

CARE BUNDLE TO REDUCE CENTRAL VENOUS CATHETER-RELATED BLOODSTREAM INFECTION: AN INTEGRATIVE REVIEW

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ABSTRACT

This is an integrative review of literature aimed to identify evidence-based interventions which make up care bundles to reduce central venous catheter-related or associated bloodstream infections. To collect data in Brazilian and international databases were used the key word bundle and the descriptors catheter-related infection, infection control and central venous catheterization, resulting in fifteen articles, after inclusion criteria application. This work showed five interventions as those commonly employed in the bundles methods: hand hygiene, chlorhexidine gluconate for skin antisepsis, use of maximal sterile barrier precaution during the catheter insertion, avoid the femoral access and daily review of catheter necessity with prompt removal as no longer essential. The majority of the studies showed a significant reduction in bloodstream infection related to or associated with central venous catheters.

Descriptors: Catheter-related infection. Infection control. Central venous catheterization. Patient safety. Pediatric nursing.

RESUMO

Trata-se de uma revisão integrativa da literatura, que objetivou identificar intervenções baseadas em evidência que compõem o método bundle, designados à redução de infecção de corrente sanguínea relacionada ou associada a cateter intravenoso central. Para a coleta de dados online, em bases nacionais e internacionais, foram utilizados a palavra-chave bundle e os descritores catheter-related infection, infection control e central venous catheterization, resultando, após aplicação dos critérios de inclusão, amostra de quinze artigos. Este trabalho evidenciou cinco intervenções como as mais frequentemente empregadas na construção dos bundles: higienização das mãos, gluconato de clorexidina como antisséptico para pele, uso de barreira máxima de precaução durante a inserção cateter, evitar acessar veia femoral e verificar necessidade diária de permanência do cateter, com sua remoção imediata quando não mais indicado. A maioria dos estudos demonstrou resultados estatisticamente significantes na redução de infecção de corrente sanguínea relacionada ou associada a cateter intravenoso central.

Descritores: Infecções relacionadas a cateter. Controle de infecções. Cateterismo venoso central. Segurança do paciente. Enfermagem pediátrica.

Título: Método Bundle na redução de infecção de corrente sanguínea relacionada a cateteres centrais: revisão integrativa

RESUMEN

Esta es una revisión integradora tuvo como objetivo identificar intervenciones basadas en evidencias que componen método bundle de reducción de infección sanguínea relacionadas o asociadas con catéter intravenoso central. Para recopilar los datos en las bases brasileñas e internacionales, utilizando la palabra clave bundle y los descriptores infecciones relacionadas con catéteres, control de infecciones y cateterización venosa central, identificando, con los criterios de inclusión, muestra de quince artículo. Este estudio muestra cinco intervenciones como comúnmente empleadas en los métodos bundles: higiene de las manos, clorhexidina como antiséptico para la piel, uso de precaución de barrera máxima durante la inserción del catéter, evitar el acceso de la vena femoral y comprobar la necesidad diaria del catéter con su retirada inmediata cuando posible. La mayoría de los estudios analizados mostraron una reducción significativa de infección sanguínea relacionadas o asociadas con catéteres intravenosos centrales.

Descriptores: Infecciones relacionadas con catéteres. Control de infecciones. Cateterismo venoso central. Seguridad del paciente. Enfermería pediátrica.

Título: Método bundle en la reducción de infecciones relacionadas a catéteres centrales: una revisión integrativa.

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INTRODUCTION

Central venous catheters are essential devices for health care nowadays⁽¹⁻²⁾. According to the *Centre for Disease Control and Prevention* (CDC), half of the patients in Intensive Care Units (ICU) in the United States of America (USA) use some kind of Central Venous Catheter (CVC) resulting in an amount of 15 million catheters / day every year⁽³⁻⁴⁾.

This kind of device is used in a variety of therapeutic applications such as hemodynamic monitoring, application of fluids, medicines, blood derivatives and parenteral nutrition^(1,5-6).

Despite the advantages of its use, there are risks associated with it, among them the colonization and the bloodstream infection^(3,5,7-9). Catheter-Related Bloodstream Infection (CRBSI) stands out as the main complication resulting from the use of this kind of device according to lab tests confirmation. If the association between catheter and bloodstream infection is not confirmed by lab tests, but CVC is the most probable cause of the infection, it is characterized as Central Line-Associated Bloodstream Infection (CLABSI)⁽¹⁰⁾.

The majority of CRBSIs is caused by microorganisms of cutaneous microbiota through the contamination of the catheter insertion site, through the infusion of contaminated IV solutions, through the device's connections, through hematogenous dissemination and through the staff's hands. Authors relate the risk of acquiring CRBSI with the kind of infused solution, the catheter's on-call time, the professional experience in the patient care, among others⁽¹¹⁻¹⁴⁾.

CRBSI repercussion is so relevant that American *Institute for Healthcare Improvement* (IHI) listed it as one of the six main initiatives in campaigns directed to save a hundred thousand lives and, later, five million lives, attempting to improve patient care, preventing death by adopting simple and effective measures of easy implementation⁽¹³⁾.

Defining *bundle*

Nowadays there are plenty of strategies developed in order to reduce the risk of CRBSI. Such strategies are described in CDC as guidelines (*Guidelines for the Prevention of Intravascular Catheter-Related Infections*)^(4,6) and they have been applied in clinical practice as a pack or set of interventions formed by a small group of specific care called

bundle. These care are essential to the patient safety and when they are applied together they generate significantly better results⁽¹⁵⁻¹⁶⁾.

Bundle can include constant surveillance, health staff education, training of catheter-inserting / handling staff and prevention strategies against bloodstream infection^(9,14,16-24).

It is important to emphasize that, in order to guarantee better results, it is necessary to have a high adhesion to *bundle* and the proposed guidelines must be jointly and uniformly applied to all patients, becoming a powerful tool for the safety culture⁽²⁵⁾.

It's important to observe that the translation of the term *bundle* as a pack does not seem to be culturally appropriate to the Portuguese Language because it does not mirror the concept entwined with the conduct. In our practice, we initially tried to use the term set of good practices; however, it does not mirror the need of implementation of the set in its entirety. This way, this term has been used in national health system and a synonym must be culturally defined for the methodology application

Thus, the guiding question of this investigation is: What guidelines have been used as *bundle* elements in order to reduce catheter-related bloodstream infection?

In the face of the aforementioned considerations and of the large number of CVCs used in clinical practice nowadays, the current study aims to verify scientific researches referring to the use of bundle guidelines in order to reduce CRBSI and to analyze the results of such researches.

MATERIAL AND METHOD

In order to investigate the contribution of the conducted researches on the use of bundle as a strategy to reduce CRBSI, we opted for an integrative review of the literature which is the research method that allows us to bring scientific evidences to clinical practice, in addition to enable the inclusion of studies with different designs⁽²⁶⁻²⁷⁾.

The stages that guided this integrative review were: subject identification and hypothesis selection or issues for review; establishment of criteria for the inclusion and exclusion of the articles composing the research sample; definition of the characteristics of the primary researches composing the review sample; evaluation on the included articles; interpretation of the results and review presentation, providing a critical review on the findings⁽²⁶⁾.

The criteria for inclusion were: texts in English, Spanish or Portuguese, with abstract, title and/or content in which the term *bundle* was present and texts that indicated the use of this strategy to prevent or to reduce CRBSI.

The object of study identification was carried out by searching the data base on Virtual Health Library (Biblioteca Virtual em Saúde – BIREME) and National Library of Medicine (Pubmed) through combinations of the key-word *bundle* and the descriptors *catheter-related infection*, *infection control*, *central venous catheterization*.

In the search through BIREME, we used data base from Latin-American Literature on Health Sciences (Lilacs), Medical Literature Analysis and Retrieval System on Line (Medline) and Scientific Electronic Library Online (Scielo).

As the final result search through national and international data base detected a limited number of articles on CRBSI, we also took into consideration articles that approached CLABSI, considering that the elements composing *bundle* are common to the studies of CRBSI.

In Medline data base, the combinations between *bundle*, *catheter-related infection*, *infection control* and *central venous catheterization* resulted in nine publications, one of them being excluded for not contemplating the inclusion criteria. In Pubmed data base, sixteen publications were found, eight of them were also found in Medline and three of them were excluded for not falling within this study's purpose.

In the search in Lilacs and Scielo data base, terms such as *bundle*, *central venous catheterization* and *infection control* were used, resulting in three identical articles in each data base. Only two of them fit inclusion criteria. After analyzing these different data bases we ended up with fifteen articles.

RESULTS AND DISCUSSION

Table 1 presents an overview of the studies identified and included in the current integrative review, according to the guidelines adopted in *bundle* method and the main results.

Data are presented upon the analysis of the fifteen articles, fourteen in English and one in

Authors	Objective/ Methodology	Interventions	Results/ Conclusion
Smith ⁽⁵⁾ / United Kingdom, 2007.	To describe <i>bundle</i> strategies that could be used to minimize the occurrence of CRBSI* in Pediatric ICU†. Type of study: Descriptive/ Pediatric (ICU).	<i>Bundle</i> : hands hygiene; the use of 0.5% chlorhexidine gluconate mixture with 70% alcohol as antiseptic; the use of maximal barrier precaution; replace transparent sterile semipermeable dressings every seven days or when it gets dirty; aseptic technique of “not touching” to access or to manipulate central catheter; daily review of the catheter necessity with prompt removal when no longer essential.	It presents subsidies to the identification of the main elements on <i>bundle</i> and reports that the use of these care may reduce the incidence of CRBSI.
Casey, Elliott ⁽⁶⁾ / USA‡, 2010.	To describe different types of central catheters, the risk associated with its use and prevention measures against CRBSI. Type of study: Descriptive and upgrading	<i>Bundle</i> : the use of single lumen catheter; to avoid accessing femoral vein; the use of maximal barrier precautions; hands hygiene; chlorhexidine gluconate as antiseptic; transparent semipermeable sterile dressing; scrub the catheter's ports or hubs; the use of antiseptic / antibiotic-impregnated catheters, connectors and sets changing routine.	It provides use indications of <i>bundle</i> in order to reduce CRBSI, through the studies review. It recommends the use of antiseptic-impregnated catheters if infection rate remains high after <i>bundle</i> .

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<p>Zack⁽⁹⁾/ USA, 2008.</p>	<p>To reduce CLABSI through the use of <i>bundle</i>. Type of study: Prospective/ Single-Centre/ Adult (ICU).</p>	<p>Staff education; classes, self-study, pre and post-test. <i>Bundle</i>: hands hygiene; scrub the catheter's ports or hubs with 70% alcohol; the use of clean latex gloves to access catheter.</p>	<p>It demonstrated decrease on CLABSI rate after the use of <i>bundle</i>. CLABSI rates: Before <i>bundle</i>: 10.8/ 1000 catheter/day; After <i>bundle</i>: 3.7/1000 catheter/day.</p>
<p>Londoño, Ardila, Ossa⁽¹⁴⁾/ Colombia, 2011.</p>	<p>To identify CRBSI[§] frequency describe its relation to risk factors. Type of study: Descriptive prospective/ Single-Centre / Neonatal e Pediatric (ICU).</p>	<p>Weekly cultures on the insertion and connection site, blood cultures and culture on the tip of the catheter. <i>Bundle</i>: hands hygiene; the use of maximal barrier precautions; chlorhexidine gluconate as antiseptic; to avoid accessing femoral vein; daily review of the catheter necessity with prompt removal when no longer essential.</p>	<p>It demonstrated decrease on CRBSI rates after the use of <i>bundle</i>. CRBSI rates: Before <i>bundle</i>: 9.0/ 1000 catheter/day; After <i>bundle</i>: 3.8/1000 catheter/ day; It identified surgery as one of the main risk factors to CRBSI.</p>
<p>Shulman, Stricof, Stevens, Shields, Angert, Wasserman-Hoff, Nafday, Saiman⁽¹⁵⁾/ USA, 2009.</p>	<p>To Characterize rates of infection related to health assistance in ICUs of New York and to develop strategies to promote good practices to reduce CLABSI. Type of study: Prospective/ Multi-Centre / Neonatal (ICU).</p>	<p>To identify performance criteria, to plan and to apply improvements on the service; to select an indicator (CLABSI rate); to identify ICUs with low rates of infection and to know applied practices; to develop <i>bundle</i> in order to reduce CLABSI. <i>Bundle</i>: hands hygiene; the use of maximal barrier precautions; chlorhexidine gluconate as antiseptic; sterile transparent semipermeable dressing or gauze to cover the insertion site; daily review of the catheter necessity with prompt removal when no longer essential.</p>	<p>It demonstrated that infection rates identified vary from 1.0 to 5.8/1000 patients/ day and CLABSI rates from 2.6 to 15.1/ 1000 catheter /day.</p>
<p>Schulman, Stricof, Stevens, Horgan, Gase, Holzman, Koppel, Nafday, Gibbis, Angert, Simmonds, Furdon, Saiman⁽¹⁶⁾/ USA, 2010.</p>	<p>To verify whether the use of <i>bundle</i> and of procedures checking-list reduce CLABSI rates. Type of study: Prospective Cohort / Multi-Centre / Neonatal (ICU).</p>	<p><i>Workshops</i>; auditing; procedures checking-list, elaboration of a set of materials to insert and to bandage central venous catheter. <i>Bundle</i>: hands hygiene; the use of maximal barrier precautions; chlorhexidine gluconate or 70% alcohol as antiseptic; attention to dressing (changing every 7 days when they are wet, dirty or unattached); scrub the catheter's ports or hubs; daily review of the catheter necessity with prompt removal when no longer essential.</p>	<p>It demonstrated decrease of CLABSI rates after the use of <i>bundle</i>. CLABSI rates: Before <i>bundle</i>: 3.5/1000 catheter/day; After <i>bundle</i>: 2.1/1000 catheter/day.</p>

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Halton, Cook, David, Paterson, Safdar, Graves ⁽¹⁷⁾ / Australia, 2010.	To evaluate cost-benefit dimension of <i>bundle</i> use with the practice model in use regarding CRBSI reduction. Type of study: Prospective/ Single-Centre / Adult (ICU).	Staff education. <i>Bundle</i> : hands hygiene; chlorhexidine gluconate as skin antiseptic; maximal barrier precautions; to avoid accessing femoral vein; prompt catheter removal when no longer essential; the use of antiseptic-impregnated catheters.	It demonstrated CRBSI rate reduction after the use of <i>bundle</i> . CRBSI rates: Before <i>bundle</i> : of 7.7/1000 catheter/day; After <i>bundle</i> : 1.4/1.000 catheter/day; Elevated cost with the use of antiseptic-impregnated catheters.
Kim, Holtom, Vigen ⁽¹⁸⁾ / USA, 2010.	To evaluate <i>bundle</i> use effectiveness to central venous catheter and CRBSI. Type of study: Prospective/ Single-Centre / Adult (ICU).	Staff education; auditing; procedures checking-list; elaboration of a set of materials (composed by all necessary devices to central venous catheter handling) to insertion and dressings; staff empowerment; feedback on staff's results. <i>Bundle</i> : the use of maximal barrier precautions; to avoid accessing femoral vein; antiseptic chlorhexidine gluconate; the use of ultrasound to guide catheter insertions; changing central venous catheter inserted in the ER; daily review of the catheter necessity.	It demonstrated decrease of CRBSI rates after the use <i>bundle</i> . CRBSI rates: Before <i>bundle</i> : 9.0/1000 catheter/day. After <i>bundle</i> : 2,7/1.000 catheter/day.
Apisarntharak, Thongphubeth, Yuekyen, Warren, Fraser ⁽¹⁹⁾ / Thailand, 2010.	To determine the impact of the use of <i>bundle</i> interventions on CLABSI rates. Type of study: Prospective/ Quasi-Experimental/ Single-Centre/ Adult (ICU and surgical clinic unit).	Staff education and training. <i>Bundle</i> : hands hygiene; the use of maximal barrier precautions; chlorhexidine gluconate as skin antiseptic; to avoid accessing femoral vein; daily review of the catheter necessity with prompt removal when no longer essential.	It demonstrated decrease of CLABSI rate after the use of <i>bundle</i> . CLABSI rates: Before <i>bundle</i> : 14.0/1000 catheter/day. After <i>bundle</i> : 1.4/1000 catheter/day.
Resende, do Ó, de Brito, Abdallah, Gontijo Filho ⁽²⁰⁾ / Brazil, 2011.	To reduce CLABSI through the use of <i>bundle</i> . Type of study: Prospective/ Single-Centre/ Neonatal (ICU).	Staff education; feedback on staff's results. <i>Bundle</i> : hands hygiene; chlorhexidine gluconate as skin antiseptic; to avoid accessing femoral vein; catheter removal when it's no longer essential.	It demonstrated decrease of CLABSI rates after the use of <i>bundle</i> . CLABSI rates: Before <i>bundle</i> : 24.1 /1000 catheter/ day; After <i>bundle</i> : 14.9/1000 catheter/ day.

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<p>Marra, Cal, Durão, Correa, Guastelli, Moura⁽²¹⁾/ Brazil, 2010.</p>	<p>To evaluate <i>bundle</i> use effect on CLABSI incidence. Type of study: Prospective/ Quasi-Experimental/ Single-Centre / Adult (ICU, infirmary and surgical).</p>	<p>Staff education; elaboration of a set of materials to central catheter insertion; feedback on staff' results. <i>Bundle</i>: the use of maximal barrier precautions; chlorhexidine gluconate as skin antiseptic; to avoid accessing femoral vein; catheter removal when it's no longer necessary.</p>	<p>It demonstrated decrease of CLABSI rates after the use of <i>bundle</i>. CLABSI rates: Before <i>bundle</i> 6.4/1000 catheter/day; After <i>bundle</i>: 3.2/1000 catheter/day.</p>
<p>Guerin, Wagner, Rains, Bessesen⁽²²⁾/ USA, 2010.</p>	<p>To evaluate whether the use of <i>bundle</i> reduces infection rates. Type of study: Prospective/ Single-Centre / Adult (ICU).</p>	<p>Staff education; auditing; procedures checking-list; nursing staff empowerment. <i>Bundle</i>: hands hygiene; the use of maximal barrier precautions; chlorhexidine gluconate as skin antiseptic; attention to bandages (changing every 7 days when they are wet or unattached and the use of chlorhexidine gluconate-impregnated sponge); scrub of central catheter's hubs with 70% alcohol; to avoid accessing femoral vein.</p>	<p>It demonstrated decrease of CLABSI rates after the use of <i>bundle</i>. CLABSI rates: Before <i>bundle</i>: 5.7/1000 catheter/day; After <i>bundle</i>: 1.1/1000 catheter/day.</p>
<p>Berriel-Cass, Adkins, Jones, Fakh⁽²³⁾/ USA, 2006.</p>	<p>To reduce rates of nosocomial infection and of CRBSI. Type of study: Prospective/ Multi-Centre / Adult (ICU).</p>	<p>Staff education; Insertion staff; multidisciplinary visits; elaboration of a set of materials to central catheter handling; procedures checking-list; auditing; staff empowerment. <i>Bundle</i>: hands hygiene; the use of maximal barrier precautions; chlorhexidine gluconate as skin antiseptic; to avoid accessing femoral vein; sterile dressing for central catheter site.</p>	<p>It demonstrated decrease of CRBSI rates after the use of <i>bundle</i>. CRBSI rates: Before <i>bundle</i>: 9.6/1000 catheter/day; After <i>bundle</i>: 3.0/1000 catheter/day.</p>
<p>Chuangchitraks, Sirithangkul, Staworn, Laohapand⁽²⁴⁾/ Thailand, 2010.</p>	<p>To demonstrate CRBSI incidence after a <i>bundle</i> implementation. Type of study: Prospective Cohort / Single-Centre/ Pediatric (ICU).</p>	<p>Staff education; procedures checking-list. <i>Bundle</i>: hands hygiene; the use of maximal barrier precautions; tincture of iodine as antiseptic; selection of insertion site; daily review of the catheter necessity with prompt removal when no longer essential.</p>	<p>It demonstrated slight decrease of CRBSI rates after the use of <i>bundle</i>. CRBSI rates: Before <i>bundle</i>: 2.6/1000 catheter/day; After <i>bundle</i>: 2.4/1000 catheter/day.</p>

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Furuya, Dick, Perencevich, Pogorzelska, Goldmann, Stone ⁽²⁵⁾ / USA, 2011.	To analyze the extension of <i>bundles</i> adoption in the USA and to determine its effectiveness in preventing CLABSI. Type of study: Transversal / Multi-Central / Adult (ICU, clinical and surgical unit).	Inspection for the evaluation of units regarding the existence of central venous catheter's care routines, questionnaire administered to hospital directors on <i>bundle</i> political theories for central venous catheter: if there is a written political theory on <i>bundle</i> ; if <i>bundle</i> adhesion is observed; how frequently it is observed (most of the time /100-95%; usually /75%-94%; sometimes /25%-74%; scarcely or never /< 25%; unknown). <i>Bundle</i> : hands hygiene; the use of maximal barrier precaution; chlorhexidine gluconate as skin antiseptic; to avoid accessing femoral vein; daily review of the catheter necessity with prompt removal when no longer essential.	It shows that the use of <i>bundle</i> is associated with lower rates of infection only in places where there is a written political theory and high adhesion to the interventions proposed ($\geq 95\%$).
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Picture 1 – Description of articles identified in researched bases on the use of *bundle* in order to prevent bloodstream infection and synthesis on the results. São Paulo, SP, 2011.

Subtitle: * Catheter-Related Bloodstream Infection; † Intensive Care Unit; ‡ United States of America; § Central Line-Associated Bloodstream Infection.

Spanish, which refer to the use of *bundle* to prevent CRBSI and CLABSI, particularly focused on the study of CVC.

Eight of all selected articles referred to the use of *bundle* to prevent CLABSI and seven of them focused on CRBSI.

We observed that nine studies (60%) had adult population as their target audience^(9,17-18,22-23,25), two of them (13,3%) were carried out with children^(5,24), three of them (20%) with newborns^(15-16,20), and one of them (6,7%) with both populations, in pediatric and neonatology units⁽¹⁴⁾. Eight of them (53,3%) were developed in the USA^(6,9,15-16,18,22-23,25) and only three (20%) were developed in Latin America, two of them in Brazil⁽²⁰⁻²¹⁾ and one in Colombia⁽¹⁴⁾.

The initial objective of many studies was staff education, so they all could know the project purpose, besides training for the proper application of protocols and procedures checking-list.

One of the analyzed articles describes the updating on different types of catheters available,

infection risks related to their use and it establishes prevention measures regarding infection⁽⁶⁾.

The use of Peripherally Inserted Central Catheter (PICC) was mentioned in four studies^(14-15,21-22) and only one of them describes infection rates per catheter type⁽¹⁴⁾.

Articles analysis regarding the type of *bundle* methodology described showed that they were composed of at least three and at most six interventions and the majority of the prospective studies presented statistically significant results regarding CRBSI and CLABSI reduction, being CLABSI the object of study in most of the articles^(9,15-16,19-22,25).

Table 1 presents the summary of the interventions described as *bundle* elements and the number of times that each strategy was listed in the fifteen analyzed articles.

Hands hygiene, a practice universally known as one the main prevention measures against nosocomial infection was mentioned in most of

Table 1 – Interventions identified as *bundle* elements and citation frequency. São Paulo, SP, 2011.

Interventions identified as <i>bundle</i> elements	Frequency (n=15)	
	Absolute (f)	Relative (%)
Hands hygiene	13	86.6
Use of maximal barrier precautions for catheter insertion	13	86.6
Chlorhexidine gluconate as skin antiseptic	13	86.6
Daily review of the catheter necessity with prompt removal when no longer essential	11	73.3
Catheter's insertion site selection: avoiding femoral vein	11	73.3
Scrub the catheter's ports and hubs with antiseptic	4	26.6
Semi-permeable, sterile, transparent dressing	3	20.0
Antiseptic / antibiotic-impregnated catheters	3	20.0
Bandage care (changing routine)	3	20.0
Chlorhexidine gluconate-impregnated dressing	1	6.6
Single-lumen catheter	1	6.6
Connectors / sets changing routine	1	6.6
Clean latex gloves to access catheter	1	6.6
Ultrasound to guide catheter insertion	1	6.6
Changing central venous catheter inserted in ER	1	6.6
Tincture of iodine for skin antiseptis	1	6.6

Source: Data from the fifteen articles composing the integrative review carried out by the authors.

the studies^(5-6,9,14-17,19-20,22-25). Staff education on the need of proper hand sanitation at the moment of inserting, handling or checking CVC was one of the strategies mentioned in order to increase professional adhesion.

In order to obtain a more detailed assessment on the studies, discussion on results was divided in two thematic categories: *bundle* and CVC insertion care; *bundle* and CVC maintenance care.

Bundle and CVC insertion care

In addition to hand hygiene, the most mentioned interventions were: the use of chlorhexidine gluconate as skin antiseptic, the use of maximal barrier precautions (cap, mask, sterile apron, sterile field on patient and sterile gloves) and avoidance of accessing femoral vein when possible.

Treating the skin using $\geq 0.5\%$ alcoholic solution of chlorhexidine gluconate as antiseptic before CVC insertion is an IA-level-of-evidence recommendation⁽²⁸⁾, i.e., a strongly recommended

measure for implanting and based on well designed randomized clinical studies, however, 70% alcohol and tincture of iodine may be used as antiseptic alternatives in the case of contraindication for the use of chlorhexidine gluconate⁽²⁸⁾.

Only one study described the use of tincture of iodine as antiseptic for children's skin, however, it did not show statistically significant results⁽²⁴⁾.

The use of maximal barrier precautions for CVC insertion is an IB recommendation⁽²⁸⁾ and it was described in thirteen articles^(5-6,14-19,21-25).

Catheter insertion site is one of the main factors that lead to CRBSI because it is directly related to the site's microbiota skin density and to the risk of thrombophlebitis⁽⁴⁾.

Recommendation, IA category⁽²⁸⁾, is to avoid femoral vein for central venous catheterization in adult patients, being subclavian vein the most appropriate place. In children, femoral vein catheterization is related to low rate of mechanical complications⁽²⁸⁾.

Eleven studies described the contraindication for the use of femoral vein^(6,14,17-25), seven of them were developed with adult population^(17-19,21-23,25).

Although femoral vein catheterization in children is related to low rate of mechanical complications, as previously mentioned, three publications referred to this intervention as elements of *bundle*^(14,20,24).

Multidisciplinary clinical visit for the discussion of venous device use (category IB) was described in only one study⁽²³⁾.

Bundle and CVC maintenance care

In this group of interventions the use of the following recommendations was more often described: daily review of the catheter necessity with its removal as soon as possible; scrub of central catheter ports and hubs and bandage care.

Daily review of the catheter necessity of CVC permanence with its removal as soon as possible is a disseminated theme as an efficient intervention on infection rate reduction. It was observed in eleven studies^(5,14-21,24-25).

Scrub of central catheter's ports and hubs on each handling besides the cleanliness of the device's insertion site during dressing changes were described in four studies^(6,9,16,22).

Semi-permeable, sterile, transparent dressing has been used as it allows the visualization of catheter insertion site and it enables a lower number of bandage changes. The use of this kind of protective covering and its changing routine were described in five studies^(5-6,15-16,22).

Some articles described the use of chlorhexidine gluconate-impregnated dressing for catheter's insertion sites⁽²²⁾, the use of antibiotic/antiseptic-impregnated catheters^(6,17,22), the use of ultrasound equipment to guide CVC's insertion⁽¹⁸⁾ or connectors and sets' changing routine depending on the infusion solution⁽⁶⁾.

Strategies for increasing staff's trust, guaranteeing implementation and evaluate *bundle* adhesion were also described: creating a staff responsible for catheters insertion⁽²³⁾; auditing during CVC insertion and bandage in order to verify and guarantee that all interventions proposed in this activity will be carried out by the use of tools such as procedure checking-list^(16,18,21-24); staff empowerment allowing procedure interruption in case of noncompliance with *bundle*; elaboration of a set of materials

^(16,18,21,23) composed by all devices required to CVC insertion and dressing; feedback on the staff's results^(18,20-21) with monthly information on *bundle* adhesion and unit infection rates.

CONCLUSION

Bundle use is a current theme directly related to patient's safety besides being emphasized by specialists and by international organizations as an efficient method to prevent and to reduce bloodstream infection.

Based on the analyzed studies it is possible to see the lack of articles that describe the use of such tool in CRBSI prevention in children and, specially, in newborns.

However, it was possible to identify important aspects on clinical practice. Evidence-based interventions used in *bundles* can be applied in any kind of population or central device and, because they are jointly implemented, they generate significant results on bloodstream infection reduction rates.

Described guidelines include: hand hygiene before catheter handling; chlorhexidine gluconate used as skin antiseptic; maximal barrier precaution for central catheter insertion; sterile transparent semipermeable dressing for covering the device, with its replacement every time it gets dirty, wet or unattached; the use of antibiotic/antiseptic-impregnated catheters; daily review of the catheter necessity with its immediate removal when it's no longer essential; staff education; procedure checking-list for procedure auditing, among others.

We recognized the fact that the main and more frequent composing elements of *bundles* presented were: hand hygiene, alcoholic solution of chlorhexidine as skin antiseptic, the use of maximal barrier precautions, avoidance of femoral vein and daily review of the catheter necessity with its immediate removal when no longer essential.

Findings presented by the studies highlight the need of further research on this issue, with the intention of focusing clinical practice on how to apply and verify bundle use results in preventing PICC-related bloodstream infection, as it is a relevant line of research for nursing for the fact that these professionals are responsible for this kind of device's installation and maintenance.

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