

## RESEARCH ARTICLE (ORIGINAL) 8

## Nurses' clinical practice for the prevention of central venous catheter-related infections

*Prática clínica dos enfermeiros na prevenção da infeção associada ao cateter venoso central*

*Práctica clínica de los enfermeros en la prevención de la infección asociada al catéter venoso central*

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### Abstract

**Background:** This study analyzes an issue that has already been identified in daily nursing practice, having defined the theme “Nurses’ clinical practice for the prevention of central venous catheter (CVC)-related infections”.

**Objectives:** To identify nurses’ clinical practice and level of knowledge about CVC maintenance.

**Methodology:** Analytical and cross-sectional study, with a quantitative methodology. A data collection instrument was applied in December 2018, through the snowball sampling technique, to 272 randomly selected nurses.

**Results:** The results indicated high levels of clinical practice (90.1%) and knowledge (85.7%) about CVC dressing change and CVC maintenance. A statistically significant association was also found between nurses’ clinical practices and level of knowledge.

**Conclusion:** The study concluded that the nurses have a high level of knowledge about CVC maintenance guidelines for infection prevention and that they follow the majority of the guidelines of the bundles for prevention of CVC-related infections.

**Keywords:** central venous catheter; patient care bundles; nursing

### Resumo

**Enquadramento:** O presente estudo analisa uma problemática identificada na prática profissional diária de enfermagem, sendo definido o tema “Prática clínica dos enfermeiros na prevenção da infeção associada ao cateter venoso central (CVC)”.

**Objetivos:** Conhecer a prática clínica e o nível de conhecimentos dos enfermeiros sobre a manutenção do CVC.

**Metodologia:** Estudo analítico e transversal, com uma metodologia quantitativa, utilizando um instrumento de recolha de dados aplicado em dezembro de 2018, através da técnica de amostragem por bola de neve, a 272 enfermeiros selecionados aleatoriamente.

**Resultados:** Os resultados obtidos indicam altos níveis de prática clínica (90,1%) e de conhecimentos (85,7%) na realização do penso e na manutenção do CVC e que existe relação estatisticamente significativa entre a prática clínica e o nível de conhecimentos dos enfermeiros.

**Conclusão:** Concluiu-se que a amostra apresenta um nível alto de conhecimentos acerca das normas de manutenção do CVC da prevenção da infeção e uma prática clínica que respeita, na sua maioria, as orientações dos feixes de intervenção acerca das práticas de prevenção da infeção do CVC.

**Palavras-chave:** cateter venoso central; feixes de intervenção; enfermagem

### Resumen

**Marco contextual:** Este estudio analiza una problemática identificada en la práctica profesional diaria de la enfermería; el tema es Práctica clínica de los enfermeros en la prevención de la infección asociada al catéter venoso central (CVC).

**Objetivos:** Conocer la práctica clínica y el nivel de conocimiento de los enfermeros sobre el mantenimiento del CVC.

**Metodología:** Estudio analítico y transversal, con una metodología cuantitativa, mediante un instrumento de recogida de datos aplicado en diciembre de 2018, a través de la técnica de muestreo por bola de nieve, a 272 enfermeros seleccionados aleatoriamente.

**Resultados:** Los resultados obtenidos indican niveles elevados de práctica clínica (90,1%) y de conocimiento (85,7%) del vendaje y del mantenimiento del CVC, y que existe una relación estadísticamente significativa entre la práctica clínica y el nivel de conocimiento de los enfermeros.

**Conclusión:** Se concluyó que la muestra presenta un nivel alto de conocimiento sobre las normas de mantenimiento del CVC para la prevención de infecciones y una práctica clínica que respeta, en su mayoría, las directrices del paquete de intervención sobre las prácticas de prevención de infecciones del CVC.

**Palabras clave:** catéter venoso central; cuidados de intervención; enfermería

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## Introduction

According to the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and the European Centre for Disease Prevention and Control (ECDC), healthcare-associated infections (HAIs) are the most common infections worldwide, with approximately 10% of patients admitted to the hospital acquiring at least one infection during their hospital stay (Observatório Português dos Sistemas de Saúde [OPSS], 2018).

These infections increase morbidity and mortality rates and have significant economic and social consequences, being one of the main threats to patient safety and quality of care (OPSS, 2018).

Although recent data suggest an improvement in the incidence of infection in Portugal in recent years, particularly regarding intubation-associated pneumonia, central venous catheter (CVC)-related and MRSA bacteremia, and prosthetic knee and colorectal surgical site infections, this effort is not enough to eliminate infection, particularly in the case of CVCs (Direção-Geral da Saúde [DGS], 2017). Therefore, this study aims to explore an issue that has already been identified in daily nursing practice. Its main objective is to identify nurses' clinical practices and level of knowledge about the prevention of CVC-related infections.

## Background

They are particularly relevant in health care worldwide given their mortality rates and the increased antimicrobial resistance. Initially known as nosocomial infections, HAIs were defined as infections acquired in hospital settings by inpatients who did not present with the infection at admission, those diagnosed after discharge, or those diagnosed in health care professionals in the exercise of their duties (DGS, 2017).

According to Campos (2016) and Silva and Oliveira (2017), the best definition of HAIs refers to a diagnosis directly related to an adverse reaction when in the presence of an infectious agent, provided that it is not diagnosed at the time of hospital admission or within the first 48 hours after hospital admission.

In view of this scenario, HAI epidemiological surveillance programs were created that are currently being coordinated by the National Program for Prevention and Control of Infection and Antimicrobial Resistance (*Programa Nacional de Prevenção e Controlo das Infecções e das Resistências aos Antimicrobianos*, PPCIRA) and regularly operating in the European and national networks (DGS, 2017). However, the responsibility for preventing and controlling HAIs is both individual and collective, and the success of the programs developed in this context depends on the participation of all those involved.

This study focuses only on CVC-related infections, which, due to their complexity, result from the loss of skin and tissue integrity that promotes contacts between the environment and the bloodstream. These catheters are points of entry for microorganisms that can easily

reach the systemic circulation, increasing morbidity and mortality rates and healthcare costs, given that its prolonged use and maintenance can increase the potential for contamination and subsequent clinical infections (Costa, 2017; Goulão, 2014; Nunes & Alminhas, 2012; Silva, 2016).

DGS (2015, p. 9) defines CVC care bundles as “a set of interventions (usually 3 to 5) that, when grouped and implemented in an integrated way, lead to better outcomes and have a higher impact than the mere addition of the effect of each intervention individually”, ensuring “that patients receive recommended and evidence-based treatments and care in a consistent way”.

CVC insertion is a common procedure in critically ill patients who require complex care using the intravascular system for the administration of fluids, medication, and blood products, parenteral nutrition, hemodynamic monitoring, and renal replacement therapy, among others, and can be used in medium- and long-term treatments (Costa, 2017; Fortunatti, 2017; Goulão, 2014; Santos et al., 2014; Silva, 2014).

Guidelines have been published, mainly by the Institute for Healthcare Improvement (IHI, 2012), to help health care organizations worldwide implement multimodal interventions based on the concept of care bundles. These bundles include a set of interventions that have been associated with a higher impact on infection reduction. The following aspects should be considered: health care professionals' training, hand hygiene, maximal barrier precautions during CVC insertion, the use of alcoholic chlorhexidine for skin antiseptics, the selection of the optimal site for CVC insertion, and CVC removal as soon as possible. The implementation of these bundles should involve the multidisciplinary care team. The monitoring of best practices during CVC insertion, while ensuring a joint rather than individual performance, strengthens teamwork, contributes to more effective communication, and implies the integrated management of interventions and goals, being currently considered standard of care (Fernandes et al., 2019; Silva, 2016).

According to DGS (2015), these bundles for the prevention of CVC-related infections are a set of necessary interventions that must be implemented at the same time for a successful intervention, occurring at a specific time and place or area and that have been associated with improved quality of care and better clinical outcomes.

In summary, it is increasingly important to recognize nurses' key role as health care providers, particularly in CVC maintenance. Quality care must be achieved through work based on knowledge and skills that comply with the international guidelines adapted to our country by DGS within the scope of the implementation of care bundles and associated procedures.

## Research question

Is there an association between nurses' clinical practices and level of knowledge about infection prevention in CVC maintenance?



## Methodology

This is an analytical and cross-sectional study with a quantitative methodology. A data collection instrument was applied in December 2018, through the Facebook social network, to 272 randomly selected nurses using the snowball sampling technique. After a literature search, the data collection instrument was based on a study by Silva (2014), who authorized the use of the tool in this study. The questionnaires were numbered, and the answers were immediately submitted to the platform through the email created for that purpose, thus facilitating and speeding up the data collection procedure while safeguarding the right to self-determination, intimacy, anonymity, and confidentiality, in line with the ethical principles of the Declaration of Helsinki. Informed consent was also included for voluntary completion by the participants to comply with the General Data Protection Regulation. Statistical analysis was performed in IBM SPSS Statistics software, version 23.0 for Windows. Descriptive statistics (relative and absolute frequencies, mean, and standard deviation) were calculated. In line with the Central Limit Theorem, in which normality is assumed if  $n > 30$ , this study used Pearson's Correlation test in case of correlation between quantitative variables, Spearman's Rho in case of correlation between ordinal variables, the Student's  $t$ -test to compare two independent samples, and the ANOVA test to compare three or more independent samples, adopting a significance level of 0.05.

## Results

In this sample, the items with the highest response frequency regarding CVC dressing change were as follows: "I keep my fingernails short" (77.6%), "I keep my fingernails clean" (87.1%), "I remove all adornments from my hands before starting the procedure" (75.4%), "I record the characteristics of the insertion site" (82.4%),

"I document the characteristics of the surrounding skin" (74.6%), "I wash my hands immediately after the procedure" (79.0%), "I change the dressing if it loses integrity, gets loose, wet, or damp, or the patient complains" (84.0%), and "I record the patient's complaints" (74.3%). Although these percentages indicate that nurses' practices comply with the standards for CVC dressing change, some of these items indicate differentiated practices in this area of intervention, such as "I change the dressing 24 hours after CVC insertion" (21.3%), "I change the gauze dressing every 2 days" (10.7%), and "I change the transparent semipermeable dressing once a week" (13.6%). It should be noted that the items "I don't record the characteristics of the insertion site" (86.0%), "I use rings because my hands are protected with gloves" (76.8%), and "I don't wash my hands between removing the old dressing and performing antisepsis" (72.4%) are indicators of proper completion because the questions were negatively phrased. Concerning CVC maintenance, the following items had the highest response frequency: "I remove all adornments from my hands before starting the procedure" (80.1%), "I wash my hands immediately before performing the procedure" (83.5%), "I wash my hands after the procedure" (84.9%), "I replace systems and extension tubes if they have blood, clots, or debris" (76.1%), "I flush with saline after infusion therapy" (80.9%), and "I flush with saline after collecting blood from the lumen" (80.1%). The high response frequency in the following items should be highlighted: "I wash my hands immediately before the procedure only when they are visibly soiled" (81.6%), "I wear hand/wrist adornments" (87.1%), "If I'm wearing sterile gloves, I don't disinfect access sites and taps before handling them" (83.1%), and "If I'm wearing gloves, I don't wash my hands immediately after the procedure" (82.4%).

Clinical practice shows high levels of response frequency (90.1%), with mean response values of 147.1. It should be noted that 9.9% of the participants indicated mean levels of response frequency.

**Table 1**

*Sample distribution according to the clinical practice of CVC dressing change and CVC maintenance*

Clinical Practice	<i>n</i>	%	Measures of central tendency
Low level (Up to 66 pts)	0	0,0	Mean = 147.1
Medium level (67-133 pts)	27	9,9	Median = 148
High level (134-200 pts)	<b>245</b>	<b>90.1</b>	<i>SD</i> = 12.78
<b>Total</b>	272	100.0	

*Note.* *SD* = standard deviation.

A higher response frequency was found in nurses' level of knowledge than in their clinical practice, particularly in the following items: "The characteristics of the insertion site should be recorded" (90.1%), "Fingernails should be short" (85.3%), "Fingernails should be clean" (89.7%),

"Fingernails should be free from nail polish" (77.9%), "If wthe CVC is placed in the subclavian vein and the patient's condition allows it, turn the patient's head or ask the patient to turn his or her head in the opposite direction, or place a mask on the patient to change the

dressing” (75.4%), “A mask should be worn when changing the dressing” (74.3%), “A 2% chlorhexidine solution should be used for skin antiseptis” (77.7%), “Hand ornaments should be removed before starting the procedure” (82.4%), “The characteristics of the surrounding skin should be recorded” (86.8%), “Hands should be washed immediately after the procedure” (83.5%), and “The dressing should be changed if it loses integrity, gets loose, wet, or damp, or the patient complains” (90.1%). It should be noted that inversely formulated items also had a high response frequency, namely the following items: “I don’t have to wash my hands between removing the old dressing and performing antiseptis” (82.4%), “If I wash my hands immediately before entering the room, I don’t have to wash them again before changing the dressing” (71.3%), “I don’t have to record the characteristics of the insertion site” (71.3%), and “If my hands are protected with gloves, wearing rings does not increase the risk of infection” (76.8%).

Concerning knowledge about CVC maintenance, a high response frequency was found, particularly in the following items: “If possible, a single route should be used to administer blood products” (78.7%), “If possible, a single route should be used to administer fat emulsions” (76.1%), “Hand adornments should be removed before starting the

procedure” (79.8%), “Systems with fat emulsions should be replaced every 24 hours” (73.5%), “The hands should be washed immediately before performing the procedure” (88.2%), “The hands should be washed after performing the procedure” (85.7%), “The systems and extension tubes should be replaced if they have debris, blood, or clots in their inner walls” (83.5%), “Catheters should be flushed with saline after each infusion” (80.5%), and “Catheters should be flushed with saline after collecting blood from the lumen” (81.6%). It should also be noted that the negatively phrased questions had a high response frequency, namely in the following items: “Hands should only be washed immediately before the procedure if when they are visibly soiled” (86.0%), “Wearing hand/wrist adornments doesn’t increase the risk of infection” (73.2%), “If I’m wearing sterile gloves, I don’t have to disinfect access sites and taps before handling them” (83.8%), and “If I’m wearing gloves, I don’t have to wash my hands immediately after the procedure” (84.6%).

A high level of knowledge (85.7%) was observed concerning CVC dressing change and CVC maintenance, with mean response values of 144.2.

It should be noted that 13.6% of the sample had medium levels of knowledge, and 0.7% of the sample had low levels of knowledge.

**Table 2**

*Sample distribution according to the level of knowledge about CVC dressing change and CVC maintenance*

Level of Knowledge	n	%	Measures of central tendency
			Mean = 144.2
Low level (Up to 66 pts)	2	0.7	
Medium level (67-133 pts)	37	13.6	Median = 145.5
High level (134-200 pts)	233	85.7	SD = 12.72
Total	272	100.0	

Note. SD = standard deviation.

The results obtained from the correlation between the level of knowledge and the clinical practice indicate a positive, moderate, and statistically significant correlation, that is, as one increases, the other also increases. The results indicate a highly significant statistical correlation

( $p = 0.000$ ), confirming the association between nurses’ knowledge about recommended standards and their clinical practice regarding CVC maintenance, that is, a high level of knowledge corresponds to a high level of clinical practice.

**Table 3**

*Correlation between nurses’ clinical practice and their level of knowledge about recommended standards for CVC maintenance*

		Clinical Practice - CVC dressing change and CVC maintenance
Level of knowledge about CVC Dressing Change and CVC Maintenance	Pearson’s correlation	0.702*
	<i>p</i>	<b>0.000</b>

\*\* Correlation is significant at 0.01 (two extremities).

The results are discussed below to theoretically contextualize the data obtained in the empirical research.



## Discussion

Concerning the values of the participants' professional practice regarding CVC dressing change, the most frequently applied techniques included those items related to nail care, as a likely source of infection, the use of adornments, hand hygiene, techniques for changing dressings, and records. The results obtained are consistent with the literature review conducted, namely with the studies by Furuya et al. (2011) and Silva (2014).

The results on the clinical practices regarding CVC maintenance indicate a higher response frequency in the items related to the use of adornments, hand hygiene, device replacement, flushing techniques, and the use of gloves. These results are corroborated by Silva (2014) and Fernandes et al. (2019).

The results regarding nurses' level of knowledge about CVC dressing change indicate a higher response frequency in the items related to the characteristics of the insertion site, nail care as a potential focus of infection, the patient positioning technique, the equipment used to change CVC dressings, hand hygiene, and techniques for changing dressings. The results obtained in this study are also corroborated by Osorio et al. (2013), who indicate that the implementation of care bundles contributed to a staff adherence rate of over 80% and a decrease in the rate of CVC-related bloodstream infections from 5.56 to 3.26 per 1,000 catheter days.

Concerning nurses' level of knowledge about CVC maintenance, the items with the highest response frequency were those related to the administration of blood products and fat emulsions, hand adornments, the change or replacement of systems, hand hygiene, flushing techniques, and the use of gloves. The overall high values obtained concerning the clinical practice of CVC dressing change and CVC maintenance indicate that most of the sampled nurses continuously use the strategies related to CVC infection prevention in their clinical practice.

Concerning the level of knowledge about CVC dressing change and CVC maintenance, the majority of nurses have high levels of knowledge. These data are contrary to those found by Ullman et al. (2014), who concluded that nurses lacked knowledge about the prevention of CVC-related infections and found major differences between what they learn in theory and what they apply in their daily professional practice, recommending increased attention from the health care team to the prevention of these infections. Moreover, Silva and Oliveira (2017) found a low adherence to hand hygiene (22.7%) and hub disinfection (10.4%) among nurses, concluding that nurses' level of knowledge has no direct statistical association with clinical practice.

Concerning the starting question, the results obtained in this study indicate a statistically significant correlation between nurses' knowledge about recommended standards and their clinical practices regarding CVC maintenance. These results are also supported by Cherifi et al. (2013) in their study on the impact of an intervention bundle application program for CVC infection control in five intensive care units (ICUs) in Belgium. The authors found

that the use of care bundles decreased the rate of CVC-related infections and that the higher the monitoring of care bundles, the higher the decrease in the rate of CVC-related infections. They also found that the most relevant factors influencing the effectiveness of care bundles were the lack of leadership and support in the ICUs and the high turnover among ICU nurses. Lopes et al. (2012) found that a low incidence of infection can be explained by a robust, active infection control program associated with the health professionals' continuous training and the regular revision of care protocols. Perin et al. (2016) emphasize that aseptic techniques combined with the health professionals' continuous acquisition of knowledge and accountability for the direct application of these techniques are strategies for reducing CVC infection rates, particularly in ICUs.

It should also be noted that most data obtained in this study are in line with the international and national guidelines on CVC maintenance, particularly those issued by IHI, WHO, CDC, and ECDC that recommend the application of care bundles that respect hand hygiene; maximal barrier precautions; the antisepsis of the insertion site; the optimization of the insertion site (preferably the subclavian vein), the daily review of CVC necessity and its removal as soon as possible. They are also in line with DGS (2017), which requires compliance with protocols for the prevention of CVC-related infections and compliance with care bundles. The results obtained in this study are similar to those found by Costa (2017) and Fernandes et al. (2019). One of the limitations of this study is that these results cannot be generalized to the general population. Moreover, some personal constraints were also experienced, namely concerning time availability.

Based on these results, it can be concluded that clinical practice, when combined with the level of knowledge, is a very important distinctive factor in the delivery of specialized nursing care, directly contributing to the quality of care. Infection prevention is a top priority considering the current pandemic situation worldwide.

## Conclusion

This study answered the question: "Is there an association between the nurses' clinical practice and their level of knowledge about the prevention of Central Venous Catheter-related infections?". The authors concluded that the sampled nurses have a high level of knowledge about the recommended CVC maintenance standards for infection prevention. The majority of nurses in their clinical practice follow the guidelines on the application of care bundles for CVC-related infection prevention.

The authors also concluded that the most frequent interventions for the prevention of CVC-related infections comply with the guidelines published by international and national health organizations, namely those concerning hand hygiene, the use of maximal barrier precautions, antisepsis and optimization of the insertion site; daily review of CVC necessity or CVC removal when necessary, as well as the compliance with the protocols for preventing CVC-related infections and care bundles. For these reasons,



the objective initially proposed was achieved. This study also found a statistically significant correlation between nurses' clinical practice and their level of knowledge about the recommended standards for CVC maintenance, thus answering the starting question. The results obtained in this study are in line with the protocols adopted by public and private health care organizations in Portugal to reduce the incidence of CVC-related infections, increase the quality of care, and prevent the increase of the still high mortality rates of CVC-related infections. In this context, the role of nurses as the first line of intervention in the prevention of CVC-related infections, the implementation of protocols, training, and monitoring of CVC-related infection prevention procedures had been increasingly recognized, directly contributing to the implementation of theoretical and practical skills. As a contribution to improving the quality of care and due to the evidence on the relevance of this topic, we intend to present these data in future in-service training. Due to the relevance of this intervention for nursing practice, specialized training on best practices in CVC maintenance will reduce infection outbreaks, directly involving health professionals and enabling behavioral changes.

#### Author contributions

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