Objective: to describe the results of the use of a bundle for central-line care on the occurrence of bloodstream infection in intensive care units (ICU).

Method: integrative review. This paper aimed to answer the following question << What are the results of the use of a bundle for central-line care on the occurrence of bloodstream infections in neonatal and pediatric ICUs?>>. We searched the databases of LILACS and MEDLINE. Results: we selected eight articles published in the last five years, which have shown positive results in reducing bloodstream infection associated with the implementation of and compliance with bundle recommendations. The most important items identified in the bundle were: hand hygiene; insertion-site antisepsis; maximal barrier precautions; optimal catheter-site selection; dressings; optimal central-line maintenance care practices; and training. Conclusion: compliance with bundle recommendations is important in preventing catheter-related bloodstream infection. Descriptors: Catheter-Related Infections; Catheterization; Central Venous; Intensive Care Units; Patient Safety.

RESUMO
Objetivo: descrever os resultados da utilização do bundle de cateter venoso central (CVC) na ocorrência de infecção de corrente sanguínea em unidades de terapia intensiva (UTI). Método: revisão integrativa, a fim de responder ao questionamento << Quais os resultados da utilização da estratégia bundle de CVC na ocorrência de infecções de corrente sanguínea em UTI neonatais e pediátricas?>>. As buscas foram realizadas nas bases LILACS e MEDLINE. Resultados: foram selecionados oito artigos, publicados nos últimos cinco anos, que evidenciaram resultados positivos na redução de infecção de corrente sanguínea a partir da implementação de e da adesão às recomendações do bundle. Os itens de maior importância identificados no bundle foram: higienização das mãos, limpeza do sítio de inserção, uso de precaução máxima de barreira, local de inserção, curativos, cuidados na manutenção do CVC e treinamento. Conclusão: a adesão ao bundle de CVC é importante na prevenção de infecção de corrente sanguínea relacionada ao cateter. Descriptores: Infecções Relacionadas a Cateter; Cateterismo Venoso Central; Unidades de Terapia Intensiva; Segurança do Paciente.

RESUMEN
Objetivo: describir los resultados del uso del bundle de catéter venoso central (CVC) sobre la ocurrencia de infección del torrente sanguíneo en unidades de cuidados intensivos (UCI). Método: revisión integrativa con el fin de responder a la pregunta << ¿Cuáles son los resultados de la utilización de la estrategia del bundle de CVC en la ocurrencia de infecciones del torrente sanguíneo en UCIs neonatales y pediátricas?>>. La búsqueda se realizó en las bases de datos LILACS y MEDLINE. Resultados: se seleccionaron ocho artículos publicados en los últimos cinco años, que mostraron resultados positivos en la reducción de infección del torrente sanguíneo con la aplicación y el cumplimiento de las recomendaciones del Bundle. Los elementos más importantes identificados en el Bundle fueron: higienización de las manos; limpieza de la zona de inserción; sitio de inserción; vendajes; cuidados en el mantenimiento del CVC; y capacitación. Conclusión: la adhesión al bundle de CVC es importante en la prevención de infección del torrente sanguíneo relacionada con el catéter. Descriptores: Infecciones relacionadas con catéteres; Cateterismo Venoso Central; Unidades de Cuidados Intensivos; Seguridad del Paciente.
INTRODUCTION

Children admitted to Neonatal and Pediatric Intensive Care Units (ICUs) usually need special care due to acute, highly severe and complex conditions. Thus, they often require a safe, long-term venous access for intravenous therapy.

Due to anatomical and physiological reasons, it is more difficult to obtain venous access in newborns and children, and there is a high frequency of loss of venous access. Thus, the use of central venous catheterization has become a common practice in the management of pediatric patients, in order to avoid excessive peripheral venous puncture attempts.

Central venous catheterization (CVC) is indicated for the continuous administration of intravenous fluids, medications, prolonged parenteral nutrition, blood products, hemodynamic monitoring, and may also constitute a crucial part of the hemodialysis process.

However, although they are very important devices in pediatric and neonatal ICU settings, the advantages provided by the use venous catheters are opposed by the complications that may arise from its use, such as catheter-related bloodstream infection (CRBSI) - which is the main complication, according to laboratory tests. If the association between catheterization and bloodstream infection is not confirmed by laboratory tests, but there is suspicion that the CVC is the most likely cause of infection, then it is defined as catheter associated bloodstream infection (CABSI).

Most cases of CRBSI are caused by microorganisms in the skin microbiota, contamination of the catheter insertion site, infusion of contaminated IV fluids, contamination of the catheter hub, hematogenous spread from a distant site of infection, and contamination from the hands of the health care team. Some authors also associate the risk of acquiring CRBSI with the catheter dwell time, the qualifications and experience of the staff who will provide care to the patient, among others.

A study conducted in Baltimore, USA, analyzed data from 2,592 central catheters in 1,819 children. 116 CRBSI occurred over 44,972 catheters-day. Incidence rate in the analyzed cohort was 2.58 cases per 1000 catheter-days.

A prospective study conducted with a sample of 226 newborns admitted to the neonatal ICU of a hospital in London has analyzed data collected from 302 central catheters. The incidence of catheter-related bloodstream infection among infants with corrected gestational age between 29 and 36 weeks was 19.2%. In the total study population, the incidence rate of CRBSI was 21%.

Neonatal and pediatric intensive care patients have several risk factors for the development of catheter-related bloodstream infection, such as immunological impairment, need for repeated invasive procedures, blood products administration, among others. Thus, there is an increase in mortality and morbidity rates among these patients, as well as an increase in the length of hospital stay and in hospital costs.

To prevent complications related to central venous access, it is essential to prioritize patient safety through the implementation of care protocols and quality care indicators, and constantly monitor adverse events. In order to do so, the health care team must pay attention to the correct insertion and apply effective surveillance to the maintenance of catheters.

Among the strategies to reduce the risk of catheter-related bloodstream infection, we may mention those outlined in the Centers for Disease Control and Prevention (CDC) guidelines, which are implemented in clinical practice through an interventions package. Such package combined a small group of specific evidence-based care practices and is called bundle. These care practices are essential for providing effective and safe care to patients, as they show significantly better results when applied together and in a systematic manner to all patients.

Bundles help health professionals deliver better and more reliable care to patients, thereby dramatically reducing the incidence of lethal infections. They may include constant monitoring, health professionals’ education and training in the insertion and care of central lines, as well as bloodstream infection prevention strategies. However, it is noteworthy that, in order to obtain the best results, there should be high bundle compliance and all guidelines should be carefully followed.

A study conducted in the neonatal intensive care unit of a hospital in New York has found an incidence rate of catheter-related infection in newborns of 25%. This rate has remained constant for three years until proactive management measures to minimize infection have been implemented. After applying these measures, infection rates dropped to 7.1%.

This study is justified by the high use of central venous catheters in neonatal and
pediatric ICUs, and the importance of knowing and applying disease prevention measures in the context of catheter-related bloodstream infections. Therefore, it is of paramount importance to investigate strategies such as the use of bundles for central-line care, in order to promote risk management and risk reduction in pediatric and neonatal ICUs. We highlight the lack of studies addressing the implementation of care bundles for prevention of bloodstream infection in neonatal and pediatric units.

The theoretical framework adopted in this study was practice based on evidence (PBE). PBE employs tools to achieve the consolidation of scientific knowledge on a given subject, seeks to find optimal and efficient professional practices/behaviors/actions to solve an established problem, through the gathering of consistent and relevant evidence, listed according to its quality.14

OBJECTIVE

To describe the results of the use of a bundle for central-line care on the occurrence of bloodstream infection in neonatal and pediatric intensive care units (ICU).

METHODS

This is an integrative literature review, which allows the synthesis of results from a large amount of published studies focusing on a particular area of interest.15

The development of integrative reviews includes six stages: The integrative review was developed following six stages: formulation of the research question, literature search, study categorization, evaluation of the included studies, results discussion and interpretation, and an evidenced knowledge synthesis.15–16

The research question asked was: What are the results of the use of a bundle for central-line care on the occurrence of bloodstream infections in neonatal and pediatric Intensive Care Units?

We searched the following databases: Medical Literature Analysis and Retrieval System Online (MEDLINE) via PubMed; and Latin American Literature on Health Sciences (LILACS). We combined the keyword ‘bundle’ with the following terms: catheterization, central venous [AND] catheter related infections [AND] Intensive care units, pediatrics [AND] Intensive care units, neonatal.

Primary articles published in Portuguese, English and Spanish in the last five years and addressing the use of bundle for central-line care and prevention of catheter-related bloodstream infection in neonatal or pediatric ICUs were included in this study. Review articles, articles that did not directly address the proposed theme and duplicates in the databases were excluded from the review.

All studies found were assessed by their title and abstract, and the relevant articles were read in full. Two independent researchers characterized and analyzed the selected studies by gathering information and synthesizing ideas. We used a tool17 for data extraction, which was adapted to allow the collection of specific information on the topic. The following information was extracted: title, author, area of expertise, year of publication, language, design, objectives, methods, results, conclusions and level of scientific evidence of the study. An analytical reading of the studies was made in order to sort the information found and answer the research question. Next, an interpretative reading was performed to allow the understanding of the material chosen, a judicious grading of level of evidence, and the provision of a theoretical construct for analysis. The level of evidence18 was determined as shown in Figure 1.

<table>
<thead>
<tr>
<th>LEVELS</th>
<th>Study types</th>
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<tbody>
<tr>
<td>I</td>
<td>Strong evidence derived from at least one properly designed systematic review of multiple, well-designed, randomized control trials (RCTs).</td>
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<tr>
<td>II</td>
<td>Evidence derived from at least one well-designed, randomized control trial.</td>
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<tr>
<td>III</td>
<td>Evidence derived from a well-designed clinical trial without randomization.</td>
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<td>IV</td>
<td>Evidence derived from a well-designed cohort or case-control study.</td>
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<td>V</td>
<td>Evidence derived from a systematic review of descriptive and qualitative studies.</td>
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<tr>
<td>VI</td>
<td>Evidence derived from a single descriptive or qualitative study.</td>
</tr>
<tr>
<td>VII</td>
<td>Evidence derived from opinions of respected authorities or reports of expert committees.</td>
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Figure 1. Level of evidence classification.18
34 articles were found in the LILACS database. Of these, 27 were excluded because they did not directly address the proposed topic, were duplicates in the databases, or did not address the care of neonates or children. 20 papers were found in the MEDLINE database. Of these, 17 excluded because they did not directly address the proposed topic, were duplicates in the databases, or did not address the care of neonates or children.

Thus, the final sample was composed of eight articles: seven had been published in English, two in Portuguese and one in Spanish.

Four studies had been conducted at Pediatric Intensive Care Units (PICU),\textsuperscript{11,19-21} four at Neonatal Intensive Care Units (NICU),\textsuperscript{22-25} and one at pediatric and neonatal departments.\textsuperscript{21}

With regard to the studies design, two were prospective studies,\textsuperscript{22,25} two were prospective and intervention studies,\textsuperscript{19,23} and two were time-series studies.\textsuperscript{20,21} The other studies were: a before-and-after intervention study,\textsuperscript{11} a prospective cohort study,\textsuperscript{13} and a prospective longitudinal descriptive study.\textsuperscript{21} Two articles had been conducted at a single site\textsuperscript{11,23} and six were multi center studies.\textsuperscript{13,19,20,22,25-26}

All articles in the sample addressed the prevention of catheter-related bloodstream infection in neonatal and/or pediatric ICUs through the implementation of care bundle guidelines. Figure 2 summarizes the main results obtained in the studies selected for this review.
<table>
<thead>
<tr>
<th>First author/year</th>
<th>Methods/Objective</th>
<th>Interventions</th>
<th>Results</th>
<th>Level of Evidence</th>
</tr>
</thead>
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<tr>
<td>1. Vilela R, Dantas SRPE, Trabasso P, 2010&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Cohort study that aimed to evaluate the evolution of interdisciplinary interventions and their impact on CRBSI indicators of a Pediatric ICU and on blood microorganisms isolated from blood.</td>
<td>Direct: Hand hygiene, implementation of a surveillance system for the CVC insertion process, with maintenance of a record of non-compliance instances by the nurse. Indirect: Catheter connection and hub antisepsis prior to its opening, with 70% alcohol; replacement of disposable caps after opening them; encouraging the use of lateral injectors for serum catheters and the replacement of immersion baths by rub hygiene in patients with CVC.</td>
<td>Reduced rates after implementation of direct and indirect interventions. Before the intervention, the incidence density was above the 90th percentile of the National Healthcare Safety Network (NHSN). After the interventions, the incidence density was close to the 75th percentile, which is an expected level in PICU.</td>
<td>IV</td>
</tr>
<tr>
<td>2. Rosenthal VD, Dueñas L, Sobreira-Oropeza M, Ammark K, Navoa-Ng JA, Casares ACB et al., 2013&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Controlled study without randomization that aimed to analyze the impact of the International Nosocomial Infection Control Consortium (INICC) on CRBSI rates in NICUs.</td>
<td>Bundle implemented: proper hand hygiene before catheter insertion or manipulation; use the kit with the necessary material for insertion of the catheter; use of maximum barrier precautions during insertion of the catheter; use of sterile gauze dressings at the catheter insertion site; good conditions of cleanliness of the sterile dressing at the site of catheter insertion; and disinfection of the catheter hub, connectors and entrance before handling the catheter.</td>
<td>55% reduction in the incidence of CRBSI in the NICU.</td>
<td>III</td>
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<tr>
<td>3. Rosenthal VD, Ramachandran B, Villamil-Gómez W, Armas/Ruiz A, Navoa-Ng JA, Matta-Cortés L et al., 2012&lt;sup&gt;3&lt;/sup&gt;</td>
<td>Controlled study without randomization that aimed to analyze the particular effect of a multidimensional preventive strategy on CRBSI rates in Pediatric ICU in developing countries between October 2003 and December 2010.</td>
<td>Bundle implemented: proper hand hygiene before catheter insertion and manipulation; use of a chlorhexidine-based antiseptic solution to clean the skin for catheter insertion; use of the kit with the necessary material for insertion of the catheter; use of maximum barrier precautions during insertion of the catheter; disinfection of the catheter hub, connectors and entrance before handling the catheter; removal of unnecessary catheters.</td>
<td>55% reduction in the incidence of CRBSI in the NICU.</td>
<td>III</td>
</tr>
<tr>
<td>4. Resende DS, Ó JM, Brito DvD, Abdallah VOS, Filho PPG, 2011&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Prospective and intervention study that aimed to reduce CABSI rates in Neonatal Intensive Care Units (NICU) through the implementation of a set of care measures, including some infection control and prevention strategies.</td>
<td>Bundle: hand hygiene; use of maximum barrier precautions during insertion of the catheter; cleaning of the skin with a 0.2% chlorhexidine solution; avoidance of femoral puncture (if possible); removal of unnecessary catheters.</td>
<td>Bundle effectiveness in reducing CABSI. Reduction from 32% to 19.6% of CABSI. Reduction from 24.1 to 14.9 of CABSI per 1000 catheter-days. Reduction from 21.9 to 12.5 of CABSI</td>
<td>III</td>
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| 5. Miller MR, Niedner MF, Huskins C, Colantuoni E, Yenokyan G, Moss M et al., 2011 &15
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<td>Prospective cohort study that aimed to evaluate the long-term (3 years) impact of central-line care practices in pediatrics on the reduction of CRBSI rates in Pediatric ICUs and to evaluate the additional impact of rubbing chlorhexidine and chlorhexidine-impregnated sponges on the skin.</td>
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<td>Insertion bundle: hand hygiene before the procedure; rub chlorhexidine gluconate on the insertion site skin for 30 to 60 seconds in children older 2 years of age, and for 2 minutes when the insertion site is the groin; do not use iodine or iodine-based ointments; separate sterile material; create checklists; use maximum barrier precautions; train the staff on how to insert the catheters. Maintenance Bundle: daily assessment of the need for the catheter; use only chlorhexidine for dressing change, rubbing the skin for 30s; change gauze dressings every 2 days and transparent film dressings every seven days, unless they are dirty, wet or loose; replace infusion sets after 72 hours, unless they are contaminated or suspected of being infected; replace the blood product or lipids administration sets 24 hours after the start of administration.</td>
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<tr>
<td>56% reduction in CRBSI rates after interventions. Rubbing chlorhexidine or chlorhexidine-impregnated sponges on the insertion site skin did not result in a significant reduction of CABSI rates when compared to the results obtained through bundle compliance.</td>
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<tr>
<td>Prospective cohort multi center study that aimed to investigate whether the adoption of insertion and maintenance bundles reduced CRBSI rates in NICU, and whether the use of checklists during catheter maintenance reduced CRBSI rates in these units.</td>
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<td>Insertion Bundle: developing a central-line insertion kit with all the items needed for the procedure; hand hygiene with alcohol-based solution approved by the hospital or with soap containing antiseptic agents before and after palpating the insertion sites, and before and after inserting the catheter; use maximum barrier precautions (sterile gloves, gowns and drapes, cap and mask); clean the skin with 2% chlorhexidine and 70% alcohol; use transparent film or sterile gauze dressings. Maintenance bundle: hand hygiene as mentioned in the insertion bundle; assess the insertion site for the early detection of inflammatory signs; change dressings with 2% chlorhexidine and 70% alcohol whenever they are dirty, wet or loose;</td>
</tr>
<tr>
<td>67% reduction in CABSI rates in perinatal centers of New York.</td>
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7. Miller MR, Griswold M, Harris JM, YenoKyan G, Huskins WC, Moss M et al., 2010

Controlled study without randomization that aimed to develop and assess the effectiveness of central-line care practices in reducing CABSI rates in Pediatric Intensive Care Units (PICU).

Insertion bundle: hand hygiene before the procedure; rub chlorhexidine gluconate on the insertion site skin for 30 to 60 seconds in children older 2 years of age, and for 2 minutes when the insertion site is the groin; do not use iodine or iodine-based ointments; separate sterile material; create checklists; use only polyurethane or Teflon catheters; train the staff on how to insert the catheters.

Maintenance Bundle: daily assessment of the need for the catheter; use only chlorhexidine for dressing change, rubbing the skin for 30s; change gauze dressings every 2 days and transparent film dressings every seven days, unless they are dirty, wet or loose; replace infusion sets after 72 hours, unless they are contaminated or suspected of being infected; replace the blood product or lipids administration sets 24 hours after the start of administration.

43% reduction in CABSI rates. The main strategy for reducing CABSI rates was the maintenance bundle.

8. Schulman J, Stricof RI, Stevens TP, Holzman IR, Shields EP, Angert RM et al., 2009

Prospective cohort study that aimed to develop a care bundle for reducing CABSI rates in Neonatal Intensive Care Units (NICU).

Insertion Bundle: developing a central-line insertion kit with all the items needed for the procedure; hand hygiene with alcohol-based solution approved by the hospital or with soap containing antiseptic agents before and after palpatting the insertion sites, and before and after inserting the catheter; use maximum barrier precautions (sterile gloves, gowns and drapes, cap and mask); clean the skin with 2% chlorhexidine and 70% alcohol; use transparent film or sterile gauze dressings.

Maintenance bundle: hand hygiene as mentioned in the insertion bundle; assess the insertion site for the early detection of inflammatory signs; change dressings using an appropriate antiseptic whenever they are dirty, wet or loose; use only hospital-approved standard intravenous catheter; use only hospital-approved standard intravenous catheter; use aseptic technique when changing the infusion set and when manipulating the catheter, always rubbing the hub; daily assessment of the need for the catheter, removing it when no longer needed.

Reduction in CABSI rates associated with higher newborn weight.
use aseptic technique when changing the infusion set and when manipulating the catheter, always rubbing the hub; daily assessment of the need for the catheter, removing it when no longer needed.

Figure 2. Summary of key findings of the selected studies. Belo Horizonte, MG, Brazil, 2014.
All eight studies assessed and confirmed the positive impact of using bundles for central-line care on catheter-related infections. In a cohort study, the authors found that the incidence of CRBSI before implementation of the bundle strategy in the pediatric ICU was 9.4 CRBSI/thousand days of CVC. After the intervention, the incidence dropped to 6.5 CRBSI/thousand days of CVC.11 In the controlled study without randomization conducted at a pediatric and neonatal ICU, the use of the bundle resulted in a 55% reduction in the incidence of CRBSI in the NICU.19 Another prospective and intervention study confirmed the effectiveness of the bundle in reducing CRBSI and CABSI incidence rates, which dropped from 32% to 19.6%.21 Two prospective cohort studies - Miller et al.20 and Schulman et al.25 - found a reduction of 56% and 67%, respectively, in CABSI incidence rates after the interventions. Miller et al.21 found a 43% reduction in infection rates mainly due to the strategies adopted to maintain the catheter. Finally, the study by Schulman24 also confirmed previous findings about the benefits of the bundle strategy in reducing infection rates.

In order to provide further details on the studies reviewed here, the discussion session was divided into the most important bundle actions identified: hand hygiene, insertion site antisepsis, maximum barrier precautions, catheter-site selection, dressings, optimal central-line maintenance care practices and training teams.

- **Hand hygiene**

All evaluated articles highlight hand hygiene as a bundle strategy to reduce catheter-related infection. However, only two articles recommend the use of an alcohol-based product approved by the hospital, or soap containing antisepic agents before and after palpatining the insertion-site, and before and after inserting the catheter.13,25 These recommendations are important because they corroborate those stated in the Centers for Disease Control and Prevention (CDC) guideline. A multi center study also mentioned the use of a checklist for hand hygiene with soap containing antisepic agents as an extra tool used with the other bundle items.19

- **Insertion site antisepsis**

The following antisepic solutions were used to disinfect the insertion site before CVC: 2% chlorhexidine, 0.2% chlorhexidine, 0.5% chlorhexidine, 70% alcohol and povidone-iodine (PVP-I).11,13,19-21,23,25 Only one study has not mentioned insertion site antisepsis as a bundle item.22

In one study, skin antisepsis was made with 2% degerming chlorhexidine, followed by saline solution and 0.5% chlorhexidine.11 Other studies used chlorhexidine in children above 2 years of age, and indicated the importance of rubbing the insertion site for 30 seconds, unless the insertion site was the femoral site, which should be rubbed for 2 minutes, leaving it to dry.19-21 There were no specific recommendations for children younger than two years in the studies reviewed.

Vilela et al. found that the effectiveness of chlorhexidine-based solutions in reducing bacterial skin flora was higher than that of PVP-I solutions, including the alcoholic ones.11 The guideline for prevention of CRBSI and CABSI recommends the use of chlorhexidine>0.5% with 70% alcohol to clean the catheter insertion site. However, if there is a contra indication to the use of chlorhexidine, tincture of iodine, iodophor or 70% alcohol should be used as alternatives.26

- **Maximum barrier precautions**

Most of the articles included in this review mention the use of maximum barrier precautions as a bundle strategy. Nevertheless, only a few studies specify the barriers that must be used. These are: sterile caps, masks, protection glasses, gowns, drapes and gloves. These precautions are also listed in the CDC guidelines.26

- **Catheter-site selection**

Only one study addresses the catheter insertion site and states that the femoral site should be avoided when possible.23 In contrast, another study claims that femoral puncture in children is often more convenient, since the evidence for an increased risk of infection associated with the insertion site are not definitive for children, although it is the case for adults.21

Another article reported the occurrence of six cases of infection at the insertion site during the study period: four in the femoral site, one in the jugular site and one in the basilica site.21

According to the CDC, central-lines should be preferably inserted in distal points in the
arms and legs, and in the scalp of pediatric patients, and the femoral site should be avoided.26

- **Dressings**

The studies indicate the use of sterile gauze and transparent film as dressing options after catheter insertion. Sterile gauze dressing changes should be performed every two days or when the dressing is dirty, wet or loose. Transparent film dressings need to be replaced after seven days or when the dressing is dirty, wet or loose.13,20–21,25

Only one of the articles mentions that an appropriate antiseptic solution (2% chlorhexidine or 70% alcohol) on each dressing change.13 he CDC guideline recommends the use of chlorhexidine for daily cleaning the patient’s skin.26

Moreover, the CDC also recommends the use of sterile gauze or transparent film dressings, which should be changed as described above.26 However, if there is risk of displacement or loss of the catheter when changing the dressing in pediatric patients, the dressing change may be delayed as long as the dressing is intact.

- **Optimal central-line maintenance care practices**

With respect to central-line maintenance practices, some studies have emphasized the importance of catheter connection and hub antisepsis before inserting the catheter, in order to reduce the incidence of CRBSI or CABSI. Some articles suggest the use of an alcohol 70% solution.11,13,19,22,25

In addition, only a few studies mention the importance of daily monitoring the insertion site for the early detection of inflammatory signs.13,25 However, most studies recommended the daily assessment of the need for the catheter, which should be removed immediately when not longer essential.13,19,21,23,25 This is in line with the CDC guidelines.26

- **Training teams**

In addition to aforementioned actions to prevent CRBSI or CABSI, education and training of health professionals on the insertion and maintenance of catheters was also seen as an essential measure.20–21 As suggested by the CDC, it is necessary to train the health staff regarding indication criteria for central-line use, proper procedures for insertion and maintenance of catheters, and appropriate measures for infection prevention and control.26 Thus, all studies claim that, in order to reduce CRBSI and CRASI incidence rates in neonatal and pediatric ICUs, are necessary not only optimal insertion practices but also, and particularly, optimal maintenance care practices.20–21

The studies also showed that to maintain the good results in the control of catheter-related infections, it is essential to have the involvement of the entire health care team, provide continuing education activities, have ICU staff members discuss CRBSI and CABSI cases, assure effective participation of the Hospital Infection Control Commission (CCHI) and give feedback to the staffs about the reduction of infection rates in their units after the implementation of the bundle strategy for central-line care.11,23,27

**CONCLUSION**

The use of care bundles currently is a hot topic associated with patient safety. Bundles are used as a strategy to prevent and reduce CRBSI and CABSI.

Based on the results of this study, we conclude that there is a shortage of studies describing this tool for the prevention of CRBSI and CABSI in children and neonates. The analysis of the articles revealed that measures to prevent and control CRBSI and CABSI represent a challenge to health care professionals, since newborns are subjected to multiple invasive procedures during hospitalization, which increases the risk of acquiring infections. Summarized, it can be said that with the implementation of a bundle for central-line care containing the main guidelines related to the insertion and maintenance of catheters, it is possible to reduce CRBSI rates.

Additional broader studies are needed to shape and direct clinical practice to implement bundle strategies for the prevention of the bloodstream infection in pediatrics, with a special focus on the nursing staff, who is directly involved in the insertion and maintenance of catheters.

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Utilização do bundle de acesso venoso central em unidades de cuidados intensivos de neonatos: a experiência do Hospital Universitário de Belo Horizonte, Brasil.

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