REVISTA DE ENFERMAGEM REFERÊNCIA
homepage: https://rr.esenfc.pt/rr/
ISSNe: 2182.2883

RESEARCH ARTICLE (ORIGINAL)

Quality index in central venous catheters maintenance in an intensive care unit

Índice de qualidade na manutenção do cateter venoso central num serviço de medicina intensiva

Índice de calidad en el mantenimiento del catéter venoso central en una unidad de cuidados intensivos

Solange Marisa Lage Gomes [1, 2]
https://orcid.org/0000-0002-4093-0443

Matilde Delmina da Silva Martins [1, 3]
https://orcid.org/0000-0003-2656-5897

Maria José Gonçalves Alves [1, 4]
https://orcid.org/0000-0001-8506-4393

[1] Polytechnic Institute of Bragança, School of Health, Bragança, Portugal

[2] Hospital Center of Trás-os-Montes e Alto Douro, Intensive Medicine Unit, Vila Real, Portugal

[3] Health Sciences Research Unit: Nursing UICISA: E), Nursing School of Coimbra (ESEnfC), Coimbra, Portugal

[4] Polytechnic Institute of Bragança, Mountain Research Center (CIMO), Bragança, Portugal

Corresponding author
Solange Marisa Lage Gomes
E-mail: smarisalg@hotmail.com

Received: 11.11.20
Accepted: 20.10.21

Abstract
Background: Healthcare-associated infections are one of the main threats to patient safety and quality of care. Although central venous catheters (CVCs) are increasingly used for diagnostic and therapeutic purposes, they are responsible for about 90% of bacteremia in hospitals.
Objectives: To analyze the CVC Maintenance Quality Index (MQI) in an intensive care unit (ICU) of a hospital center in northern Portugal.
Methodology: Cross-sectional and analytical study. The sample consisted of 35 nurses and 170 CVC maintenance observations using the observation grid adapted from the Directorate-General for Health to determine the MQI.
Results: A CVC MQI of 89.2% was obtained. The female gender and being a specialist influenced the CVC MQI ($p < 0.05$).
Conclusion: The CVC MQI was within the recommended values. In-service training and research are essential to improve nursing care.

Keywords: critical care; central venous catheter; nursing care; maintenance quality

Resumo
Enquadramento: As infeções associadas aos cuidados de saúde são consideradas como uma das principais ameaças à segurança do doente e à qualidade dos cuidados. O uso do cateter venoso central (CVC) com fins diagnósticos e terapêuticos é cada vez mais frequente, mas, simultaneamente são responsáveis por cerca de 90% das bacteriemias a nível hospitalar.
Objetivos: Analisar o Índice de Qualidade de Manutenção (IQM) do CVC num serviço de medicina intensiva (SMI) de um centro hospitalar do norte de Portugal.
Metodologia: Estudo transversal e analítico. A amostra foi de 35 enfermeiros e 170 observações de manutenção ao CVC, através da grelha de observação adaptada da Direção-Geral da Saúde para determinar o IQM.
Resultados: Foi obtido um IQM do CVC de 89,2%. O sexo feminino e ser especialista influenciaram o IQM do CVC ($p < 0,05$).
Conclusão: IQM do CVC dentro dos valores recomendados. A formação e a investigação em contexto de trabalho são fundamentais para a melhoria na prestação de cuidados de enfermagem.

Palavras-chave: cuidados críticos; cateter venoso central; cuidados de enfermagem; índice de qualidade de manutenção

Resumen
Marco contextual: Las infecciones asociadas a la asistencia sanitaria se consideran una de las principales amenazas para la seguridad del paciente y la calidad de la atención. El uso del catéter venoso central (CVC) con fines diagnósticos y terapéuticos es cada vez más frecuente, pero, a la vez, es responsable de cerca del 90% de las bacteriemias a nivel hospitalario.
Objetivos: Analizar el Índice de Calidad de Mantenimiento (ICM) del CVC en una unidad de cuidados intensivos (UCI) de un centro hospitalario del norte de Portugal.
Metodología: Estudio transversal y analítico. La muestra estuvo compuesta por 35 enfermeros y 170 observaciones de mantenimiento del CVC, para lo cual se utilizó la parrilla de observación adaptada de la Dirección General de Salud para determinar el ICM.
Resultados: Se obtuvo un ICM del CVC de 89,2%. El sexo femenino y ser especialista influyeron en el ICM del CVC ($p < 0,05$).
Conclusión: ICM del CVC dentro de los valores recomendados. La formación y la investigación en el lugar de trabajo son fundamentales para mejorar la prestación de los cuidados de enfermería.

Palabras clave: cuidados intensivos; catéteres venosos centrales; atención de enfermería; índice de calidad de mantenimiento

How to cite this article: Gomes, S. M., Martins, M. D., & Alves, M. J. (2021). Quality index in central venous catheters maintenance in an intensive care unit. *Revista de Enfermagem Referência*, *5*(8), e20181. https://doi.org/10.12707/RV20181

Introduction

Today, healthcare provides unprecedented health gains for future generations of patients and their families, but these achievements come with associated risks, such as healthcare-associated infections (HAIs; Aloush, 2018). In 2011, the World Health Organization (WHO) defined HCAIs as infections acquired by hospitalized patients during the process of care that are not present at the time of admission. HAIs represent a significant threat to patient safety and quality of care (Souza et al., 2015). According to the Portuguese nursing and midwifery regulator (Ordem dos Enfermeiros - OE, 2017), HAIs are a clinical situation resulting from organic reactions of infectious agents or their toxins acquired as a result of healthcare and health interventions. They may also affect health professionals during the performance of their activities. One of the hospital inpatient units with the highest risk of infection is the intensive care unit (ICU). These specialized units have highly qualified human resources that provide uninterrupted medical and nursing care and access the most advanced diagnostic and therapeutic technologies. One of the most prevalent infections are nosocomial bloodstream infections (BSIs) originating from microorganisms in the skin flora. They result from infection at the catheter insertion site, the infusion of contaminated intravenous solutions, the connection of medical devices, and the health professionals' hands. In 2017, new studies on hospital infections in Portugal found a prevalence of HAIs of 7.8% (10.5% in 2012), with a positive decrease in ventilator-associated pneumonia in adult ICUs in 2016, with values of 7.1 per 1,000 ventilator days (Direção-Geral da Saúde [DGS], 2017). According to the same author, the incidence rate of central venous catheter (CVC)-related infections per 1,000 catheter days in adult ICUs was 0.9.
In 2018, Borges and colleagues established a relationship between the risk of acquiring an infection and the type of infusion solution, catheter dwell time, and the professionals' experience with critically ill patients.
Although the results show a decreasing trend, these hospital infections are currently a challenge in the delivery of care to hospitalized critically ill patients and the prevention and control of invasive procedures (Souza et al., 2015). Therefore, according to the same author, throughout their professional practice, nurses should consider it essential to their intervention and work environment. In view of the above, this study aimed to analyze the CVC Maintenance Quality Index (MQI) in an ICU of a hospital center in northern Portugal.

Background

In ICUs, care is more complex, and HAIs spread more easily due to the use of increasingly invasive diagnostic and therapeutic methods and patient-related factors (Oliveira, Meneses, et al., 2015). Critically ill patients have a significantly higher risk of acquiring these infections (Tajeddin et al., 2016) due to the use of invasive devices, particularly central lines, urinary catheters, and endotracheal tubes (Tajeddin et al., 2016). Thus, the CVC is an invasive medical device designed to access venous circulation, and its use in critically ill patients has become an essential daily practice in ICUs due not only to high-flow vascular access for the administration of fluids, blood, hemodialysis, and nutritional support but also to issues related to hemodynamic monitoring (Aloush, 2018; Günther et al., 2016; Mushtaq et al., 2018). Although CVCs are increasingly used for diagnostic and therapeutic purposes, they are responsible for about 90% of bacteremia in hospitals (Mushtaq et al., 2018). In Europe, in 2017, around 8.3% of critically ill patients admitted to ICUs acquired a HAI during their stay: pneumonia, BSI, or urinary tract infection (European Centre for Disease Prevention and Control, 2017). In 2017, the National Health Surveillance Agency (ANVISA) reported that CVC-related infections are the leading cause of HAIs.
Thus, the introduction of Standard No. 022/2015 (DGS, 2015) and the ICU's adherence to the Hospital in Europe Link for Infection Control Through Surveillance in Intensive Care Units (HELICS-ICU) program contributed to the introduction of intervention bundles and the epidemiological surveillance of CVC-associated bloodstream infections. The guidelines for providing care to patients with CVCs are described as intervention bundles for CVC insertion and maintenance (DGS, 2015).

Research question

What is the CVC MQI at an ICU of a hospital center in northern Portugal?

Methodology

An analytical and cross-sectional study was conducted in the ICU of a hospital in northern Portugal from April to June 2019. The sample consisted of 35 nurses who performed 170 CVC maintenance procedures. Data were collected using the direct observation grid designed by the researcher during her rotating shifts, in collaboration with the nursing team of the National Program for Prevention and Control of Infection and Antimicrobial Resistance (*Programa Nacional para a Prevenção e Controlo de Infeções e de Resistência aos Antimicrobianos*, PPCIRA). A total of 170 direct observations were randomly made to the study participants regarding the intervention bundles for the Prevention of CVC-Related Infection (PCVCRI) at the time of maintenance. Each professional made, on average, 4.8 observations.
All ethical rules and the participants' rights were respected based on the Declaration of Helsinki and the Oviedo Convention. The study was submitted for analysis and authorization to the Chair of the Board of Directors and the Ethics Committee of the hospital. It was approved on 20 December 2018, under number 494/2018. All participants gave their informed consent after being informed of the study objectives. Data were coded, entered, and analyzed using IBM SPSS Statistics, version 25, to ensure and respect the participants' anonymity. Descriptive statistics were used by calculating the absolute and relative frequencies for all categorical variables under study. The following statistical tests were used to analyze the correlation between continuous

variables: Pearson's correlation coefficient (r) for comparison of means, the Student's *t*-test, and the two-way analysis of variance (ANOVA). The MQI was calculated by dividing the sum of the positive answers by the number of applicable answers. An expected MQI of at least 80% was assumed to establish the sample. The significance level was set at 0.05. The data collection instrument used for sociodemographic characterization was a questionnaire composed of 12 closed-ended questions on age, gender, academic and professional qualifications, professional experience, training in PCVCRI, and perception of knowledge about the topic in question. A direct observation grid was also applied to the work team mentioned above to collect more data. This grid was adapted based on the care bundle for PCVCRI of Standard No. 022/2015 (DGS, 2015). Given the importance of the guidelines for PCVCRI, it became essential to add more intervention bundles to be observed in the CVC maintenance/dressing grid, such as evidence of use of a single route for administration of blood products, lipid solutions, and total parenteral nutrition (TPN); evidence of replacement of administration sets and extension tubing every 96 hours; evidence of replacement of administration sets containing lipid solutions every 24 hours (TPN); evidence of replacement of administration sets containing Propofol every 6-12 hours; evidence of replacement of administration sets and extension tubing containing blood, clots, or sediment; evidence of saline flush after bolus administration; evidence of maintenance of the stopcocks protected with a sterile field; evidence of records of patient complaints whenever possible and hand hygiene after the procedure.

Results

The nurses' mean age (*n* = 35) was 33.9 years (*SD* ± 6.0 years), with a minimum of 26 years and a maximum of 59 years. Most participants were women (71.4%), with an undergraduate degree (48.6%), and the professional category of specialist nurse (34.3%). Of these, 91.7% were specialized in medical-surgical nursing (Table 1).

Table 1

Sociodemographic data, academic qualifications, and area of specialization of the nursing team (n = 35)

Variables		*n*	%
Gender	Male	10	28.6
	Female	25	71.4
Age	26 – 29 years	7	20.0
	30 – 39 years	24	68.6
	40 – 49 years	3	8.6
	50 – 59 years	1	2.9
	Mean ± *SD*	33.9 ± 6.0	
Academic qualifications	Undergraduate degree	17	48.6
	Postgraduate degree	6	17.1
	Specialization	4	11.4
	Master's degree	8	22.9
Area of specialization	MSN	11	91.7
	Rehabilitation	1	8.3
Work regime	Rotating shifts	34	97.1
	Fixed shifts	1	2.9

Note. SD = standard deviation; MSN = medical-surgical nursing.

Concerning the team's professional experience, Table 2 shows that the mean length of professional experience is high (approximately 11 years), with a reduction in the length of professional experience in the institution (7.5 years) and the length of professional experience in the ICU (5.6 years).

Table 2

Professional experience of the nursing team

Variables	*Mean ± SD*
Length of professional experience	10.8 ± 6.7
Length of professional experience in the institution	7.5 ± 6.7
Length of professional experience in the ICU	5.6 ± 5.9

Note. ICU = intensive care unit; *SD* = standard deviation.

Table 3 shows that all participants reported having knowledge about the PCVCRI, of whom 60% rated their knowledge as good. Of the 35 surveyed nurses, 85.7% reported having training in this area. When questioned about where they had received training, 93.3% reported having received in-service training.

Table 3

Sampled nurses' knowledge and self-assessment about the PCVCRI (n = 35)

Variables			*n*	(%)
Knowledge about PCVCRI		Yes	35	100
Self-assessment of the knowledge about PCVCRI		Sufficient	13	37.1
		Good	21	60
		Excellent	1	2.9
Training on PCVCRI		Yes	30	85.7
		No	5	14.3
Training:	In-service	Yes	28	93.3
		No	2	6.7
	Academic	Yes	6	20
		No	24	80
	Conferences, seminars	Yes	3	10
		No	27	90
Time elapsed since last training		< 6 months	20	57.1
		1 year	10	28.6
		>2 years	0	12.5
		>3 years	5	14.3
Knowledge about the existence of the CVC standard		Yes	35	100
Standardization of CVC placement/maintenance care		Yes	35	100

Note. PCVCRI = prevention of central venous catheter-related infection; CVC = central venous catheter.

The overall MQI of CVC was 89.2%. The lowest levels of adherence were related to hand hygiene with water and a pH-neutral soap (67.1%), disinfection of connectors with an alcohol-based solution (71.8%), replacement of the Propofol set every 12 hours (24.4%), and CVC dressing with aseptic technique (72.2%; Table 4).

Table 4

Distribution of the MQI in the PCVCRI by criterion and calculation of the overall MQI (n = 170)

Criteria	Category		
	Y + N	Y	QI (%)
1 - Daily assessment of the need for the CVC	170	132	77.6
2 - Hand hygiene with water and a pH-neutral soap	170	114	67.1
3 - Hand disinfection with an alcohol-based solution	170	166	97.6
4 - Disinfection of connectors with an alcohol-based solution	170	122	71.8
5 - CVC dressing change with an aseptic technique	90	65	72.2
6 - Frequency of CVC dressing change	90	89	98.9
7 - Handwashing/disinfection with an alcohol-based solution after the procedures	170	133	78.2
8 - Single route for blood infusion up to a maximum of 4 hours after initiation	8	8	100
9 - Single route for TPN	24	24	100
10 - Replace TPN set after 24 hours	24	24	100
11 - Replace Propofol set every 12 hours	82	20	**24.4**
12 - Replace saline, electrolyte, and infusion systems every 96 hours	170	170	100

13 - Replace administration sets and/or extension tubing with blood or clots	33	33	100
14 - Saline flush (0.9%) after bolus administration	160	159	99.4
15 - Non-vented 3-way stopcock protected with a sterile field	170	169	99.4
CVC Maintenance Quality Index	1601	1428	89.2

Note. CVC = central venous catheter; TPN = total parental nutrition; Y + N = number of applicable answers obtained by subtracting the number of non-applicable answers from the number of assessed questions. Y = positive answers; QI= Quality Index.

Table 5 shows statistically significant differences between the CVC MQI and gender, with female nurses having a higher mean score than male nurses ($t = 2.474$; $p = 0.019$). The professional category influenced the CVC MQI because specialist nurses had a higher CVC MQI ($t = 4.110$; $p < 0.001$). Statistically significant differences were also found between the CVC MQI and the nurses' academic qualifications ($F = 4.779$; $p = 0.008$). The Bonferroni post hoc test revealed statistically significant differences between undergraduate and Master's degrees ($p = 0.018$).

No statistically significant differences were found between CVC MQI, age, length of professional experience in the institution, and length of professional experience in the ICU, with a p-value > 0.05 (Table 5).

Table 5

Comparison of the CVC MQI based on the nursing team's profile: gender, professional category, and academic qualifications

Dependent variable	Independent variable			Category	*n*	± *SD*	*t*	*p*
MQI	Nursing team (*n* = 35)	Gender		Male	10	77.9±9.3	-2.474	0.019
				Female	25	84.8±6.9		
	Nursing team (*n* = 35)	Professional category		Nurse	23	78.9±8.3	-4.110	0.000
				Specialist nurse	12	88.8±2.3		
			F				*p*	
MQI	Nursing team (*n* = 35)	Academic qualifications	4.779				0.008	

Note. IQM = mean quality index; *SD* = standard deviation; *t* = Student's *t*-test; *p* = significance value; F = Leneve's test.

Discussion

The sample of this study consisted of 35 nurses, mostly women, aged 30-39 years. These results are consistent with the profile found by Nunes (2018) who justified that these services pose increased challenges, complexity, and motivation to young professionals at the beginning of their careers. According to the same author, the majority of older professionals are not motivated to attend continuous training and knowledge update courses and do not tolerate the pressure exerted on them in these services, ending up being transferred. The sample in this study consisted mostly of women, which is in line with the data issued by the Portuguese nursing and midwifery regulator (Ordem dos Enfermeiros, 2018) that 82.2% of nurses working that year in Portugal were women. In addition, being a woman was also associated with higher CVC MQI scores (84.9% *vs* 77.9%). Similar results were obtained by Oliveira et al. (2016), who found that being a woman and having more training in infection prevention improved CVC MQI scores.

Concerning academic qualifications, 48.6% of the nurses had an undergraduate degree and 34.3% had a postgraduate degree (specialization and Master's degree), with a prevalence of the specialization in medical-surgical nursing (MSN; 91.7%). This finding is relevant considering that the Ordem dos Enfermeiros (2018) reported that only 21.6% of the specialist nurses in these services were specialized in MSN. According to Regulation no. 743/2019, of September 25, it is increasingly important for ICU teams to have at least 50% of nurses specialized in MSN, preferably in the area of critical care nursing, on a permanent basis, and that the same rule be ensured in each shift. The results show that 34.2% are specialist nurses (12), of whom 91.7% have a specialization in MSN. Although only 34.3% of the sampled nurses had postgraduate training (specialization and Master's degree), the percentage of MSN specialists was higher (91.7%) than the recommendation in the regulation mentioned above.

Professional experience in ICUs was an analyzed variable to explore whether professionals were experienced in CVC manipulation, given that it is a common practice in these services and little or not used in other professional settings. In this study, most participants had, on average, more than five years of professional experience in the current ICU, so it can be concluded that they are experienced or even experts in their area of care as they had at least five years of professional experience in an intensive care setting, which is in line with the results found in another study (Oliveira et al., 2016).

According to DGS (2015), when grouped and implemented in an integrated way, care bundles promote better outcomes, with greater impact than adding the effect of each intervention individually. The CVC MQI was 89.2%, thus it is within the recommended range (above 80% or close to 95%), which is corroborated by other studies (Oliveira, Caetano, et al., 2015, Oliveira, Meneses, et al., 2015; Oliveira et al., 2016; Padilla Fortunatti, 2017). According to the same authors, the individual QI value related to the disinfection of connectors with an alcohol-based solution was only 17.5% compared to that found in this study, 71.8%. The nursing team's knowledge about the frequency of CVC dressing change was homogenous, with a QI of 98.9%. In other words, gauze dressings should be changed every 24 hours; transparent dressings should be changed after 7 days; and dressings that are wet, loose, or stained with blood should be changed immediately (Bell & O'Grady, 2017; DGS, 2015; Oliveira, Caetano, et al., 2015; Oliveira, Meneses, et al., 2015; Oliveira et al., 2016). Concerning the application of dressings using an aseptic technique, the QI value in this study was only 72.2%. Thus, the nursing team reached a non-compliance rate of 27.8% in this parameter, with 43.8% of nurses not using a sterile field/dressing kit, 25% of nurses not using sterile masks and gloves, and, finally, 6.2% of nurses not correctly performing skin antisepsis with 2% chlorhexidine at the time of application and drying.

With regard to hand hygiene at different moments, this study found that the individual QI for hand hygiene before CVC handling was only 67.1%, and the individual QI for handwashing/disinfection with an alcohol-based solution after the procedures was higher (78.2%) but below the ideal QI value (80%). These results are corroborated by the study of Oliveira, Meneses, and colleagues (2015), where the handwashing procedure was not performed, showing the professionals' lack of adherence to hand hygiene. Several authors (Oliveira, Caetano, et al., 2015; Padilla Fortunatti, 2017) emphasize the importance of hand hygiene given that hands can harbor microorganisms and transfer them from one surface to another directly, through direct skin-to-skin contact, or indirectly, through potentially contaminated objects. Controlling these infections through careful and frequent hand hygiene (the five moments) meets the legal and ethical requirements, promotes safety, and increases the quality of care provided to critically ill patients. Other studies (Oliveira, Meneses, et al., 2015; Padilla Fortunatti, 2017) report that the origin of health professionals' negligence in performing the hand hygiene technique may be associated with skin reactions on the hands, lack of motivation, lack of time, lack of preparation, and lack of awareness about the importance of hands in the transmission of microorganisms. However, the authors of this study believe that the low adherence to hand hygiene before the procedures may be related to the fact that the sanitization or disinfection time was shorter than recommended and, therefore, was reported as incorrect. It may also be associated with the frequent use of gloves, with hand hygiene not always occurring between each glove change. The nurses' failure to replace the Propofol infusion system every 12 hours (QI of 24.4%) stands out. Propofol infusion systems should be replaced every 6-12 hours, depending on laboratory indications (ANVISA, 2017; Bell & O'Grady, 2017; DGS, 2015). This result is explained by the fact that the nursing team usually changes the syringe containing Propofol when the infusion ends rather than after 6-12h, particularly when the infusion rate is low, in order to minimize clinical therapeutic and material waste.

The professional category also influenced the CVC MQI value because holding a specialization influenced the CVC MQI with a p-value < 0.001. Given that the specific skills of the nurse specialist in medical-surgical nursing in Regulation no. 429/2018, of 16 July, are to treat critically ill patients and maximize the prevention, intervention, and control of infections and antimicrobial resistance, the high CVC MQI obtained in this study may be explained by the high percentage of nurses with this specialization. Thus, it can be concluded that holing this specialization allows obtaining a higher CVC MQI, probably because these contents are addressed in theoretical and practical classes throughout the academic/professional training. The challenge for health institutions today is to design an appropriate model based on the organization of each service to ensure the success of the intervention, motivating health professionals in their professional practice (ANVISA, 2017; Oliveira et al., 2016). To this end, and according to Regulation no. 743/2019, of 25 September (OE), it is increasingly important for ICU teams to have at least 50% of nurses specialized in MSN, preferably in the area of critical care nursing.

The continuous education and training of the nursing team are key strategies regarding CVC placement, maintenance, and manipulation, particularly to prevent CVC-related BSIs (ANVISA, 2017; Oliveira et al., 2016). These results are encouraging and probably reflect the value presented by the CVC MQI found in this study. Although the data only reflect the subjectivity of the respondents, with different backgrounds and experiences, the authors of this study believe that their opinion on the PCVCRI and adherence to CVC maintenance in this unit is valid, as well as what it represents in their professional lives. The main limitations of this study are the small sample size and, consequently, the low frequency of observations, as well as the restriction to a single ICU.

Conclusion

This study found that the CVC MQI is within the recommended range, that is, above 80%, except for the parameters related to hand hygiene with water and a pH-neutral soap, disinfection of connectors with an alcohol-based solution, CVC dressing change with an aseptic technique, and replacement of the Propofol system every 12 hours. The academic qualifications, being a specialist nurse, and gender influenced the CVC MQI, leading to higher mean scores. Based on these results, the authors of this study believe that health professionals' training is a key strategy

for preventing and reducing infection risks. Therefore, they emphasize the importance of continuous training, particularly on the indicators with lower adherence in this study, and academic training for constant knowledge update and provision of high-quality nursing care. These units should include specialist nurses, particularly in MSN, complying with the legal requirements. Awareness campaigns about the importance of hand hygiene should be implemented to increase the compliance rate to this bundle. Further studies should be conducted in different units with larger samples and for longer periods of time to identify other risk factors and draw conclusions for optimizing nursing care and improving quality in healthcare.

Author contributions

Conceptualization: Gomes, S. M., Martins, M. D.
Data curation: Gomes, S. M., Martins, M. D.
Methodology: Gomes, S. M., Martins, M. D., Alves, M. J.
Writing – original draft: Gomes, S. M., Martins, M. D., Alves, M. J.
Writing – review & editing: Gomes, S. M., Martins, M. D., Alves, M. J.

References

Agência Nacional de Vigilância Sanitária. (2017). *Medidas de prevenção de infecção relacionada à assistência à saúde* (2nd ed.). http://www.riocomsaude.rj.gov.br/Publico/MostrarArquivo.aspx?C=p-CiWUy84%2BR0%3D

Aloush, S. (2018). Educating intensive care unit nurses to use central venous catheter infection prevention guidelines: Effectiveness of an educational course. *Journal of Research in Nursing, 23*(5), 406-413. https://doi.org/10.1177/1744987118762992

Bell, T., & O'Grady, N. P. (2017). Prevention of central line-associated bloodstream infections. *Infectious Disease Clinics of North America, 31*(3), 551-559. https://doi.org/10.1016/j.idc.2017.05.007

Borges, L. C., Souza, T. B., & Spolidoro, F. B. (2018). Atuação do enfermeiro frente ao risco de infecção com cateter venoso central na unidade de terapia intensiva. *Revista Enfermagem em Evidência, 2*(1), 1-14. https://www.unifafibe.com.br/revistasonline/arquivos/enfermagememevidencia/sumario/74/17122018184624.pdf

Direção-Geral da Saúde. (2015). *Norma 022/2015: Feixe de intervenções de prevenção de infeção relacionada com cateter venoso central.* https://www.dgs.pt/directrizes-da-dgs/normas-e-circulares-normativas/norma-n-0222015-de-161220151.aspx

Direção-Geral da Saúde. (2017). *Programa de prevenção e controlo de infeções e de resistência aos antimicrobianos - 2017*. https://www.sns.gov.pt/wp-content/uploads/2017/12/DGS_PCIRA_V8.pdf

European Centre for Disease Prevention and Control. (2017). *Healthcare-associated infections acquired in intensive care units*: *Annual epidemiological report for 2017*. https://www.ecdc.europa. eu/sites/default/files/documents/AER_for_2017-HAI.pdf

Günther, S. C., Schwebel, C., Hamidfar-Roy, R., Bonadona, A., Lugosi, M., Ara-Somohano, C., Minet, C, Potton, L., Cartier, J.-C., Vésin, A., Chautemps, M. Styfalova, L., Ruckly, S., & Timsit, J.-F. (2016). Complications of intravascular catheters in ICU: Definitions, incidence and severity. A randomized controlled trial comparing usual transparent dressings versus new-generation dressings (the advanced study). *Intensive Care Medicine, 42*(11), 1753-1765. https://doi.org/10.1007/s00134-016-4582-2

Mushtaq, A., Navalkele, B., Kaur, M., Krishna, A., Saleem, A., Rana, N., Gera, S., Chandramohan, S., Surapaneni, M., & Chopra, T. (2018). Comparison of complications in midlines versus central venous catheters: Are midlines safer than central venous lines? *American Journal of Infection Control, 46*(7), 788-792. https://doi.org/10.1016/j.ajic.2018.01.006

Nunes, M. (2018). *Projeto de intervenção estratégica numa Unidade de Cuidados Intensivos* [Master's thesis, Lisbon University Institute]. Repositório do ISCTE-IUL. http://hdl.handle.net/10071/17245

Oliveira, F. J., Caetano, J. A., Silva, V. M., Almeida, P. C., Rodrigues, A. B., & Siqueira, J. F. (2015a). O uso de indicadores clínicos na avaliação das práticas de prevenção e controlo de infecção de corrente sanguínea. *Texto & Contexto Enfermagem, 24*(4), 1018-1026.

Oliveira, F. J., Meneses, L. S., Caetano, J. A., Silva, V. M., Oliveira, M. L., & Machado, J. J. (2015b). Avaliação das práticas de adesão à higienização das mãos relacionadas com linhas vasculares em uma unidade de terapia intensiva. *Revista Visa em Debate: Sociedade, Ciência & Tecnologia, 3*(4), 55-61. Https://doi.org/10.3395/2317-269x.00520

Oliveira, F. T., Stipp, M. A., Silva, L. D., Frederico, M., & Duarte, S. C. (2016). Comportamento da equipe multiprofissional frente ao Bundle do cateter venoso central na terapia intensiva. *Escola Anna Nery, 20*(1), 55-62. https://doi.org/10.5935/1414-8145.20160008

Ordem dos Enfermeiros. (2017). *Padrões de qualidade dos cuidados especializados em enfermagem médico-cirúrgica*. https://www.ordemenfermeiros.pt/media/5681/ponto-2_padroes-qualidade-emc_rev.pdf

Ordem dos Enfermeiros. (2018). *Ordem dos Enfermeiros: Balcão único: 31-12-2018. Membros activos*. https://www.ordemenfermeiros.pt/media/11135/c%C3%B3pia-de-2018_acumulado_dadosestatisticos_nacional.pdf

Padilla Fortunatti, C. F. (2017). Impacto de dois bundles na infeção relacionada a cateter central em pacientes críticos. *Revista Latino-Americana de Enfermagem, 25*, e2951. https://doi.org/10.1590/1518-8345.2190.2951

Regulamento n.º 429/2018, da Ordem dos Enfermeiros. (2018). *Diário da República: II série*, n.º 135. https://dre.pt/application/conteudo/115698617

Regulamento n.º 743/2019, da Ordem dos Enfermeiros. (2019. *Diário da República: II série*, n.º 184. https://dre.pt/application/conteudo/124981040

Souza, E. S., Belei, R. A., Carrilho, C. M., Matsuo, T., Yamada-Ogatta, S. F., Andrade, G., Perugini, M. R., Pieri, F. M., Dessunti, E. M., & Kerbauy, G. (2015). Mortalidade e riscos associados a infeção relacionada à assistência à saúde. *Texto & Contexto Enfermagem, 24*(1), 220-228.

Tajeddin, E., Rashidana, M., Razaghia, M., Javadia, S. S., Sherafata, S. J., Alebouyeh, M., Sarbazi, M. R., Mansouri, N., & Zali, M. R. (2016). The role of the intensive care unit environment and health-care workers in the transmission of bacteria associated with hospital acquired infections. *Journal of Infection and Public Health, 9*, 13-23. https://doi.org/10.1016/j.jiph.2015.05.010

World Health Organization. (2011). *Report on the burden of endemic health care-associated infection worldwide: A systematic review of the literature.* https://apps.who.int/iris/bitstream/handle/10665/80135/9789241501507_eng.pdf