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MEDICAL AND NURSING TEAM SELF-REPORTED KNOWLEDGE ON BLOODSTREAM INFECTION PREVENTION MEASURES

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ABSTRACT

Objective: to evaluate the self-reported knowledge of the medical and nursing teams regarding bloodstream infection prevention measures related to the central venous catheter.

Methods: a cross-sectional study carried out at the intensive care unit of a large State run emergency hospital in Belo Horizonte, Minas Gerais (Brazil). The population was composed of doctors, nurses and nurse technicians responsible for the insertion and maintenance of central venous catheters. A face-to-face interview was conducted, and a structured questionnaire was used as the research instrument. In order to know the distribution of the data, descriptive statistics was used and for the analysis of the factors associated with knowledge the Poisson regression with robust variance was implemented. The considered significance level was 5% ($p < 0.05$) and the confidence interval was 95%. The Shapiro-Wilk test was used to verify the normality of the data.

Results: the self-reported knowledge median in the different researched questions was 42.8%. In the evaluation of knowledge regarding the catheter insertion, the percentage of self-reported knowledge of the doctors was 100%. On the contrary, the maintenance measures reported by the nursing team were lower than 50%, highlighting hub disinfection (35%) and duration of disinfection (7.2%).

Conclusion: in a general overview of the eligible questions for the evaluation of team knowledge, a limited knowledge of the measures, considered gold standard in the prevention of central venous catheter-related bloodstream infection, was verified, reinforcing the importance of continuous education and further discussion regarding the prevention of this infection.

DESCRIPTORS: Catheter-related infections. Intensive care units. Patient safety. Central venous catheters. Knowledge.

CONHECIMENTO AUTORREFERIDO DAS EQUIPES MÉDICA E DE ENFERMAGEM QUANTO ÀS MEDIDAS DE PREVENÇÃO DE INFECÇÃO DA CORRENTE SANGUÍNEA

RESUMO

Objetivo: avaliar o conhecimento autorreferido das equipes médica e de enfermagem quanto às medidas de prevenção de infecção da corrente sanguínea relacionada ao cateter venoso central.

Métodos: estudo transversal realizado na unidade de terapia intensiva de um hospital público de urgência e emergência de Belo Horizonte, Minas Gerais. A população foi composta por médicos, enfermeiros e técnicos de enfermagem responsáveis pela inserção e manutenção dos cateteres venosos centrais. Conduziu-se entrevista face a face, sendo utilizado como instrumento um questionário estruturado. A fim de se conhecer a distribuição dos dados utilizou-se estatística descritiva e para análise dos fatores associados ao conhecimento a regressão de Poisson com variância robusta. O nível de significância considerado foi de 5% ($p < 0,05$) e o intervalo de confiança de 95%. O teste de Shapiro-Wilk foi utilizado para verificar a normalidade dos dados.

Resultados: a mediana do conhecimento autorreferido nas diferentes questões pesquisadas foi de 42,8%. Na avaliação do conhecimento sobre a inserção do cateter o percentual autorreferido pelos médicos foi de 100%. Em contrapartida, as medidas de manutenção referidas pela equipe de enfermagem foram inferiores a 50%, destacando-se a desinfecção do *hub* (35%) e tempo de duração para essa desinfecção (7,2%).

Conclusão: na análise global das questões elegíveis para avaliação do conhecimento das equipes, constatou-se um conhecimento limitado às medidas consideradas padrão ouro na prevenção de infecção da corrente sanguínea relacionada ao cateter venoso central, reforçando a importância de mais investimentos na discussão da prevenção dessa infecção, bem como na educação permanente.

DESCRIPTORES: Infecções relacionadas a cateter. Unidades de terapia intensiva. Segurança do Paciente. Cateteres venosos centrais. Conhecimento.

CONOCIMIENTO AUTORREFERIDO DE LOS EQUIPOS MÉDICOS Y DE LA ENFERMERÍA SOBRE LAS MEDIDAS DE PREVENCIÓN DE INFECCIÓN DE LA CORRIENTE SANGUÍNEA

RESUMEN

Objetivo: evaluar el conocimiento autorreferido de los equipos médicos y de la enfermería en relación a las medidas de prevención de infección de la corriente sanguínea relacionada al catéter venoso central.

Métodos: estudio transversal realizado en la unidad de terapia intensiva de un hospital público de urgencia y la emergencia de gran porte de Belo Horizonte, Minas Gerais. La población fue compuesta por médicos, enfermeros y técnicos de enfermería responsables por la inserción y mantenimiento de los catéteres venosos centrales. Se realizó una entrevista cara a cara utilizando como instrumento un cuestionario estructurado. Con el objetivo de saber la distribución de los datos se usó la estadística descriptiva y para el análisis de los factores asociados al conocimiento se utilizó la regresión de Poisson con variancia robusta. El nivel de significancia considerado fue de 5% ($p < 0,05$) y el intervalo de confianza de 95%. El test de Shapiro-Wilk fue utilizado para verificar la normalidad de los datos.

Resultados: la mediana del conocimiento autorreferido en las diferentes preguntas investigadas fue de 42,8%. En la evaluación del conocimiento sobre la inserción del catéter, el porcentaje autorreferido por los médicos fue del 100%. En contrapartida, las medidas de mantenimiento referidas por el equipo de enfermería fueron inferiores a 50%, destacándose la desinfección del *hub* (35%) y el tiempo de duración para esa desinfección (7,2%).

Conclusión: en el análisis global de las preguntas elegibles para la evaluación del conocimiento de los equipos se constató un conocimiento limitado para las medidas consideradas como estándar oro en la prevención de una infección de la corriente sanguínea relacionada al catéter venoso central, reforzando la importancia de mayores esfuerzos en la discusión de la prevención de esa infección así como en la educación permanente.

DESCRIPTORES: Infecciones relacionadas con el catéter. Unidades de terapia intensiva. Seguridad del Paciente. Catéteres venosos centrales. Conocimiento.

INTRODUCTION

Healthcare-Associated Infections (HAIs) are persistent adverse events in the healthcare services, which become a public health problem due to the impact from increased costs of treatment, hospitalization time, and morbidity and mortality.¹ Among HAIs, central venous catheter (CVC) related bloodstream infections are the primary causes of intensive care unit (ICU) infections.² It is estimated that 30,000 new cases of this infection occur in ICUs in the United States every year. According to the latest epidemiological data, the incidence between 2011 and 2015 in Brazil was 4.8 infections per 1,000 CVCs per day.⁴ These infections are also associated with an increase in hospitalization duration between three and 20 days and at a cost of approximately US \$ 30,000 per patient,⁵ with a possible mortality rate of up to 69%.⁶

The use of intravascular devices, especially CVCs, is the main risk factor for bloodstream infections, with approximately 90% of them related to its use. CVC-related infections become more severe in ICUs due to the patients' clinical condition, prolonged hospitalization, the use of immunosuppressive and antimicrobial medication and consequent colonization by resistant microorganisms.⁷

Despite the high incidence in ICUs, CVC-related bloodstream infections can be prevented through programs that focus on continuous education, health professional training, adherence to recommendations during catheter insertion and maintenance, and HAIs epidemiological surveillance.⁸

Thus, the main preventive measures are described by the Center for Disease Control and Prevention (CDC) and have been included in clinical practice in the form of a package or set of interventions, called bundles. Hand hygiene, maximal barrier precautions, skin asepsis with chlorhexidine during catheter insertion and dressing change, selection of the CVC insertion site, daily evaluation, and immediate removal of unnecessary CVCs are among the measures that make up the bundle.⁵

In addition to these measures, continuous education and training programs for health professionals that insert and handle the CVC are recommended, as well as periodic knowledge assessment and adherence to measures for the whole team involved in catheter insertion and maintenance.

However, professionals still have low adherence to these measures and little is known about the relationship between knowledge and practice, which implies maintaining a high incidence of this infection.⁹

In view of the above, the objective was to evaluate the self-reported knowledge of the medical and nursing teams regarding CVC-related bloodstream infection preventative measures in an ICU.

METHOD

A cross-sectional study in which factor and effect were evaluated at the same time, performed at the ICU of a large State run emergency hospital in Belo Horizonte, Minas Gerais (Brazil), from July to

August 2016, after the approval of the Ethics Committee of the Federal University of Minas Gerais - CAAE 53642016.1.0000.5149.

The population was composed of the team responsible for the insertion and maintenance of the CVCs (doctors, nurses and nursing technicians), meaning those active in the direct assistance to the patient, considering that there was no specific team that inserted CVCs in the ICU.

The study included physicians, nurses and nursing technicians of both sexes, independent of the age group, responsible for insertion and maintenance of CVCs, and excluded professionals who were on medical leave, maternity leave, vacation or not on duty during the research and those who were not found after the third attempt at communication.

The data collection consisted in approaching the teams after meeting all the ethical precepts, leading to a face-to-face interview, using a structured questionnaire elaborated from the recommendations based on evidence proposed by the Guideline for the prevention of intravascular of the Center for Disease Control and Prevention (2011), which is composed of two parts⁵ and is widely accepted for the prevention of CVC-related bloodstream infections: part I: sociodemographic characteristics - sex, age, profession, length of training, length of professional activity, length of time in the institution and work shift; part II: Self-reported knowledge of evidence-based practices for the prevention of CVC-related bloodstream infections.

The analyzes were performed with the aid of the statistical program Data Analysis and Statistical Software (Stata), version 14, using descriptive statistics. Poisson regression with robust variance was used for the analysis of factors associated with knowledge. The significance level for statistical inference was 5% ($p < 0.05$) and the confidence interval was 95%. The Shapiro-Wilk test was used to verify the normality of the data and due to the non-normal distribution the median was adopted to categorize the results.

RESULTS

A total of 187 professionals were eligible for the study. A total of 131 professionals were included in the study, 22 were doctors (16.8%), 20 were nurses (15.3%), and 89 were nurse technicians (67.9%).

The application of the questionnaire sought to verify the self-reported knowledge among the different teams regarding CVC-related bloodstream infection preventive measures.

Regarding the sociodemographic characteristics of the professionals, the median age of the study participants was 37 years, varying between 24 and 64. The training time was between one and 38 years, with a median of 11. The length of professional practice ranged from one to 38 years with a median of 10 years, and the length of professional practice in the ICU ranged from one to 25 years with a median of four years.

Regarding training on CVC-related bloodstream infections, 93 professionals (71%) reported not having received training in the year 2015 and 12 (9.2%) did not remember. The places where these professionals received the training were in the study institution itself (57.7%) or in other institutions (42.3%).

Considering the self-reported preventive measures for bloodstream infections prior to CVC insertion by the medical staff, all respondents reported using barrier measures such as: sterile gloves, masks, caps, aprons, a sterile field and surgical preparation of the hands and skin asepsis of the patient. The most recommended antiseptic for skin asepsis was chlorhexidine followed by rubbing alcohol (77.3%) and the anatomic site recommended for the insertion of the CVC was the subclavian vein (50%) and the jugular vein (50%). Regarding the criterion used to remove the CVC inserted in an emergency situation, the majority (52.6%) reported that replacement of the catheter should occur as fast as possible. The other answers were: if the patient presented with a fever (21%) and there were no criteria for substitution (26.4%).

The main measures taken by the nursing team to prevent bloodstream infections during CVC manipulation were gloves (55.1%), the use of an antiseptic when changing dressings (51.4%), hand hygiene (36.7%), sterile dressings (29.4%) and dressing change according to the unit protocol (28.4%). The practice of disinfecting the hub before the administration of medications through the CVC was reported by 55% of the team. In contrast, 53.3% reported that there is no specific time to perform disinfection. The use of sterile gloves during dressing changes (79.8%) and the daily evaluation of the CVC insertion site (96.3%) were mentioned by the majority of professionals.

On questioning the medical and nursing teams regarding the dressing of the CVC insertion site, the dressings mentioned were sterile gauze and a clear dressing (89.3%) and the most reported antiseptic was the association of chlorhexidine followed by rubbing alcohol (75.6%).

The professionals' knowledge regarding the CVC-related bloodstream infection prevention bundles was also verified. Regarding the bundle concept, only 24 professionals (18.3%) said they were aware of such. 13 out of those 24 professionals (54.2% of the 24) managed to conceptualize the term.

The general knowledge of the professionals was evaluated by the self-reported knowledge median in the different studied questions, represented

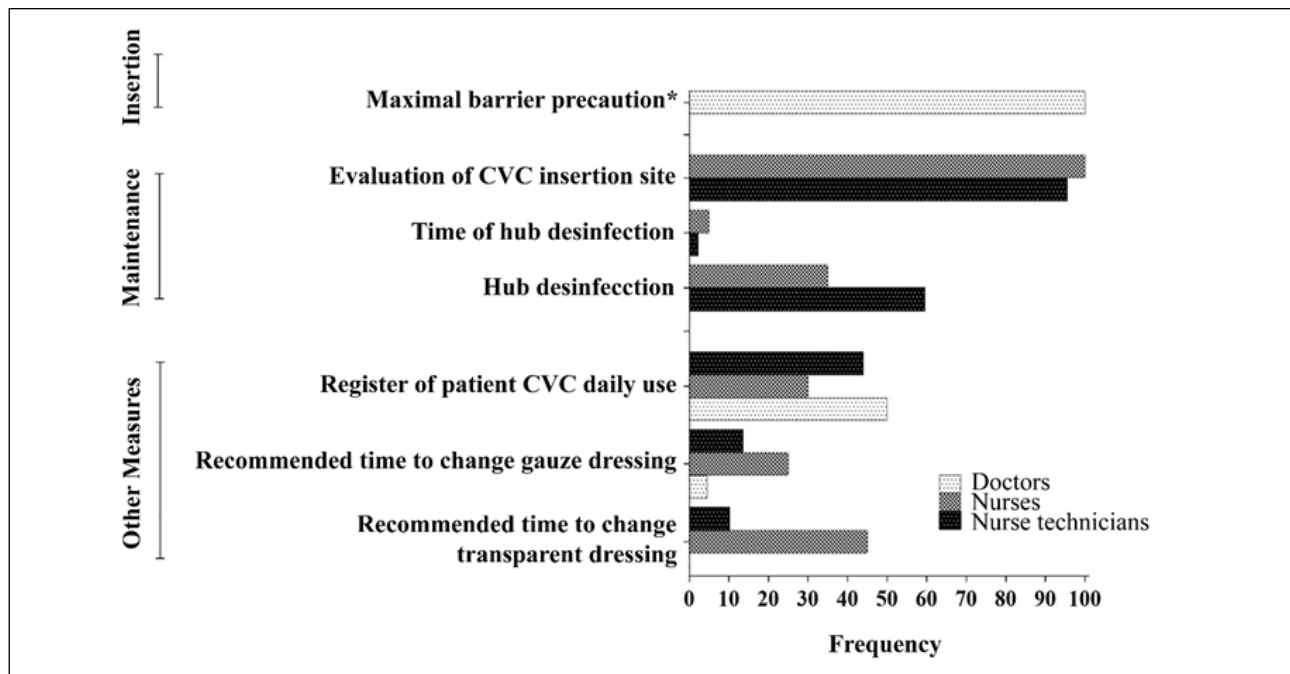
by the measures defined as gold standard for the prevention of CVC-related bloodstream infection according to the Guideline for the prevention of intravascular catheter-related infections of the Center for Disease Control and Prevention. The average self-reported knowledge was 43.4% (standard deviation ± 19.6), with a median of 42.8%, with a minimum of zero and a maximum of 85.7%. Self-reported knowledge was also calculated according to the professional category (Table 1).

Table 1 - Frequency of self-reported knowledge of bloodstream infection preventive measures related to central venous catheters for each professional category. Belo Horizonte, MG, Brazil, 2016. (n = 131)

Variable	Professional category		
	Nurse	Nurse Technician	Doctor
Knowledge			
Standard-Deviation	18.1	17.4	7.5
Median	28.5	38	70
Maximum	14	0	60
Minimum	57	71	80

According to the median of the answers, a highest percentage was observed in the medical team, followed by nurse technicians and nurses. The percentages of correct answers for the various evaluated topics according to the professional

category are presented in Figure 1. In the insertion variable only the physicians were approached (n=22) and for the maintenance variable the respondents were the nurses (n=20) and the nurse technicians (n=89).



*Maximal barrier precaution: surgical preparation of the hands, use sterile gloves, mask, cap, apron and sterile field.

Figure 1 - Frequency of eligible measure for self-reported knowledge by professional category. Belo Horizonte, MG, Brazil, 2016. (n=131)

The bivariate analysis between the sociodemographic variables and the self-reported knowledge answers variable for the eligible preventive measures

of CVC-related bloodstream infections is presented in table 2. The data considers the percentage of self-reported measures of 42.8%, categorized by the median.

Table 2 - Factors associated with self-reported knowledge of central venous catheters related bloodstream infection preventative measures, categorized by the median knowledge. Belo Horizonte, MG, Brazil, 2016. (n=131)

Variables	Proportion <42.8%	Proportion >42.8%	Prevalence rate (IC95%)	p Value
	n (%)	n (%)		
Sex				
Male	18 (56.2)	14 (43.7)	-	
Female	63 (63.6)	36 (36.4)	0.83 (0.51-1.33)	0.444
Age group				
≤ 37 years of age	44 (59.5)	30 (40.5)	-	
> 37 years of age	37 (64.9)	20 (35.1)	0.86 (0.55-1.35)	0.529
Professional category				
Nurse	14 (70.0)	6 (30.0)	0.3 (0.15-0.58)	0.000
Nurse technician	67 (75.3)	22 (24.7)	0.24 (0.17-0.35)	0.000
Doctor	0 (0)	22 (100.0)	-	
Time passed since graduation				
≤ 11 years	38 (54.3)	32 (45.7)	-	
> 11 years	43 (70.5)	18 (29.51)	0.64 (0.40-1.02)	0.066
Length of professional career				
≤ 10 years	38 (55.1)	31 (44.9)	-	
> 10 years	43 (69.3)	19 (30.7)	0.68 (0.43-1.07)	0.102
Length of professional activity in ICU				
≤ 4 years	40 (54.1)	34 (45.9)	-	
> 4 years	41 (71.9)	16 (28.1)	0.61 (0.37-0.99)	0.047
Work shift				
Day	42 (67.7)	20 (32.3)	-	
Night	39 (83.0)	8 (17.0)	0.52 (0.25-1.09)	0.086
On call	0 (0)	22 (100.0)	3.1 (2.1-4.45)	0.000

*ICU: Intensive Care Unit

In the bivariate analysis, a significant association ($p < 0.05$) was found between the professional category variables, the length of time working in the ICU and work shift. It was observed that nurses and nurse technicians presented a low index in the self-reported knowledge, as well as all the professionals who had working in the ICU for more than four years. On the contrary, the on-call professionals, regarding the medical team, presented more knowledge.

According to the multivariate analysis, only the "professional category" variable was significant ($p = 0.00$) and all the others lost their significance.

DISCUSSION

In order to evaluate the self-reported knowledge, the preventative measures for CVC-related bloodstream infections during catheter insertion and handling were considered, which were considered the critical periods for contamination and consequent infection.

The majority of the interviewed professionals reported not having received CVC-related bloodstream training in the year 2015. Training can be one of the means of developing workers' skills so

that they may become more productive, creative, and innovative.¹⁰ In a three-year training module with the multidisciplinary ICU team in Geneva, Switzerland, which addressed the recommended measures during the insertion and maintenance of CVC resulted in a 76% reduction in infections.¹¹ In a similar study conducted in Taiwan, the rate of infection was reduced by 100%.¹²

Regarding the measures used by the medical team to prevent bloodstream infections during CVC insertion, the use of barrier measures (sterile gloves, mask, cap, apron and sterile field), and surgical preparation of the hands and asepsis of the CVC insertion site was reported by 100% of participants. An example of the relevance of the adoption of these measures was seen in studies in ICUs in the United States, where a rate of infection of the CVC-related bloodstream was reduced by up to 70%.¹³⁻¹⁵

The recommended access site for CVC insertion was also evaluated, the medical team chose the subclavian and jugular vein. Access via the subclavian vein was associated with a lower risk of infection compared to the jugular and femoral, with an incidence of 0.97; 2.99 and 8.34 per 1000 catheters per day, respectively.¹⁶ Similar findings occurred in another study that obtained an incidence of 5.4 for subclavian access, 10.2 for jugular access and 14.7 per 1000 femoral catheters per day.¹⁷

Regarding the criteria used by the medical team for the removal of CVCs inserted in emergency situations, 52.6% responded that the catheter should be replaced as soon as possible. In these situations, the aseptic techniques for insertion of the CVC (maximal barrier precaution, insertion site asepsis and hand hygiene) may not be adopted, which increases the possibility of contamination at the insertion site. Therefore, it is recommended to replace these catheters within 48 hours due to the risk of infection of the blood stream.

Concerning the solution used and the time spent to disinfect the hub, rubbing 70% alcohol was the most mentioned solution. However, 53.3% said they did not know the correct time to perform this practice. Hub disinfection is recommended before administering medication and should be done by rubbing an alcohol swab on the hub for 15 to 30 seconds.⁸ The main types of dressings used to cover the CVC insertion site were sterile gauze and transparent film dressings, which is similar to the study findings,¹⁸ where 71.2% of the respondents stated that they used these dressings. Thus, dressing with sterile gauze or transparent film dressing is effective as

a protective barrier as long as the recommended criteria for use and change are followed.¹⁹

As for the antiseptic used for asepsis of the patient's skin during dressing change, chlorhexidine was the most reported. Asepsis of the CVC insertion site with chlorhexidine solution >0.5% has been recommended by CVC-related infection prevention guidelines and is widely used because of its excellent antimicrobial activity, prolonged residual effect and rapid action.^{5,8} A study comparing the use of chlorhexidine and iodopovidone (PVP-I) resulted in a lower incidence of CVC-related bloodstream infections than when using chlorhexidine.²⁰ A similar study reported a 72% reduction in CVC colonization when 46% chlorhexidine with PVP-I was used.²¹

Regarding the knowledge of the professionals, the median proportion of questions related to self-reported knowledge was 42.8% and, in the professional category, the medical team had a higher percentage (70%), followed by nurse technicians (38%) and nurses (28.5%).

Previous research evaluating professional knowledge regarding preventative measures for CVC-related bloodstream infections in the ICU showed similar results: in the study, the medical and nursing teams responsible for the insertion and maintenance of the CVCs in the ICUs of seven hospitals were interviewed in Athens, Greece, with an average percentage of 42.9% being obtained.²² With the same objectives, the average knowledge was 43% in 12 ICUs in the Calabria region in Italy.²³ In ICUs in the city of Alexandria, in Egypt, the knowledge of the medical and nursing staff was evaluated and the averages were 36.9% and 32.7%, respectively. However, there was no statistically significant difference between the knowledge of physicians and nurses.⁹ Even though the research was performed in several countries, the results showed a similar knowledge average of the teams regarding preventative measures for CVC-related bloodstream infections in the ICU.

As it is self-reported knowledge, it is inferred that professionals may have mentioned the measures they consider to be more or less important and not necessarily those used during the care with the patient with a CVC. Therefore, the knowledge can be different from the daily practice, because the professionals act according to their intentions and perceptions, due to attitudes in relation to the behavior and subjective norms.²⁴

Since there is a lack of knowledge on this subject, this research highlighted important results regarding the professional knowledge responsible

for the insertion and handling of CVCs. Regarding the limitations of the present study, one may point out the convenience sample, which may have led to a selection bias, and due to the research being performed in only one institution, that it may have restricted the extrapolation or comparison of the results with other institutions, and possibly interfere with their external validity.

It is emphasized that the aspects related to knowledge among medical and nursing teams should be addressed in future studies in order to understand the strategies that can be used to improve knowledge regarding CVC-related bloodstream preventative measures.

CONCLUSION

In a general overview considering the self-reported knowledge median of 42.8% of the eligible questions for the evaluation of the knowledge of the medical and nursing teams, limited knowledge regarding measures considered gold standard in the prevention of related bloodstream infection to the CVC were verified. These measures were mainly in related to the nursing team and the self-reported knowledge of the disinfection measures of the hub; amount of time for the disinfection of the hub; recording the days of CVC use by the patient; recommended time to change dressing with gauze and transparent film, which was less than 50%.

Regarding the importance of the professionals' knowledge in relation to the insertion and maintenance of the CVC with focus on the risk of bloodstream infection related to this device, it is fundamental to devote more attention and studies to the factors that interfere with knowledge regarding the infection prevention measures.

The results of this study reveal evidence that safe practices need to be cultivated in patient care, especially those in critical conditions. In addition, it can be used to review CVC insertion and handling practices, which may result in better quality of care, patient safety, morbidity and mortality reduction as a result of this infection.

REFERENCES

1. Agência Nacional de Vigilância Sanitária. Infecção primária da corrente sanguínea: análise do indicador nacional das unidades de terapia intensiva brasileiras no ano de 2013. Brasília, DF. 2014; 4(8):1-23.
2. National Healthcare Safety Network. NHSN Central Line-associated Bloodstream Infection Surveillance in 2014. National Center for Emerging and Zoonotic Infectious Diseases [Internet]. 2014 Mar [cited 2016 Feb 02]. Available from: <http://www.cdc.gov/nhsn/PDFs/training/training-CLABSI-2014-with-answers-BW.pdf>
3. National Healthcare Safety Network. Patient Safety Component Manual. Atlanta [Internet]. 2017 Jan [cited 2017 Sep 20]. Available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/pscmanual_current.pdf
4. Agência Nacional de Vigilância Sanitária. Boletim de Segurança do Paciente e Qualidade em Serviços de Saúde nº 14: Avaliação dos indicadores nacionais das Infecções Relacionadas à Assistência à Saúde (IRAS) e Resistência microbiana do ano de 2015. Brasília (DF) [Internet]. 2016 Dec [cited 2017 Sep 20]. Available from: <https://www20.anvisa.gov.br/segurancadopaciente/index.php/publicacoes/item/boletim-de-seguranca-do-paciente-e-qualidade-em-servicos-de-saude-n-13-avaliacao-dos-indicadores-nacionais-das-infeccoes-relacionadas-a-assistencia-a-saude-iras-e-resistencia-microbiana-do-ano-de-2015>
5. Center for Disease Control and Prevention. Guideline for the Prevention of Intravascular Catheter-Related Infections, 2011. Atlanta [Internet]. 2011 [cited 2016 Jun 07]. Available from: <http://www.cdc.gov/hicpac/pdf/guidelines/bsi-guidelines-2011.pdf>
6. Agência Nacional de Vigilância Sanitária. Medidas de prevenção de infecção relacionada à assistência à saúde. Brasília, DF: Agência Nacional de Vigilância Sanitária; 2013: 1-87.
7. The Joint Commission. Preventing Central Line - Associated Bloodstream Infections: A Global Challenge, a Global Perspective. Oak Brook, IL: Joint Commission Resources. [Internet]. 2012 May [cited 2016 Feb 02]. Available from: https://www.jointcommission.org/assets/1/18/CLABSI_Monograph.pdf
8. Loveday HP, Wilson JA, Pratt RJ, Golsorkhi M, Tingle A, Bak A, et al. Epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect* [Internet]. 2014 Jan [cited 2016 Jul 16]; 86(1):1-70. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/24330862>
9. Alkubati SA, Ahmed NT, Mohamed ON, Fayed AM, Asfour HI. Health care workers' knowledge and practices regarding the prevention of central venous catheter-related infection. *Am J Infect Control* [Internet]. 2015 Jan [cited 2016 Dec 16]; 43(1):26-30. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/25448304>
10. Leandro AIP, Branco ES. Importância do treinamento e desenvolvimento nos serviços de saúde. *Rev Adm Hosp Inov Saúde* [Internet]. 2011 [cited 2016 Nov 16]; 3(6):64-9. Available from: <http://revistas.face.ufmg.br/index.php/rahis/article/view/1018/876>
11. Zingg W, Cartier V, Inan C, Touveneau S, Theriault M, Gayet-Ageron A, et al. Hospital-Wide Multidisciplinary, Multimodal Intervention

- Programme to Reduce Central Venous Catheter-Associated Bloodstream Infection. PLoS ONE [Internet]. 2014 Apr [cited 2016 Nov 16]; 9(4):e93898. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3979709/>
12. Wu PP, Liu CE, Chang CY, Huang HC, Syu SS, Wang CH, et al. Decreasing catheter-related bloodstream infections in the intensive care unit: interventions in a medical center in central Taiwan. *J Microbiol Immunol Infect*. 2012 Apr [cited 2016 Oct 30]; 45(5):370-6. Available from: <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0093898>
 13. Burden AR, Torjman MC, Dy GE, Jaffe JD, Littiman JJ, Nawar F, et al. Prevention of central venous catheter-related bloodstream infections: is it time to add simulation training to the prevention bundle? *J Clinical Anesthesia* [Internet]. 2012 Nov [cited 2016 Apr 16]; 24(7):555-60. Available from: <http://www.sciencedirect.com/science/article/pii/S0952818012002450>
 14. Allen GB, Miller V, Nicholas C, Hess S, Cordes MK, Fortune JB, et al. A multitiered strategy of simulation training, kit consolidation, and electronic documentation is associated with a reduction in central line-associated bloodstream infections. *Am J Infect Control* [Internet]. 2014 Jun [cited 2016 Apr 16]; 42(6):643-4. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/24837115>
 15. Thom KA, Li S, Custer M, Preas MA, Rew CD, Cafeo C. Successful implementation of a unit-based quality nurse to reduce central line-associated bloodstream infections. *Am J Infect Control* [Internet]. 2014 Feb [cited 2016 Apr 16]; 42(2):139-43. Available from: <http://www.sciencedirect.com/science/article/pii/S0196655313012029>
 16. Lorente L, Henry C, Martín MM, Jiménez A, Mora ML. Central venous catheter-related infection in a prospective and observational study of 2,595 catheters. *Crit Care* [Internet]. 2005 Sep [cited 2017 Sep 22]; 9(6):31-5. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1414031/>
 17. Nagashima G, Kikuchi T, Tsuyuzaki H, Kawano R, Tanaka H, Nemoto H, et al. To reduce catheter-related bloodstream infections: is the subclavian route better than the jugular route for central venous catheterization? *J Infect Chemother* [Internet]. 2006 Dec [cited 2017 Sep 22]; 12(6):363-5. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/17235641>
 18. Dedunska K, Dyk D. Prevention of central venous catheter-associated bloodstream infections: A questionnaire evaluating the knowledge of the selected 11 evidence-based guidelines by Polish nurses. *Am J Infect Control* [Internet]. 2015 Dec [cited 2017 Sep 22]; 43(12):1368-71. Available from: [http://www.ajicjournal.org/article/S0196-6553\(15\)00793-2/pdf](http://www.ajicjournal.org/article/S0196-6553(15)00793-2/pdf)
 19. Oliveira FJG, Caetano JA, Silva VM, Almeida PC, Rodrigues AB, Siqueira JF. Use of clinical indicators in the evaluation of prevention and control practices for bloodstream infection. *Texto Contexto Enferm* [Internet]. 2015 Dec [cited 2017 Apr 09]; 24(4):1018-26. Available from: <http://dx.doi.org/10.1590/0104-0707201500004040014>
 20. Mimos O, Lucet JC, Kerforne T, Pascal J, Souweine B, Goudet V. Skin antisepsis with chlorhexidine-alcohol versus povidone iodine-alcohol, with and without skin scrubbing, for prevention of intravascular-catheter-related infection (CLEAN): an open-label, multicentre, randomised, controlled, two-by-two factorial trial. *Lancet Infect Dis* [Internet]. 2015 Sep [cited 2017 Sep 22]; 386(10008):2069-77. Available from: [http://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736\(15\)00244-5.pdf](http://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(15)00244-5.pdf)
 21. Girard R, Comby C, Jacques D. Alcoholic povidone-iodine or chlorhexidine-based antiseptic for the prevention of central venous catheter-related infections: in-use comparison. *J Infect Public Health* [Internet]. 2012 Feb [cited 2017 Sep 22]; 5(1):35-42. Available from: [http://www.jiph.org/article/S1876-0341\(11\)00108-0/fulltext](http://www.jiph.org/article/S1876-0341(11)00108-0/fulltext)
 22. Koutzavekiaris I, Vouloumanou EK, Gourni M, Rafailidis PI, Michalopoulos A, Falagas ME. Knowledge and practices regarding prevention of infections associated with central venous catheters: a survey of intensive care unit medical and nursing staff. *Am J Infect Control* [Internet]. 2011 Sep [cited 2016 Jul 20]; 39(7):542-7. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/21496955>
 23. Bianco A, Coscarelli P, Nobile CG, Pileggi C, Pavia M. The reduction of risk in central line-associated bloodstream infections: knowledge, attitudes, and evidence-based practices in health care workers. *Am J Infect Control* [Internet]. 2013 Feb [cited 2016 Jul 20]; 41(2):107-12. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/22980513>
 24. Comer A, Harris AD, Shardell M, Braun B, Belton BM, Wolfsthal SD, et al. Attaining Safety for Patients through Interdisciplinary Risk Reduction Efforts (ASPIRRE) Subgroup. Web-Based Training Improves Knowledge about Central Line Bloodstream Infections. *Infect Control Hosp Epidemiol* [Internet]. 2011 Dec [cited 2016 Nov 20]; 32(12):1219-22. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3331708/>

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