication administration, with an average time of three hours in each work shift (ranging from 2 to 5 hours). There were days where observation occurred during the three shifts.

The semi-structured interview used a script with guiding questions and some inductive phrases that addressed the current nursing practices in the service and the factors that influenced them in the scope of the peripheral venipuncture process. The interviews were recorded and performed in a private setting (25 to 45 minutes).

The delimitation of the case study sample was based on the lack of new information and data saturation.<sup>24</sup> The possibility of interrupting the data collection was corroborated by the Pearson Coefficient (0.89 to 0.76). Thus, 16 interviews and approximately 160 hours of participant observation were performed.

Viability/Piloting Stage (October/2015): the sectional study was implemented using a questionnaire with 30 questions related to the technique and indications for PICC insertion, length of stay, final tip positioning and nursing care provided to the patient in the PICC maintenance and removal. The questionnaire was read and answered by the nurses during work hours (15 to 20 minutes). The same inclusion and exclusion criteria were adopted for the case study, and the sample consisted of 22 nurses.

The case study findings and the level of knowledge of nurses related to PICC in the sectional study supported the planning of an educational intervention (November/2015 and February/2016): a) two theoretical-practical courses (16h each) involving 15 nurses; b) four workshops over the period of eight days, aimed at developing the nursing protocols related to patient care and PICC insertion, maintenance and monitoring, involving seven nurses; c) two theoretical courses (2h/day) with 27 nurses on PICC care; and d) external training of a nurse in an intravenous therapy service in Madrid, Spain (one week, April/2016).

Prospective cohort pilot study (July to September/2016): patients with PICC or PVCs were followed up for 40 days. For the patients with a PVC, entry into the cohort occurred at their hospital admission and their exit occurred when the PVC was removed due to discharge, transfer, death, or central venous catheter insertion (CVC). In patients with PICC, they entered the cohort at any time during hospitalization and their exit was due to the removal of PICC for any reason.

Patients older than 18 years of age and undergoing intravenous treatment via PVC or PICC were included in the cohort study. There were 38 eligible patients in the PVC group, one was excluded due to having a CVC and one due to receiving oral therapy, totalling 36 patients. In the PICC group, nine patients were included and there was no exclusion. The independent and dependent variables (complications) were obtained in the patients' medical records or through an instrument purposefully developed for the present study. Validated scales were used to evaluate phlebitis<sup>25</sup> and infiltration.<sup>26</sup>

The focus group was performed after three months of PICC use in patients (October/2016). In order to include and exclude nurses, the same criteria described in the case study were adopted. Among the 27 eligible nurses, three were excluded because of vacation leave and three did not provide care to patients with PICC. 12 of the 21 nurses who met the inclusion criteria were invited to participate in the focus group, with four refusals due to the fact that the activity occurred outside working hours. Three did not attend the scheduled date and time, totalling five nurses.

The focus group began with a guiding question: What were the changes that occurred in nursing practices after the implementation of the PICC? The leading questions were aimed at identifying the facilitating factors and obstacles for the changes, how to overcome the difficulties and the benefits of using the PICC. The group took place in a meeting room in the clinic (40 minutes), and was coordinated by the main researcher and aided by a master's degree student.

Considering the consistency of the data, the Pearson coefficient (0.75), the nurses' interaction in the group, the achievement of the objectives and the low availability of the nurses, a single focus group was performed.

Field notes and the full transcript of the individual and focus group interviews were performed on the Word program for Windows and exported to the NVivo® Pro, version 11 for analysis.

The findings of the case study and focus group were submitted to thematic analysis, assuming three theoretical positions: 1) the theoretical interpretation position; 2) the option of inductive thematic analysis; and 3) the choice of the semantic level, *i.e.*, the themes were identified according to the explicit meanings in the data.<sup>27</sup> A narrative description was made for the educational intervention.

Data from the cross-sectional and cohort studies were analysed using the Statistical Package for the Social Sciences SPSS® program, version 20, using descriptive statistics (absolute and relative frequencies and measures of central tendency and dispersion). The incidence rate of complications considered the cumulative incidence of 100 catheters/day.

This research was approved by the Ethics Committee of the Hospital where the investigation was performed. In order to ensure anonymity, the nurses' statements were identified by the letter "e" followed by a numerical sequence. The excerpts of the participant's observations were identified by the acronym "Obs".

## RESULTS

The 22 nurses were mostly women (82.5%), with an average age of 31 (Q1=28, Q3=41) and worked in the service for average of five years (Q1=4, Q3=13).



In the participant observation and interview, Nursing practices in the peripheral venipuncture process was identified as the thematic category. Two subcategories emerged from this category: Nursing practices and patient safety, and The influences on nursing practices.

In the subcategory, Nursing practices and patient safety, the sources used by nurses to identify their practices were identified. Formal education in school and the nurse-patient interactions in the clinical situations were the main forms for the acquisition of experiential knowledge and competences, according to the following excerpts: *look, it comes from our knowledge, from what we learned at school, right? And then it comes with the work we do every day (e13). The dilution level of the medication we will be able to adapt to the type of patient, [...] when they have weaker veins we can dilute more so as not to be so aggressive with the vein. [...] (e11). The nurse sought to confirm with another older colleague in the service if the two serum balloons were actually saline because they were different brands (Obs).*

Teamwork contributed to a safe nursing practice, since the cooperation of the more experienced nurses resulted in the reduction of venipuncture attempts, according to nurses' statements: *if there is any doubt, [...] we ask for help from someone who is more experienced. [...] (e9). We ask for help if we can't do something, [...]. We try 3 times [...] (e15). I observed several situations involving cooperation and teamwork, especially the venipuncture of patients with difficult venous access (Obs).*

In this second subcategory, the influence of the medical team on the nursing practices was observed. Such influences occurred when the nurses contraindicated the PVC and the medical team insisted on the permanence of this catheter, thus avoiding central venous access. This fact led the nurses to successive venipuncture, attempts, according to the following reports: *sometimes we are pressured to be able to puncture even a venule, a vessel of tiny caliber, just to avoid other procedures like the central catheter (e15). When we really do not find any access in the upper limbs we go to the lower limbs [...] (e3). During the shift, the nurse reports that an 85-year-old woman in bed 25 had no peripheral venous access, with a glucose level of 59. [...]. The nurse says two colleagues had tried without success. The doctor insists to try one more time (Obs).*

The characteristics of the patients regarding age and venous network also influenced nursing practices and, consequently, the success of peripheral venipuncture procedure, according to the following excerpts: *we have elderly patients, in terms of venous accesses, they are already very debilitated and I feel that I have great difficulty in being able to feel the veins (e1). The lack of visibility [of the veins] I think is one of the conditions (e7). The nurse asks the woman if the veins are dancers. And the woman answers that she doesn't know. And the nurse says that the veins dance, they disappear (Obs).*

## Sectional study

In the sectional study, the level of nurses' knowledge about PICC (score of right answers) reached an average value of 15.5 points (0-24;  $\pm 5.7$ ), with a maximum of 30 points. The percentage of correct answers ranged from 5.5% to 94.5%, with nurses demonstrating unawareness regarding the PICC insertion and maintenance care (Table 1). These results highlighted the need for specific educational intervention in order to acquire new care skills.

**Table 1** - Nurses' knowledge about care regarding the insertion and maintenance of peripherally inserted central venous catheter (PICC) with wrong answers greater than 30% Coimbra, Portugal, 2015 (n = 22)

Clinical items of the nurses' knowledge	n	%
Skin preparation for PICC insertion	18	81.8
Length of stay of PICC	17	77.2
Syringe size for administering medications	16	72.7
Indication of the use of PICC clearing technique	16	72.7
PICC removal technique	13	59.0
Selection of catheter size to be inserted in adults	12	54.5
Use of the PICC at home	12	54.5
Placement of the catheter tip in the superior vena cava	12	54.5
Fixation at the insertion site (absence of suture)	11	50.0
Indications for PICC insertion	11	50.0
Measure of amount of catheter to be inserted	7	31.8

In-service education activities were implemented through two theoretical/practical courses for 15 nurses (50%) with an instructor certified by the PICC Academy Network (PAN). The content met the international training recommendations for PICC insertion and care.<sup>28</sup> Under the guidance of the instructor, all nurses performed ultrasonographic evaluation of the veins of colleagues and the insertion of a PICC into a realistic prototype.

The protocols were developed in the workshops, which were signed by the managers and implemented in the nursing and medical practices, namely: ultrasound guided insertion; prevention of complications; insertion dressing; clearing; flushing; blood collection via PICC; and removal.

A third theoretical course on care for the maintenance and monitoring of patients with PICC was carried out with all nurses. The fourth activity was an external training with a nurse to acquire new skills related to PICC insertion

In the cohort study, the 36 patients with PVCs were men (66.5%) and the average age was 84.5 years (50-96, Q1=77, Q3=87.5). The nine patients with PICC were predominantly male (78%), average age of 84 years (62-93, Q1=71, Q3=85.5). In most patients, the age was ≥80 years (PVC=64%, PICC=66.5%). The main reason for hospitalization was an infectious pathology (PVC=69.5%; PICC=66.5%). Hypertension (PVC=69.5%; PICC=55.5%) and diabetes mellitus were the most common pre-existing pathologies (44.5% in both groups).

Indications for PICC insertion: difficulty in venipuncture and/or absence of peripheral veins for puncture (60%); administration of irritant drugs and/or with pH≤5 or ≥9 (70%); intravenous therapy scheduled for more than seven days (30%); administration of parenteral nutrition (10%). The small caliber of the patients' veins contraindicated PICC insertion in 10 patients.

In all 137 PVCs, a safety system (Introcan Safety® B. Braun®) were used for the insertion (visualization and/or palpation), with the gauges 20 and 22 (27% and 73%, respectively). Insertion site: back of the hand (32.8%), forearm (49.6%), antecubital fossa (8.8%), arm (4.4%) and foot (4.4%).

The ten PICC (Vygon®) were inserted in nine patients by a single nurse. The insertion was performed using the Micro Seldinger technique with ultrasonography in the middle section of the arm, in the basilica (90%) and brachial (10%) veins, with French calibers 3, 4 and 5 (40%, 40% and 20%, respectively).

The tip of the PICC was identified in 100% of the evaluations by the P wave with the maximum height, i.e., at the junction of the superior vena cava and the right atrium, using the intracavitary



electrocardiogram. The change of the PICC dressing (transparent impermeable transparent film and fixation without suture - PICC Grip-Lok®) and accessory systems (extensor and multipurpose bidirectional valve) was carried out by three specific nurses and the other care was performed by all the nurses of the team.

Regarding the total number of catheters inserted in the patients with PVCs, the median was three catheters (1-12, Q1=1, Q3=5) and the mode was one catheter with the PICC (89%). In one patient two PICCs were inserted, due to the first becoming obstructed. In both catheters, an average of 1.5 venipuncture attempts were required until success (CVP =1-6,  $\pm 0.7$ ; PICC=1-3,  $\pm 0.6$ ), with a mode of one puncture=79%, PICC=70%). When all the venipunctures were added up (PVC insertion and blood collection for examinations), a median of eight punctures (1-31; Q1=4.5, Q3=14) was observed. In PICC patients, the majority of blood collection was performed via the PICC (60%), avoiding in average seven venipunctures per patient (1-14;  $\pm 4.5$ ), and a median of six punctures (Q1=2.5 - Q3=10).

According to table 2, complications in relation to infiltration and accidental removal had higher incidences in PVCs. Obstruction occurred in the PICC but no infection or thrombosis.

**Table 2** - Incidence of complications related to the use of PVCs and PICC, Coimbra, Portugal, 2016

Complications	PVC		PICC	
	Cumulative incidence* %	Incidence per 100 PVCs/ day†	Cumulative incidence‡ %	Incidence per 100 PICCs/ day§
Phlebitis	22.2	1.7		
Infiltration	38.8	6.2		
Obstruction	27.7	3.3	22.2	2.3
Accidental removal of catheter	47.2	5.8		
Fluid from catheter insertion site	36.1	4.2		

Notes: \*n: 36 patients; †447 PVCs/day; ‡n: 9 patients; §130 PICC/day.

The mean length of stay of the PVCs was 76h (4-480, SD $\pm$ 82.7) and the median was 48h (Q1=23, Q3=96); the mean length of stay for PICC was 348h (2-770; SD  $\pm$ 274.3) and the median was 330h (Q1=111; Q3=528). Obstructed PICC (n=3) remained on average 219.5h (76-313;  $\pm$ 126.2), i.e., nine days, with a median of 270 hours (Q1=76).

In the focus group, five nurses participating were women, with an average age of 38 years (27-48,  $\pm$ 7.8). The average working experience in the service was 12 years (1-19;  $\pm$ 6.9).

Two empirical categories emerged from the reflections obtained through the thematic analysis: Benefits and difficulties regarding PICC use in nursing practices; and Factors that contributed to changes in nursing practices.

In the category, Benefits and difficulty regarding PICC use in nursing practices, the benefits of PICC for the patients and nurses emerged, namely: fast and safe administration of medications; reduction of venipunctures; pain reduction and local complications; there were no patients without venous access; reduction in the time nurses spent in the search for peripheral veins; and stress reduction and/or pressure exerted by physicians. These benefits are exemplified in the following nurses' reports: *I think it was a major change in our profession [...], it has improved a lot, both in terms of quality of medication administration to patients, and in our time with patients, because a lot of the time we were there on top of the patient searching for a vein, for long periods of time, hurting*

*the poor things [...]. The medication was guaranteed. [...], a safe, fast and guaranteed administration (e7). There are many advantages, like reducing the amount of punctures, and the problem of having patients without venous access [...] (e12). Not even in terms of reducing pain, edema and anxiety, which is sometimes associated. We go the patient and say: oh! Let's poke it one more time [...] (e17).*

The need to mobilize the knowledge acquired in the courses emerged as a difficulty, since the few patients with PICC did not provide a rapid acquisition of tacit knowledge and did not allow to provide care quickly. This demanded reflection on action and on action for an intentional, evidence-based, and secure action. The difficulties were identified in the following excerpts: *I don't have much experience in taking care of patient with a PICC, but sometimes I have had difficulties because I did not have practice, it took me a lot longer, but I think it's normal [...] (e11). It takes a lot more time to prepare the medication because we have to remember that Lasix cannot be administered in a 3ml syringe, it has to be in a bigger caliber, [...] and turn the tap off before and then turn the tap off after [...] (e7).*

In the second category of the focus group, Factors that contributed to the changes in nursing practices contributed to the changes in the practices: the developed nursing protocols, which aided in the clarification of doubts, and the research process itself. These factors are exemplified in the following nurses' statements: *The nursing protocols help to clarify some doubts when they arise, and we do not have colleagues here who are more on the subject and always support [...] (e5).*

## DISCUSSION

Oftentimes, the nurse is influenced by the decisions of the medical team, by the characteristics of the patient's venous network, which is often limited by the availability of other catheters in the institution, as well as the need for specific skills to insert or provide care to patients with a venous catheter, such as the PICC.<sup>29-30</sup> The different views of doctors and nurses regarding the intravenous therapy process, the low level of knowledge of nurses in relation to PICC, the lack of knowledge regarding nurse autonomy in indicating the type of intravenous device for the patient and the absence of institutional protocols are other factors which influence nursing practices.<sup>31</sup>

In order to guarantee nurse autonomy and greater visibility of their practice in the context of the venipuncture process, as an interdisciplinary work, it is fundamental to perform practices based on the best scientific evidence. Thus, given the low percentage of nurses' knowledge regarding care during insertion, maintenance and removal of PICC in the present study and in others,<sup>9-31</sup> the importance of permanent education in nursing is an essential element in order to reflect on nursing practices and update knowledge regarding the safe provision of quality care to the patient.<sup>31</sup>

The low level of knowledge of the nurses regarding patient care in the insertion and maintenance of PICC is an interpersonal stressor.<sup>21</sup> Therefore, in view of the risk of this stressor compromising patient safety, it is essential for nurses to constant update their knowledge.<sup>3</sup> Such conduct and clinical judgment of the nurse on the risks and benefits of each type of catheter,<sup>5-6,32-33</sup> and on the identified nursing needs and diagnoses of each patient<sup>31</sup> will support the indication and selection of the most appropriate venous catheter to the patient according to its characteristics and the prescribed intravenous therapy.<sup>6,34</sup>

The clinical judgment of the nurse with regard to the selection of a venous catheter should also involve an analysis of the dimensions of comfort, anxiety and restrictions in the patient's daily life activities<sup>35</sup>. In order to reduce anxiety and increase patient self-confidence and safety, individualized care is recommended, involving the patient in selecting the catheter type<sup>36</sup> and providing all pertinent information prior to insertion.<sup>35</sup>

In the context of the present study, in-service education by means of courses is a primary intervention, as proposed by the Betty Neuman model,<sup>21</sup> as it allowed the new scientific evidence to be updated, the acquisition of new knowledge and specific competences of patient care regarding the insertion, maintenance and removal of PICC, as well as reflection on the current nursing practices.<sup>29,37–38</sup>

The elaboration of institutional protocols on patient care for the insertion and maintenance of PICC was another primary intervention<sup>21</sup> adopted in this study to meet the specificities of the patients and the nurses of that service. According to the nurses, the nurses contributed to the changes in nursing practices, to standardizing nursing care and to the clarification of doubts, allowing the nurse to provide care based on the best evidence and focused on the prevention of complications. These aspects corroborate with other studies when they discuss the importance and benefits of continuing education, the elaboration and implementation of care protocols in nursing practices aimed at improving safety and quality of care.<sup>31,38–39</sup>

The attitude of the nurses regarding the use of PICC as a technological innovation in nursing practices, the support of the nursing and medical managers, the implementation of the protocols and the actions carried out by the research process also contributed to the changes in nursing practices and favored a collective culture for the adhesion of PICC.<sup>40</sup> However, the need to mobilize knowledge acquired in the courses and the few patients with PICC did not provide a rapid acquisition of tacit knowledge, requiring more reflection on the action and about the action in order to provide quality care.

The benefits of using PICC in nursing practices in the investigated service are corroborated in other studies.<sup>13,16,20</sup> The number of venipuncture attempts for catheter insertion and blood collection for exams is one of the quality indicators and evidences patient satisfaction, since it has an impact at the sensorial level.<sup>13,20,35</sup> Therefore, PICC insertion should be guided by venous ultrasonography under local anesthesia and by a nurse who has participated in qualification courses and presents competences to perform this procedure, which contributes to better visualization of the veins and reduces the difficulty of venipuncture, and consequently the number of venipuncture attempts and pain.<sup>33–34,41–42</sup>

The use of an imaging method (venous ultrasonography) prior to PICC insertion allows the determination of the ideal insertion zone - green zone - (*Zone Insertion Method-ZIM*),<sup>41</sup> the caliber of the vein and the selection of the caliber of the PICC compatible with the caliber of the vein (preferably 1/3 of the caliber of the vein), thus reducing insertion complications (such as transfixation of the vein and difficulty in progressing the catheter) and post-insertion (such as phlebitis and venous thromboembolism). In addition, ultrasonography aids visualization of the vein during puncture and catheter insertion.<sup>33–34,41–42</sup>

Regarding the incidence of complications and patient safety, an individual nursing assessment of each patient is essential in order to indicate the insertion of a venous catheter with final positioning in the peripheral vein or central vein (superior vena cava).<sup>6,31,34</sup> The difficulty of peripheral venous puncture with the conventional method (visualization and palpation), the need to administer parenteral nutrition and irritant and/or vesicant medications and with pH≤5 or ≥9, and intravenous therapy for more than seven days were the main indications for PICC insertion in the present study. These indications are supported by scientific evidence<sup>6,14,34</sup> and aim to prevent complications, especially local ones, such as phlebitis and infiltration, when using PVCs, which are the most common.<sup>7–11,25–26</sup>

By guiding practice, scientific evidence contributes to a lower incidence of complications, as demonstrated in the present study, since obstruction was the only complication evidenced in patients with a PICC (2.3/100 PICC/day).

The incidence rate (1.7/100 PVC/day) and cumulative incidence of PVC phlebitis (22.2%) in the patients in this study was lower than the rates of similar studies: in Portugal, with 43.8%<sup>9</sup> and 61.5%,<sup>43</sup> in Brazil, with 36.5%,<sup>11</sup> and in France, with 8.4/100 CVP/day.<sup>44</sup> However, this rate is higher

than the 8.5% found in a Colombian study<sup>8</sup> and higher than the 19.3% found in another Brazilian study.<sup>7</sup> The variation in the incidence of phlebitis may be supported by the different evaluative methodologies used to determine phlebitis and in the adequate indication of PICC for the patient in the present study, namely for administration of irritants and/or vesicant medications, with pH $\leq$ 5 or  $\geq$ 9 and parenteral nutrition, thus reducing the risk of phlebitis and infiltration, common in the peripheral venous catheter.<sup>7-11</sup>

Although the incidence of complications related to PVCs documented in the present study is lower than the incidence of other investigations performed in Portugal<sup>9,43</sup> and in other situations,<sup>11,44</sup> the incidence rate of phlebitis is still 5% higher than the recommended by Infusion Nurses Society.<sup>42</sup>

Infiltration, obstruction, accidental removal and fluid outflow through the PVC insertion site were other complications documented in this study and presented a higher incidence than other studies.<sup>11,32,43-45</sup> Thus, other investigations are necessary to analyze the risk factors for these complications and/or deviations from the scientific evidence. Such results may support the implementation of interventions in nursing practices to reduce the incidence of these complications, venous re-puncture, pain related to the insertion of a new PVC, material costs and nursing care time, in addition to improving patient safety and quality of care.

The tacit knowledge accumulated in everyday clinical situations, permanent education and teamwork that helps to reduce the number of venipuncture attempts are other interventions at primary level<sup>21</sup> used by the nurses of the present study, which are actions aimed at patient safety. These findings are corroborated with data from the cohort study, since the mean amount of venipuncture attempts until success was 1.5 in both PVC and PICC, similar to another study with 1.16 punctures for the insertion of the PICC and 2.27 for the PVC.<sup>20</sup>

The present study contributes to the identification of some factors that influence nursing practices in the peripheral venipuncture process and consequently in the quality of patient care and safety. Knowledge of these factors provides information regarding the need to implement educational intervention based on the best evidence available in order to improve nursing care, safety and patient well-being.

The study provides information on the feasibility of using PICC safely in nursing practices after a structured educational intervention. The results identify areas that need to be investigated and provide data for sample calculation, with the objective of continuing the study, especially through randomized clinical investigation for cost-effectiveness analysis, as proposed by the MRC in order to implement and evaluate complex interventions.<sup>22</sup>

As limitations, the following are considered: the option for the single case study, not allowing generalization of the results; the sample size in the cohort pilot study; the absence of evaluating post-infusion phlebitis; the single focus group, caused by the low availability of nurses to participate in others focus groups.

## CONCLUSION

Nursing practices in the peripheral venipuncture process are influenced by inter- and extra-personal stressors capable of compromising patient safety.

The research process, in-service education activities, and the nursing protocols enabled nurses to acquire competences regarding PICC. In addition, they contributed to changes in nursing practices and the implementation of care based on scientific evidence.

The use of PICC in patient care ensured intravenous treatment, reduced the number of venipunctures and the incidence of complications when compared to PVCs.

The PICC is a valid and feasible alternative which improves the quality of nursing care, the safety and well-being of patients, since the choice of a venous catheter should be based on the

clinical judgment of the nurse and the scientific evidence indications and contraindications; patient characteristics and prescribed intravenous medications; venous access availability and intravenous therapy duration; patient preferences; knowledge and skills of the nurses; and the risks and benefits to the patient.

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## NOTES

### ORIGIN OF THE ARTICLE

Article extracted from the thesis - Nursing practices and patient safety in phlebotomy and the administration of intravenous therapy, presented to the *Universidade de Lisboa*, in 2017.

### CONTRIBUTION OF AUTHORITY

Study design: Braga LM, Salgueiro-Oliveira AS, Henriques MAP, Parreira PMSD.

Data analysis and interpretation: Braga LM, Salgueiro-Oliveira AS, Henriques MAP, Arreguy-Sena C e Albergaria VMP e Parreira PMSD. Writing and / or critical review of content: Braga LM, Salgueiro-Oliveira AS, Henriques MAP, Arreguy-Sena C e Albergaria VMP e Parreira PMSD.

Review and final approval of the final version: Braga LM, Salgueiro-Oliveira AS, Henriques MAP, Arreguy-Sena C e Albergaria VMP e Parreira PMSD.

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### ETHICS COMMITTEE IN RESEARCH

Approved by the Ethics Committee in Research with Human Beings of *Centro Hospitalar and Universitário de Coimbra*, number 020-15 and 087-15, June 04, 2015.

### CONFLICT OF INTEREST

There is no conflict of interest.

### HISTORICAL

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