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IMPACT OF THE BUNDLES IMPLEMENTATION ON THE REDUCTION OF BLOODSTREAM INFECTIONS: AN INTEGRATIVE REVIEW

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ABSTRACT

Objective: to analyze the national and international scientific research regarding the impact of the bundles in the prevention of central venous catheter-related bloodstream infection in an adult intensive care unit.

Method: integrative review of articles published in Portal Capes, Virtual Health Library, PubMed, Science Direct, Cochrane, CINAHL and SCOPUS, between 2011 and 2016.

Results: 16 articles were found, 100% related to the implementation of the bundles for the insertion of the central venous catheter and 50% to related to the maintenance of this device. The intervention time was varied, as were the number of measurements and the analyzation period analyzed (catheter insertion / maintenance). However, all studies showed that there was a reduction of between 26% e 100% of bloodstream infections related to the use of the device.

Conclusion: the adoption of the bundle showed a positive impact on the reduction of infections. However, there was no direct relationship between the number of measures described in the studies or length of implementation time or higher rates of infection reduction.

DESCRIPTORS: Catheter-related infections. Catheters. Intensive care unit. Hospital infection. Patient safety.

IMPACTO DA IMPLEMENTAÇÃO DO *BUNDLE* NA REDUÇÃO DAS INFECÇÕES DA CORRENTE SANGUÍNEA: UMA REVISÃO INTEGRATIVA

RESUMO

Objetivo: analisar as produções científicas nacionais e internacionais sobre o impacto do *bundle* na prevenção de infecção da corrente sanguínea relacionada ao cateter venoso central em unidade de terapia intensiva adulta.

Método: revisão integrativa de artigos publicados no Portal Capes, Biblioteca Virtual em Saúde, Pubmed, Science Direct, Cochrane, Cinahl e Scopus, entre 2011 e 2016.

Resultados: encontraram-se 16 artigos, 100% relacionados à implementação dos *bundles* para a inserção do cateter venoso central e 50% à manutenção deste dispositivo. O tempo de intervenção foi variado, bem como o número de medidas e o período analisado (inserção/manutenção do cateter). No entanto, a redução da infecção da corrente sanguínea relacionada ao dispositivo foi apontada em todos os estudos entre 26% e 100%.

Conclusão: a adoção de *bundle* evidenciou um impacto positivo na redução da infecção. Todavia, não se observou uma relação direta entre o número de medidas descritas nos estudos ou o maior tempo de implementação e taxas mais altas de redução da infecção.

DESCRITORES: Infecções relacionadas a cateter. Cateteres. Unidade de terapia intensiva. Infecção hospitalar. Segurança do paciente.

IMPACTO DE LA IMPLEMENTACIÓN DEL *BUNDLES* EN LA REDUCCIÓN DE LAS INFECCIONES DE LA CORRIENTE SANGUÍNEA: UNA REVISIÓN INTEGRATIVA

RESUMEN

Objetivo: analizar las producciones científicas nacionales e internacionales sobre el impacto del *bundles* en la prevención de infección del flujo sanguíneo relacionado al catéter venoso central en unidad de terapia intensiva adulta.

Método: revisión integrativa de artículos publicados en el Portal Capes, Biblioteca Virtual en Salud, PubMed, Science Direct, Cochrane, CINAHL y SCOPUS, entre 2011 y 2016.

Resultados: se encontraron 16 artículos, 100% relacionados a la implementación de los lotes para la inserción del catéter venoso central y 50% al mantenimiento de este dispositivo. El tiempo de intervención fue variado, así como el número de medidas y el período analizado (inserción / mantenimiento del catéter). Sin embargo, la reducción de la infección del flujo sanguíneo relacionado con el dispositivo fue señalada en todos los estudios entre el 26% y el 100%.

Conclusión: la adopción del lote evidenció un impacto positivo en la reducción de la infección. Sin embargo, no se observó una relación directa entre el número de medidas descritas en los estudios o el mayor tiempo de implementación y tasas más altas de reducción de la infección.

DESCRIPTORES: Infecciones relacionadas con catéter. Catéteres. Unidad de terapia

INTRODUCTION

Hospital-acquired infections (HAI) are defined as a local or systemic condition resulting from an adverse reaction to the presence of an infectious agent or its toxin and without evidence that the infection was present or incubated at the time of patient admission in hospital or outpatient setting. They are diagnosed, usually after 48 hours after hospitalization.[1] The main HAI are: respiratory tract infection, urinary tract infection, blood stream and surgical site infection.[2]

Data from the National Healthcare Safety Network (NHSN) show that, among HAI, central venous catheter-related bloodstream infection (CVC) are the leading cause of infection in the Intensive Care Unit (ICU).[3] It is estimated that 30,000 new cases occur in ICU departments in the United States each year.[4] In 2014, 26.5 infections per 1,000 catheters / day occurred in England. In other European countries, there was an occurrence of around 13.3 infections per 1,000 catheters/day.[5-6] This type of infection is associated with an increase in hospitalization time ranging between an extra 10 and 20 days and with a cost of approximately US $ 30,000.00 per patient.[7] The systematization of epidemiological data on CVC-related bloodstream infection in the ICU in Brazil was started in 2010, with the creation of *FormSUS*. The rates of infection varied between 4.1 and 5.1 infections per 1000 CVC / day by 2015.[8] Data regarding prolonged hospitalization and its associated costs are not known in official publications.[9] However, the mortality rate from CVC infections in then ICU can affect up to 69% of patients.[2]

The use of an intravascular device, especially CVC, is the main risk factor for bloodstream infection, and approximately 90% of these are related to its use.[3,10]

CVC-related bloodstream infections are considered, in most cases, as an avoidable complication of patient safety and may be prevented by interventions during insertion and manipulation of the catheters. The Institute for Health Improvement promoted the "Save 100,000 lives" campaign in 2004, which introduced the concept of a central line bundle, which is based on the adoption of a set of measures based on integrated scientific evidence in order to reduce these infections.[11]

These measures are described by the Center for Disease Control and Prevention (CDC) and have been included in clinical practice in the form of intervention packages, called bundles.[7,11-12]

There are several suggested measures to prevent CVC-related infection, which make up the bundles which can be performed separately or together. The needs of each institution should be considered as a priority, in addition to the patient's profile, the human and material resources, the availability of education, training and supervision with the team responsible for insertion maintenance and care of the intravenous devices.[13-14]

Bundles have been widely disseminated and are being implemented in hospital institutions. Their adoption has been identified as effective in preventing and reducing CVC- related bloodstream infections and improving the quality of service. However, professional adherence to these measures remain low, which in turn causes a high incidence of this infection. Another gap in the knowledge is the absence of studies that address the results of health professional adherence to the recommendations of preventative practices related to this type of infection. Therefore, strategies that point to improvements in clinical practice and increased

patient safety should be encouraged, especially those focused on insertion time and maintenance of the CVC.

The knowledge of the teams who are responsible for insertion and maintenance of the CVC and bundle and its impact on the prevention of bloodstream infection may highlight evidence related to safe practices which are needed improve patient care, especially those under critical conditions. This could be used to review CVC insertion and manipulation practices, leading to better quality of care and reducing the morbidity and mortality due to this infection.

Considering the importance of using the bundle in clinical practice for the reduction of bloodstream infections, the objective was to analyze the national and international scientific research regarding the impact of the bundles in the prevention of CVC-related bloodstream infections in adult ICU settings.

METHOD

An integrative literature review whose purpose was to gather and synthesize the available evidence in original articles regarding the theme. The scope of scientific evidence was used as a foundation, which composed the research focus: implementation and impact of bundle use in clinical practice by identifying a question of great practical relevance. In the concrete plan, the PICO strategy was adopted, structured as follows: P=Patient, I=Intervention, C=Comparison and O=Outcomes.[15]

A research question was defined based on this strategy: what national and international scientific research highlight the impact of the bundle in the prevention of CVC-related bloodstream infection in the adult ICU setting?

The search for articles was carried out by the *Portal Capes* and *Biblioteca Virtual em Saúde*; and the electronic databases of U.S. National Library of Medicine (PubMed), Science Direct, Cochrane, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and SCOPUS.

Inclusion criteria included: original articles that addressed the impact of bundles in the reduction of CVC-related bloodstream infection in adult ICUs regardless of research method, as well as being published as of 2011, being the year in which the CDC published the last guideline on the prevention of infections related to intravascular devices. All other articles which did not meet these criteria were excluded.

The following controlled descriptors were used: catheter related infections, catheters, intensive care unit and hospital infection. As uncontrolled descriptors: bundle, reduction of infection rates, central venous catheter, prevention and infection of the bloodstream. All these descriptors were used alone and together with the help of boolean operators.

From the association between all the controlled and uncontrolled descriptors, 36 articles were identified, which, after reading them in full, were reduced to 16 due to the inclusion criterion approach; the implementation of bundles and their potential impact in clinical practice.

The levels of evidence were characterized by hierarchy, depending on the adopted methodological approach based on categorization which was classified into six levels:[16]

- level 1: evidence resulting from the meta-analysis (controlled and randomized clinical studies);
- level 2: evidence obtained from studies with experimental design;
- level 3: evidence from almost experimental studies;
- level 4: evidence from descriptive (non-experimental) studies or qualitative approach;
- level 5: evidence from case or experience reports;
- level 6: evidence based on expert opinions or consensus.

RESULTS

Based on the inclusion criteria, the final sample consisted of 16 articles, distributed as follows: Science Direct (5/16), Pubmed (9/16) and Cinahl (2/16). As for the research design, there were cohort studies (16/16), level of evidence 2, performed in Saudi Arabia (1/16), Australia (1/16), Belgium (1/16), Brazil (1 / 16), United States (7/16), England (1/16), Kuwait (1/16), New Zealand (1/16), Sweden (1/16) and Taiwan (1/16) Years of 2011 (2/16), 2012 (1/16), 2013 (3/16), 2014 (7/16), 2015 (2/16) and 2016 (1/16).

In 100% of the researched articles, bundles were implemented in the period of CVC insertion and 50% during their maintenance, whose measurements and results are described in table 1, taking into account the intervention, comparison and outcome assumptions, especially the fact that all studies were aimed at patients admitted to an adult ICU.

Table 1 - Summary of measures implemented to prevent infection related to the central venous catheter, according to the moment of its indication (insertion, maintenance and others), duration of intervention and rate of reduction. Belo Horizonte, MG, Brazil, 2016. (n=16)

Author/Year	*Implemented Bundle* (Intervention)	Duration of intervention	Infection Reduction (Outcome)
Salama, Jamal, Rotimi, 2016.12	• Insertion: maximal sterile barrier precautions; Skin asepsis; Preference for the subclavian vein; and hand hygiene before inserting the catheter. • Maintenance: verify the need for CVC to remain.	2 years	26%
Sacks et al., 2014.14	• Insertion: maximal sterile barrier precautions; Skin asepsis; Preference for the subclavian vein; Use of ultrasound to guide catheter insertion; and hand hygiene before inserting the CVC. • Maintenance: verify the need for CVC to remain.	1 year	68%
Kim, Holtom, Vigen, 2011.17	• Insertion: maximal sterile barrier precautions; Skin asepsis; replace the CVC inserted without aseptic techniques within 48 hours; Preference for the subclavian vein; avoid insertion into the femoral vein; and use of ultrasound to guide the insertion of the catheter. • Other: training and continuous education; And feedback of results.	3 years	70%
Longmate et al., 2011.18	• Insertion: maximal sterile barrier precautions; skin asepsis; preference for the subclavian vein; Avoid insertion into the femoral; and immediate removal of CVC without clinical indication. • Maintenance: disinfecting the hub before administering drugs; hand hygiene before handling the CVC; exchange of dressings; monitor the insertion site; and asepsis of the skin when changing the dressing.	1 year	100%
Burden et al., 2012.19	• Insertion: maximal sterile barrier precautions; Skin asepsis; preference for the subclavian vein; avoid insertion into the femoral; and immediate removal of CVC without clinical indication. • Maintenance: disinfecting the hub before administering drugs; hand hygiene before handling the CVC; change of dressings; Monitor the insertion site; and asepsis of the skin when changing the dressing.	4 years	61%
Cherifi et al., 2013.20	• Insertion: maximal sterile barrier precautions; skin asepsis; hand hygiene before inserting the CVC; and avoid insertion into the femoral; maintenance: verify the need for CVC permanence; disinfection of the hub before administering medications; hand hygiene before handling the CVC; and change of dressings. • Other: feedback of results.	1 year	55%

Author/Year	*Implemented Bundle* (Intervention)	Duration of intervention	Infection Reduction (Outcome)
Exline et al., 2013.21	• Insertion: maximal sterile barrier precautions; skin asepsis; preference for the subclavian vein; replace the CVC inserted without aseptic techniques within 48 hours; use of ultrasound to guide CVC insertion; and immediate removal of CVC without clinical indication. • Other: feedback of results.	3 years	81%
Hocking, Pirret, 2013.22	• Insertion: maximal sterile barrier precautions; skin asepsis; preference for the subclavian vein; and hand hygiene before inserting the CVC. • Maintenance: verify the need for permanence of the CVC; monitor the insertion site; and disinfecting the hub before administering drugs.	3 years	75%
Hammarskjöld et al., 2014.23	• Insertion: maximal sterile barrier precautions; skin asepsis; CVC impregnated with antibiotic; let the antiseptic dry before inserting; only designated qualified professionals to insert the CVC	3 years	91%
Klintworth et al., 2014.24	• Insertion: maximal sterile barrier precautions; skin asepsis; immediate removal of CVC without clinical indication; avoid femoral vein; hand hygiene before inserting the CVC; and only designate qualified professionals to insert the catheter and CVC impregnated with antibiotic. • Other: training and continuous education; and feedback of results.	2 years	60%
Tang et al., 2014.25	• Insertion: maximal sterile barrier precautions; skin asepsis; hand hygiene before inserting the CVC; and avoid insertion into the femoral. Maintenance: verify the need for CVC permanence; disinfection of the hub; hand hygiene before handling the CVC; and dressing change • Other: training; and continuing education.	10 months	61%
Mazi et al., 2014.26	• Insertion: immediate removal of CVC without clinical indication; and hand hygiene before inserting the CVC. • Other: training and continuous education.	1 year	61%
Allen et al., 2014.27	• Insertion: maximal sterile barrier precautions; skin asepsis; hand hygiene before inserting the CVC; and preference for the subclavian vein. • Other: training and continuous education.	4 years	85%
Thom et al., 2014.28	• Insertion: maximal sterile barrier precautions; skin asepsis; hand hygiene before inserting the CVC; avoid insertion into the femoral; and immediate removal of CVC without clinical indication. • Other: training and continuos education; and feedback of results.	4 years	70%
Menegueti et al., 2015.29	• Insertion: maximal sterile barrier precautions; skin asepsis; and hand hygiene before inserting the CVC. • Maintenance: verify the need for the CVC to remain; change of dressings; and monitor the insertion site. • Other: training and continuing education.	3 years	45%

Author/Year	*Implemented Bundle* (Intervention)	Duration of intervention	Infection Reduction (Outcome)
Entesari-Tatafi et al., 2015.30	• Insertion: maximal sterile barrier precautions; skin asepsis; and hand hygiene before inserting the CVC. • Maintenance: verify the need for the CVC to remain; change dressings; and monitor the insertion site. • Other: training and continuous education.	10 years	77%

The measures implemented in the CVC insertion bundle were: maximal sterile barrier precautions; (use of sterile gloves, cap, mask, apron and sterile field - 94% of studies);[12,14,17-25,27-30] skin asepsis (94%),[12,14,17-25,27-30] hand hygiene before insertion (62%),[14,19,21,23-28] preference for the subclavian vein (44%),[12,14,17,18,21,22,27] avoiding femoral vein (37%),[17,18,20,24,25,28] immediate removal of CVC without clinical indication for its use (37%),[18,19,21,24,26.28] ultrasound to guide the insertion of the catheter (19%); [14,17,21] allow the antiseptic to dry before inserting the catheter (12%); [23,30] CVC impregnated with antibiotic (12%); The CVC was inserted without aseptic techniques within 48 hours (12%),[17,21] and only designated qualified professionals to insert the CVC (12%).

The maintenance bundle comprised: daily verification of the need for CVC permanence (87%),[12,14,20,22,25,29,30] disinfection of the hub before administering medications (62%),[18,20,22,25,30] monitor the insertion site (50%),[18,22,29,30] dressing replacement with sterile gauze every two days and transparent dressing every 7 days or whenever they are dirty, loose or moist (50%);[18,20,25,30] hygiene of the hands before handling (37%),[18,20,25] and asepsis of the skin when changing the dressing (25%). Other measures that also made up the bundle were mentioned in the articles, being: training and continuing education to professionals who insert and manipulate the CVC in 56%[17,19,24,25-30] and feedback of the results, indicated in 31%.[17,20.21,24.28]

The frequency with which the measurements were described in the studies are shown in figure 1.

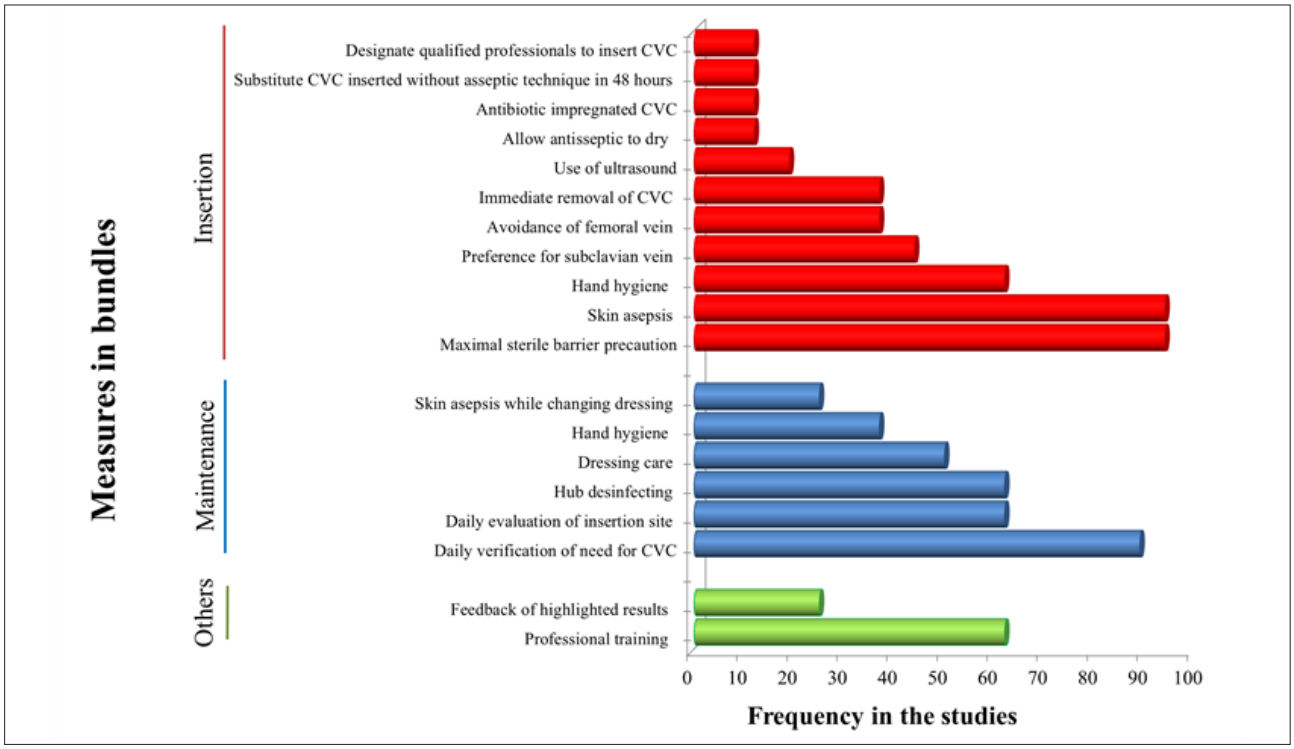

Figure 1 - Frequency of measurements contained in bundles (interventions), observed in published studies. Belo Horizonte, MG, Brazil, 2016

The measurements contained in the bundle to prevent CVC-related infection were classified according to the levels of evidence and divided into categories IA, IB, IC and II, and with the subject unresolved.[7] These classifications are used to demonstrate which preventive measures present the best scientific evidence for applicability in clinical practice, in isolation or when composing a bundle. Thus, the frequency of the adopted measurements in the studies analyzed at the time of their indication was based on the levels of evidence, according to figure 2.

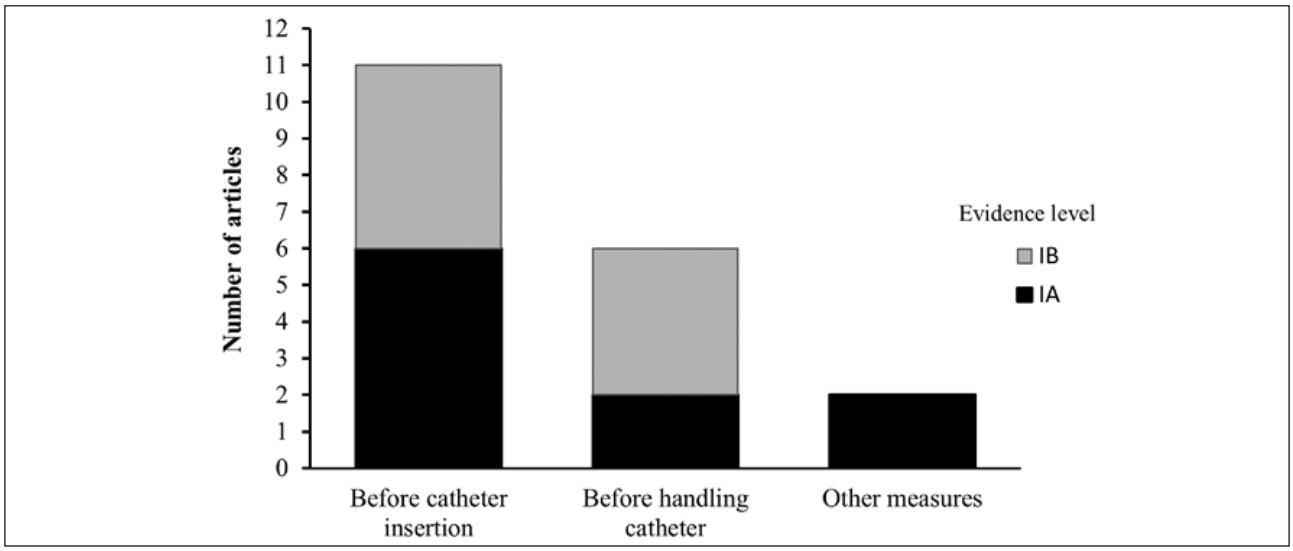

Figure 2 - Frequency of the adopted measurements in the studies analyzed, by level of evidence. Belo Horizonte, MG, Brazil, 2016

The number of measures that composed the bundle in each study with the duration of the intervention and the rate of reduction of CVC-related bloodstream infections after the bundle implementation were also related. The results are shown in figure 3.

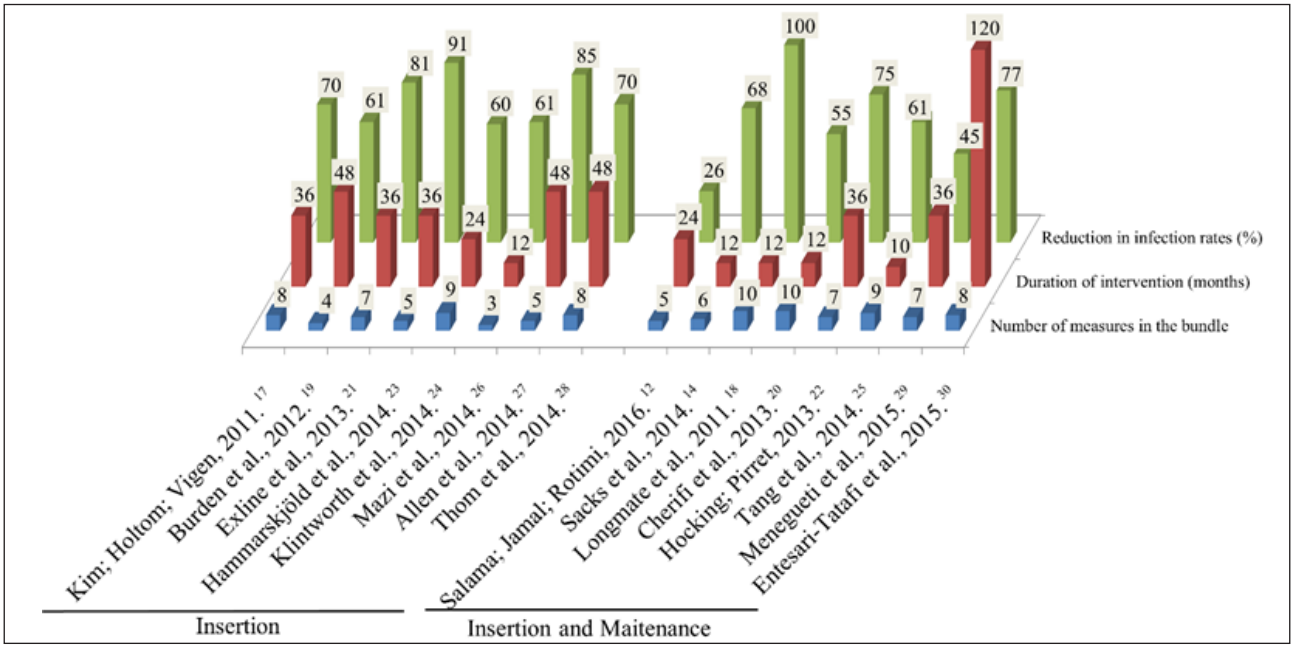

Figure 3 - Frequency of the adopted measurements in the studies analyzed, by duration of intervention and rate of reduction. Belo Horizonte, MG, Brazil, 2016

The impact of the bundle on reducing costs due to infection was measured in only two articles, with savings of US$539,902.00 and US$198,600.00 in each one after its implementation.[14,19]

Although it is not the objective of this study, it is highlighted that agents related to the cause of CVD bloodstream infections were described in only 31% of the studies, including: Negative-Coagulase *Staphylococcus, Staphylococcus aureus, Enterococcus* spp, *Klebsiella Pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa* and *Candida* spp.[12,17,20,23,25]

In the studies, 19 measures that compose bundles to prevent CVC-related bloodstream infections were found in the studies. Of these, 11 were used for catheter insertion, six during maintenance and two in continuing education and feedback of the results as a global part of the process.

Measures classified with levels of evidence AI were less used to compose the bundles. For example, for insertion of the CVC: preference for the subclavian vein (44%), avoidance of insertion in the femoral (37%), immediate removal of CVC without clinical indication (37%), CVC impregnated with antibiotic, designation of professionals qualified to use the CVC (12%). During catheter maintenance: skin asepsis when changing dressing (25%). And, like other measures: training and continuing education of professionals (62%) and feedback of results (31%).

DISCUSSION

The risk of bloodstream infection is also related to the catheter insertion site,[7] there is a greater prominence for insertion in the femoral and smaller for subclavian, whose predominant factor is the quantity and diversity of microorganisms found in each of the above mentioned regions.[30] Catheterization in the subclavian vein has been associated with a lower rate of infection compared to catheterization in the femoral. Studies in ICU in the United States, when comparing the infectious complications and the bacterial colonization of these two insertion sites, found that the incidence of infectious complications caused by insertion in the femoral site was 3.75 higher than in the subclavian and that the rate of colonization of the catheter was 20 % for the femoral site and 4% in the subclavian site.[32-33]

Another finding is the lack of emphasis on attention to the immediate removal of CVC without clinical indication. The CDC guidelines strongly recommend such a measure, since the risk of developing bloodstream infection increases with each day of use.[34]

In a university hospital in the United States, CVC permanence and clinical indication was verified with the following inference: out of 1.433 catheters/day, 25% had no indication for use.[35]Similarly, in another North American study, the percentage of patients with an unnecessary CVC was 48.9%.[36] The use of the catheter without a clinical indication is considered a risk factor and rates of bloodstream infection can be dramatically reduced if CVC are evaluated daily in order to assess necessity and length of use and thus be removed immediately when they are no longer necessary.[36]

The use of 0.5% chlorhexidine solution for CVC insertion site dressing change and asepsis has been recommended in order to prevent CVC-related infection by reducing local microbes. Chlorhexidine is widely used as an antiseptic in health care due to its excellent antimicrobial activity, its prolonged residual effect and its rapid action. Rates of bloodstream infection can be significantly reduced when asepsis is performed at each dressing change.[37-38] With daily cleaning of the CVC insertion site with 2% chlorhexidine during one year of intervention, it was possible to obtain a 58% reduction in infection rates in an ICU of a public hospital in Chicago.[39] Similarly, also in Chicago, the same intervention provided a 99% reduction in infections.[40] Using a similar project, there was a 50% reduction of vancomycin-resistant *Enterococcus* spp and 32% for methicillin-resistant *Staphylococcus aureus* over a six-month period.[41] The use of chlorhexidine at each dressing exchange has been considered a simple practice to implement, with low cost and high impact In reducing bloodstream infections.[41]

The continuing education and training programs of health professionals have been shown to be effective in preventing and reducing CVC-related infections, in addition to improving the quality of services provided. To ensure the quality of these programs, the following should be included: adequate CVC insertion and maintenance techniques, periodic assessment of knowledge, adherence to measures, infection surveillance and reporting, feedback on infection reduction and audit of the processes and results.[7,42-43] An educational intervention in the multidisciplinary team in the ICU of a Saint Louis hospital in the United States, which lasted for three years, addressed the recommended measures during the insertion and maintenance of the CVC, and resulted in the a 66% reduction of bloodstream infection.[44] It is therefore also important to only designate trained professionals who demonstrate competency for

the insertion and maintenance of the CVC,[7] in addition to providing training with a global and multidisciplinary approach, including behavioral and educational interventions for the whole team involved in catheter insertion and maintenance.[45]

Other measures were also composed in the bundles and presented a level of evidence IB, being strongly recommended for implementation,[7] such as: maximal sterile barrier precautions; skin asepsis, hand hygiene before insertion, use of ultrasound to guide the insertion of the catheter, allowing the antiseptic to dry before inserting the catheter and replacing the CVC without aseptic techniques within 48 hours. Measures associated with catheter maintenance were: to verify the need for CVC to remain, to monitor the insertion site, to disinfect the hub before administering medication, to replace the dressing with sterile gauze every two days, and to dress it every seven days or more when it is dirty, loose or moist and hand hygiene before handling.

The maximal sterile barrier precautions consists of sterile glove, cap, mask, apron and a sterile field, which contributes to reduce the microbial contamination of the professional and the environment for the patient at the time of insertion of the CVC and the subsequent risk of infection.[46] The same occurs when the skin is cleaned before insertion of the catheter, where it is recommended to use chlorhexidine alcohol >0.5%, which should be allowed to dry before insertion of the CVC. Thus, it will promote a residual effect and reduce the spread of extra luminal microorganisms towards the catheter insertion site.[47]

Hand hygiene is one of the main measures to prevent HAI. Therefore, it is essential to sanitize them before insertion and manipulation of the CVC, to minimize the spread of pathogenic microorganisms by the hands of health professionals and the consequent contamination of the catheter.[48-49]

The use of ultrasound to guide CVC insertion has been used in clinical practice to minimize the occurrence of mechanical complications, such as hemorrhage, pneumothorax, arrhythmias and arterial puncture. In addition, it has been shown to be able to reduce the duration of the procedure and the number of unnecessary attempts to cannulate the vein.[50-51] When adherence to aseptic technique cannot be guaranteed, i.e, catheters inserted in an emergency situation, these should be replaced within 48 hours due to increased possibility of bloodstream infection.[7]

Checking the need for the CVC becomes important so that the duration of the patient's use of the catheter can be monitored, since the length of CVC use is a risk factor for bloodstream infections and can also result in the CVC being removed immediately when there is no longer a clinical indication for its use. The insertion site should also be monitored. If the patient presents with sensitivity at the insertion site, fever or other manifestations suggestive of infection, the CVC should be evaluated and considered as a possible source of infection.[7] Disinfection of the hub prior to administration of drugs should be done by alcoholic rubbing for 15 to 30 seconds in order to avoid / reduce the spread of the microorganisms present in the hub to the internal lumen of the catheter.[52]

Due to its relevance, this practice became a campaign by the Association for Professionals in Infection Control and Epidemiology, called "Scrub the Hub," whose purpose was to reduce infections, educate, and encourage professionals to disinfect the hub carefully before any use, consequently it has been widely disseminated and recommended.[53-54]

The occlusive dressings should be replaced as recommended, as the moisture of the skin and the presence of dirt and secretions promote an environment conducive to microbial growth. Sterile gauze dressings should be changed within 48 hours, due to the difficulty in visualizing the insertion site and the possibility of dampening while bathing patients. The transparent polyurethane semipermeable dressing allows visualization of the insertion site and, therefore, requires less frequent changes, and thus can remain intact for seven days or whenever it gets dirty, loose or moist.[55-57]

The implementation and adherence of the measures contained in bundles, in addition to reducing infection rates, have a great economic impact on the costs caused due to infections, as evidenced by some studies analyzed, which showed a reduction of US$ 539,902.00 and US$ 198,600.00 relative to CVC-related bloodstream infections. NHSN and CDC estimates have shown that the annual costs generated due to HAI were approximately US$ 9.8 billion. Among the HAI, there are bloodstream infections, with a cost of US$ 45,814.00 per treatment. When these infections are associated with a resistant microorganism, for example methicillin-resistant *Staphylococcus aureus*, this cost increases to US$ 58,614.00. These data demonstrate the need to promote greater progress in the prevention of these infections, as well as to investigate and improve the quality of services provided as well as political efforts.[58]

CONCLUSION

The implementation of bundles has been shown to reduce CVC-related bloodstream infections, regardless of intervention time and the number of measures used. However, there were variations in the studies in relation to: number of measures implemented, duration and reduction of infection rates. There was no direct relationship between the number of measures described in the studies or the longest implementation time, and the highest rates of infection reduction. It is possible that this finding cannot be explained directly, due to aspects that were not presented by the authors of the studies, such as team motivation, institutional safety culture, feedback of results to professionals and training.

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