

Central venous catheter care interventions for preventing central line-associated bloodstream infections in adult intensive care units: A systematic review

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Responsible Editor: Laily Hidayati

Received: 31 December 2025 ◦ Revised: 3 May 2026 ◦ Accepted: 30 May 2026

ABSTRACT

Introduction: Central venous catheters (CVCs) are essential in the management of critically ill patients. However, their use may increase the risk of complications, particularly central line-associated bloodstream infections (CLABSIs). This systematic review aimed to evaluate evidence-based CVC care interventions for reducing the risk of CLABSIs in intensive care units.

Methods: This review was conducted in accordance with the PRISMA 2020 guidelines. Specific keywords related to CVC care and CLABSI prevention were used to identify articles published between 2020 and 2024 in PubMed, ScienceDirect, and Google Scholar. A total of 48,541 records were identified and screened according to predefined criteria, including original research articles written in English and available in full text. Review articles, editorials, commentaries, abstract-only articles, and articles with restricted access were excluded. Nine articles met the eligibility criteria and were critically appraised using the Joanna Briggs Institute tool to assess the methodological quality of the included studies.

Results: Daily bathing with 2% chlorhexidine, antiseptics of the insertion site using 1-2% chlorhexidine, timely dressing changes, polyhexamethylene biguanide (PHMB) dressings, and consistent adherence to central line care bundles were associated with reduced CLABSI incidence.

Conclusions: These interventions emphasize the role of nurses in maintaining CVC care and preventing healthcare-associated infections. The implementation of evidence-based CVC care practices is therefore recommended to reduce the incidence of CLABSIs in the ICU.

Keywords: CVC, CLABSIs, central line bundle, intensive care unit, nursing care

Introduction

Patients in intensive care units (ICUs) frequently require invasive vascular access to support complex and high-risk treatment. Peripheral venous access is often insufficient for vasoactive medications, hyperosmolar solutions, parenteral nutrition, blood products, and continuous hemodynamic monitoring. Therefore, CVC placement has become an important component of contemporary critical care practice (Morris and Jakobsen, 2022; Quadros *et al.*, 2022). A CVC is inserted into a major vein and is widely used to support patient care protocols in the ICU (Sun *et al.*, 2020).

CVCs are widely used in ICUs worldwide because they support patient monitoring and the administration of life-saving therapies (Cabrero *et al.*, 2023). Central

venous catheters are used in approximately 78% of ICU patients, compared with 24% of patients in non-ICU settings (Canadian Agency for Drugs and Technologies in Health 2025). The internal jugular, subclavian, and femoral veins are the most common sites for CVC placement (Quadros *et al.*, 2022). In a study involving 4,104 ICU patients, Bae *et al.* (2022) reported that the jugular vein was the most common route for CVC placement (48.9%), followed by the subclavian vein (34.0%) and femoral vein (17.1%).

Despite their clinical benefits, CVCs may cause several complications, including injury during insertion, malposition, thrombosis, and catheter-related infection (Jesus *et al.*, 2020). Among these complications, CLABSIs are among the most serious and life-threatening

consequences of CVC use. CLABSIs contribute substantially to morbidity and mortality, prolong hospital stay, and increase healthcare costs (Quadros *et al.*, 2022). International surveillance data indicate that CLABSIs remain a major challenge despite advances in infection prevention and critical care technology (Toor *et al.*, 2022).

Previous studies have shown that CLABSIs are a major source of infection in ICUs, with mortality rates ranging from 12% to 25%. Centers for Disease Control and Prevention (2022) reported 23,398 CLABSI cases in the United States. In California ICUs, the incidence rate was 1.7 per 1,000 CVC-days, and the mortality rate ranged from 12% to 15% (Toor *et al.*, 2022). Epidemiological data further show that CLABSI incidence varies across regions and healthcare systems. Although standardized prevention protocols have reduced infection rates in developed countries, rates remain high in developing countries. For example, Pitiriga *et al.* (2022) identified 59 CLABSI cases after observing 9,774 catheter-days over two years. Bloodstream infections, particularly CLABSIs, are categorized as high-risk infections because they cause death in 12-25% of affected patients. Sardi (2021) reported that bloodstream infection rates in developing countries vary widely, ranging from 20% to 62.5%.

The risk of CLABSIs is influenced by the catheter insertion site, duration of catheterization, patient comorbidities, and quality of catheter management. Compared with other venous access sites, femoral access is consistently associated with a higher infection risk. Al-Khawaja *et al.* (2021) found an increased occurrence of CLABSIs through femoral access in an ICU in Bahrain. Hafeez *et al.* (2022) also reported a higher infection risk with femoral access (58.3%) than with internal jugular access (41.7%). Similarly, Bae *et al.* (2022) found that the rate of CLABSIs in the femoral area was 32.1%. The femoral vein is located in an area that is relatively moist and more difficult to keep clean, creating conditions that facilitate bacterial growth and bloodstream infection. Therefore, preventive measures should include post-procedure protocols and appropriate catheter insertion techniques (Lutufyo, Qin and Chen, 2022; Castro, Lee and Bhutta, 2023).

Nurses have a central role in preventing CLABSIs through close patient monitoring, strict aseptic technique, and evidence-based catheter maintenance (Basri and Nurhayati, 2020; Toor *et al.*, 2022). Their responsibilities include daily assessment of catheter necessity, inspection of insertion sites, timely dressing changes, catheter hub disinfection, and maintenance of patient hygiene (Ningrum and Astrid, 2020; Quadros *et al.*, 2022). Prior research indicates that many CLABSIs can be prevented when nurses consistently adhere to standardized care protocols. However, limited resources and inconsistent protocol implementation remain common challenges in clinical practice (Atia, 2020).

The CVC care bundle is one of the best-practice approaches for CLABSI prevention. The bundle was developed from evidence-based interventions to improve patient safety through structured protocols (Atia, 2020; Rachman and Muhtar, 2022). It includes hand hygiene, maximal barrier precautions, appropriate skin antisepsis, dressing management, and daily assessment of catheter necessity (Sun *et al.*, 2020; Quadros *et al.*, 2022). Full implementation of the care bundle has been associated with reduced CLABSI rates across ICU settings (Isaifan *et al.*, 2021; Zha *et al.*, 2023).

Although many studies have evaluated strategies for CLABSI prevention, including antimicrobial approaches, wound care techniques, and bathing protocols, nurses and healthcare organizations still face challenges in selecting interventions that are both effective and feasible. These challenges arise from differences in study design, patient characteristics, and intervention strategies. The lack of recent synthesis on nurse-led CVC care further highlights the need for an updated assessment (Kikuchi *et al.*, 2020; Denkel *et al.*, 2023). This systematic review aimed to evaluate evidence-based interventions in CVC care to reduce the risk of CLABSIs in the ICU. Specifically, the review sought to answer the following question: "What evidence-based CVC care interventions are most effective for reducing CLABSI incidence among adult ICU patients?"

Materials and Methods

Study Design

This systematic review evaluated current evidence on CVC care interventions designed to reduce CVC-related infections among adult patients treated in ICUs. The review followed the PRISMA 2020 guidelines to strengthen the search, selection, appraisal, and synthesis processes and to ensure a transparent and methodologically sound review (Page *et al.*, 2021).

Search Strategy and Information Sources

The literature search was conducted in three databases: PubMed, ScienceDirect, and Google Scholar. Boolean operators (AND/OR) were used to combine terms related to infection prevention and central venous catheter care. To ensure a rigorous and database-specific search, advanced search strings were customized according to each platform and organized around three core concepts: central venous catheter, maintenance and care bundles, and intensive care unit. The search string for PubMed was: ("Central Venous Catheters"[Mesh] OR "Central Venous Catheters"[tiab] OR "CVC"[tiab] OR "central line"[tiab]) AND ("Guidelines as Topic"[Mesh] OR "guideline*" [tiab] OR "maintenance"[tiab] OR "management"[tiab] OR "patient care"[tiab] OR "care bundle*" [tiab] OR "CLABSI prevention"[tiab]) AND ("Intensive Care Units"[Mesh] OR "intensive care unit*" [tiab] OR "ICU"[tiab]). For ScienceDirect, the

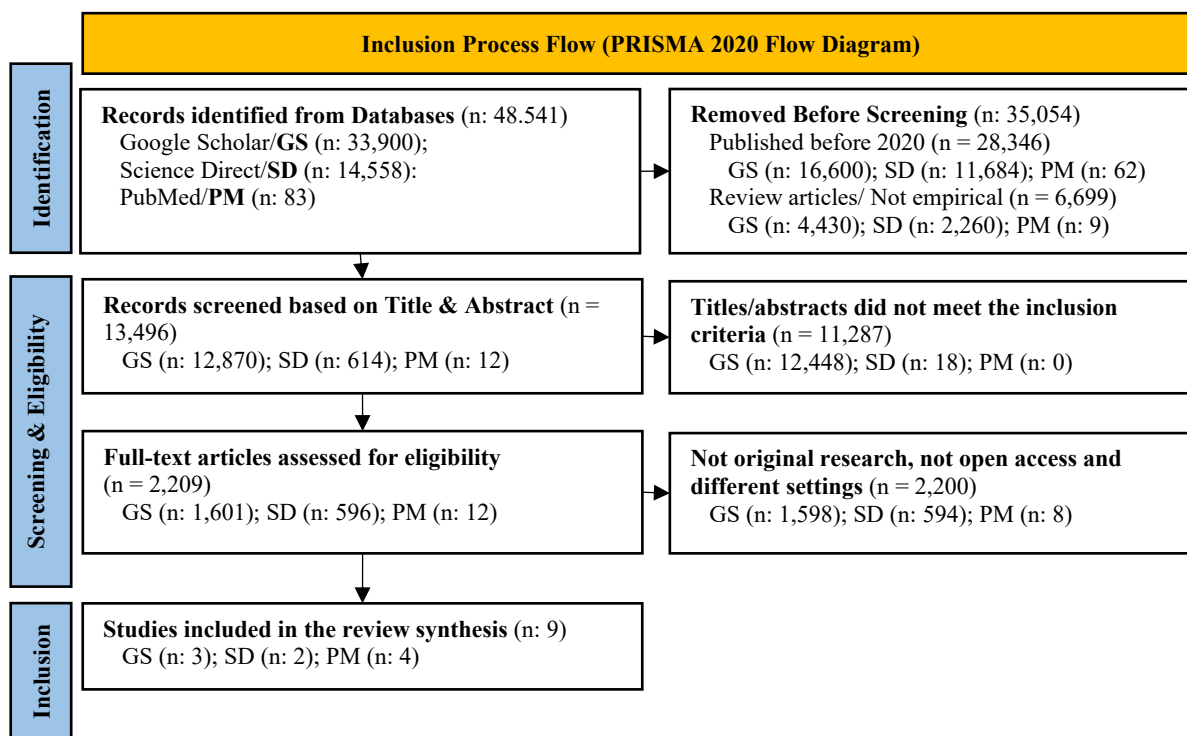


Figure 1. Flowchart of Article Selection Process

search string was: ("Central Venous Catheter" OR "CVC" OR "central line") AND ("guideline" OR "maintenance" OR "care bundle" OR "CLABSI prevention") AND ("Intensive Care Unit" OR "ICU"). For Google Scholar, the search string was: allintitle: (CVC OR "central venous catheter" OR "central line") AND (guideline OR maintenance OR bundle OR CLABSI) AND (ICU OR "intensive care").

Article Selection and Eligibility Screening

The first stage of article selection involved screening titles and abstracts to identify and exclude studies that were similar, irrelevant, or inconsistent with the review objectives. The full texts of potentially eligible articles were then assessed against the inclusion criteria. Eligible articles were published between 2020 and 2024, written in English, reported original empirical research, provided full-text access, and examined CVC care interventions for preventing CLABSIs in adult ICU patients. Review articles, editorials, commentaries, abstract-only articles, and articles published before 2020 were excluded. Any differences during the selection process were resolved through discussion between two reviewers, with a third reviewer consulted when consensus was required. The selection process followed the PRISMA flow shown in [Figure 1](#).

A total of 48,541 records were identified from Google Scholar (33,900), ScienceDirect (14,558), and PubMed (83). Before screening, 35,045 records were removed because they were published before 2020 (28,346) or were non-empirical review articles (6,699). In total, 13,496 records underwent title and abstract screening, and 11,287 were excluded because they did not meet the

review objectives. The remaining 2,209 full-text articles were assessed for eligibility. At this stage, 2,200 articles were excluded because they lacked open-access full text, were not original research, or focused on inappropriate clinical settings, such as pediatric or non-ICU settings. Ultimately, nine studies met all criteria and were included in the synthesis: Google Scholar (3), ScienceDirect (2), and PubMed (4).

Critical Appraisal

The Joanna Briggs Institute (JBI) critical appraisal tools were used to independently assess the methodological quality of the included studies. The tool can be tailored to the design of each study (Barker *et al.*, 2023). Three independent reviewers were involved to ensure rigorous and objective assessment. Each reviewer appraised the articles separately to minimize bias. A joint panel discussion was then conducted to compare evaluations and resolve discrepancies, resulting in a consensus-based final score for each study. To protect the validity of the synthesis, an 85% quality cut-off was applied for inclusion, allowing a maximum of one indicator rated as "no." Accordingly, only studies with stronger methodological execution and minimal risk of bias were included. The critical appraisal results are presented in [Tables 1 and 2](#).

Data Extraction

Data extraction was guided by predefined variables to ensure consistency and precision. Extracted data included publication details, study design and setting, respondent characteristics, CVC care interventions, measured outcomes such as CLABSI incidence, and main findings. Two reviewers independently extracted the

Table 1. Results of the Critical Appraisal of Quasi-Experimental Articles Using the JBI Instrument

Articles	JBI Critical Appraisal Checklist For Quasi-Experimental Studies Indicators									Percentage	Conclusion
	1	2	3	4	5	6	7	8	9		
Kikuchi et al. / 2020 / Japan	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%	Include
Sun et al. / 2020 / China	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%	Include
Paquet, Morlese and Frenette / 2021 / Canada	✓	✓	✓	X	✓	✓	✓	✓	✓	88%	Include
Scheier et al. / 2021 / Switzerland	✓	✓	✓	X	✓	✓	✓	✓	✓	88%	Include
Wei et al. / 2021 / United States of America	✓	✓	✓	X	✓	✓	✓	✓	✓	88%	Include
Lin et al. / 2022 / Taiwan	✓	✓	✓	X	✓	✓	✓	✓	✓	88%	Include

Note: ✓ = Yes; X = No; U = Unclear; N/A = Not Applicable

Table 2. Results of the Critical Appraisal of Randomized Controlled Trial Articles Using the JBI Instrument

Articles	JBI Critical Appraisal Checklist For Randomized Controlled Trials Indicators													Percentage	Conclusion
	1	2	3	4	5	6	7	8	9	10	11	12	13		
Pearse et al. / 2022 / Australia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%	Include
Reis et al. / 2022 / Brazil	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%	Include
Denkel et al. / 2023 / Germany	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%	Include

Note: ✓ = Yes; X = No; U = Unclear; N/A = Not Applicable

data, and any discrepancies were discussed and resolved to ensure reliability.

Data Synthesis

Narrative synthesis was used because of the substantial heterogeneity in study designs, interventions, and outcome measures across the selected articles. The synthesis process followed the Synthesis Without Meta-analysis (SWiM) guidelines to support transparency and objectivity (Campbell *et al.* 2020). Findings were organized according to the type of CVC care intervention, intervention implementation, and reported outcomes. The extracted and synthesized data are presented in [Table 3](#).

Results

Nine studies were included in the final synthesis. These studies were conducted in nine countries across four continents: Asia (Japan, China, and Taiwan), Europe (Germany and Switzerland), North America (Canada and the United States of America), South America (Brazil), and Australia. The included studies used various designs, including randomized controlled trials, quasi-experimental studies, prospective observational studies, and retrospective analyses. [Table 3](#) summarizes the characteristics and main findings of the studies.

Interventions Using Chlorhexidine Gluconate

The use of chlorhexidine gluconate (CHG) was identified as an important strategy for reducing catheter-related infections. Kikuchi *et al.* (2020) reported that maintaining CVC insertion sites with 1% CHG antiseptic significantly reduced the risk of CLABSIs within 20 days after insertion. This finding was supported by Lin *et al.* (2022), who showed that 2% CHG was more effective than 10% povidone-iodine (PVI) in inhibiting skin flora growth at the insertion site. Beyond local antiseptic, daily bathing with 2% CHG has also emerged as a preventive measure.

Scheier *et al.* (2021) reported that CLABSI incidence decreased from 2.45 to 1.00 per 1,000 catheter-days after CHG bathing was implemented. Similarly, Denkel *et al.* (2023) confirmed that daily bathing with 2% CHG cloths significantly reduced CLABSI rates compared with octenidine or routine care. However, Reis *et al.* (2022) noted that although CHG reduced bacterial density, including Enterobacteria, its effect on overall mortality was not always statistically significant compared with neutral soap.

Dressing Changes in CVC Care

Effective dressing management is essential for maintaining a protective barrier against pathogens at the CVC site. Pearse *et al.* (2022) reported that although a 7-day dressing change interval is common, specialized materials such as PHMB-impregnated dressings are safe and effective in preventing localized infections. The choice of dressing should also consider the anatomical location of the catheter. Paquet, Morlese, and Frenette (2021) suggested that dry dressings may be more appropriate for CVCs in the jugular area because they reduce the risk of dampness or detachment. Protocols generally require immediate dressing replacement when dressings become soiled, loose, or damp (Sun *et al.*, 2020; Lin *et al.*, 2022). Maintaining dressing integrity through regular assessment and timely replacement can reduce the risk of environmental contamination at the insertion site.

Implementation of CVC Care Bundles

The integration of multiple evidence-based practices into care bundles provides a comprehensive approach to infection prevention. Sun *et al.* (2020) demonstrated that a bundle including strict hand hygiene, sterile personal protective equipment, and daily assessment of catheter necessity reduced CLABSI rates from 14.8 to 5.6 per 1,000 catheter-days. This approach was supported by Wei *et al.* (2021), who observed a 42% reduction in CLABSI rates after implementing interventions such as routine CHG

bathing and immediate dressing replacement. A key component of these bundles is the scrub-the-hub technique. Sun *et al.* (2020) emphasized wiping the catheter tip with alcohol for 30 seconds at each access. In addition, Lin *et al.* (2022) reinforced that standardized protocols, including specific back-and-forth cleaning strokes and adequate drying time, are needed to maximize the antiseptic effect of the bundle.

Discussions

The systematic analysis showed that evidence-based interventions for CVC management can reduce the incidence of CLABSIs in ICUs. The findings indicate that multimodal strategies include antimicrobial application, systematic dressing management, and comprehensive CVC care bundles. These results support the growing evidence that CLABSI prevention depends largely on the quality and consistency of CVC care after insertion, particularly care delivered by nursing staff. Ningrum and Astrid (2020) explained that CVC care aims to maintain sterility at the insertion area, observe signs of infection, and change dressings to prevent infection.

Effectiveness of Chlorhexidine in CVC Care

Although study outcomes varied, CHG was frequently identified as an effective antiseptic. Daily bathing with 2% CHG significantly reduced CLABSI occurrence by decreasing the microbial load on the skin, which is an important factor in catheter-related infection (Scheier *et al.*, 2021; Denkel *et al.*, 2023). However, the findings were not uniform; Reis *et al.* (2022) observed no statistically significant difference in CLABSI incidence. CHG acts by disrupting bacterial cell membranes and has residual activity on the skin, offering protection against both gram-positive and gram-negative organisms (Hakiman, Suharti and Bahar, 2022). These characteristics may explain why CHG-based care is more effective than routine bathing in several studies.

Antisepsis of the catheter insertion site using 1-2% CHG was superior to lower concentrations, povidone-iodine-based solutions, and whole-body bathing (Kikuchi *et al.*, 2020; Paquet, Morlese and Frenette, 2021). The ability of CHG to inhibit biofilm formation at the insertion site is clinically important because biofilm can facilitate bacterial migration along the catheter tract and contribute to bloodstream infection. These findings support the recommendation that CHG should be considered a primary antiseptic for CVC management in ICUs.

Reis *et al.* (2022) found no statistically significant difference in CLABSI incidence between CHG bathing and regular soap. In that study, CHG bathing was performed by rinsing the entire body, except the face, using a cotton washcloth moistened with 2% chlorhexidine solution and allowing the skin to dry. To prevent skin dehydration after CHG application, nurses may apply a chlorhexidine-

compatible lotion at least 3-5 minutes after bathing. Although no significant difference in CLABSI incidence was observed, CHG bathing was associated with lower colonization by harmful organisms and a lower mortality rate. This finding suggests that CHG may provide indirect clinical benefits and underscores the need for standardized application techniques and adherence to protocols.

Taken together, the included studies indicate that CHG can reduce infection rates. Chlorhexidine is considered an effective antiseptic because it inhibits bacterial growth and kills bacteria. Although hypersensitivity reactions may occur, they are reported in only a small proportion of cases (Hakiman, Suharti and Bahar, 2022). CHG also has broad-spectrum antimicrobial activity, including activity against some drug-resistant organisms; therefore, its use is recommended for preventing CLABSIs (Scheier *et al.*, 2021).

Importance of Dressing Management

Proper dressing management is a crucial component of CVC care. Evidence indicates that regular and timely dressing changes can reduce the risk of CLABSIs by maintaining the catheter insertion site in a clean and dry condition (Paquet, Morlese and Frenette 2021; Wei *et al.* 2021). Regular dressing changes have also been associated with reduced CLABSI incidence (Paquet, Morlese & Frenette, 2021). Patients at risk of bleeding or excessive moisture should have dry dressings changed every 48 hours to reduce dressing contamination and microbial growth.

The findings also suggest that dry dressings may be more suitable than transparent dressings in trauma and medical/surgical ICUs because bleeding disorders are common in these settings. Dry dressings may reduce the likelihood of leaving a soiled, moist, or non-adherent dressing in place. In general, CVC dressings should be changed every three days; however, if fluid seepage, contamination, or bleeding is present, the dressing should be changed immediately (Wei *et al.*, 2021). The date of dressing placement and maintenance should be recorded so that nurses can plan the next dressing change. CVC dressings should be changed every seven days for transparent dressings or every 48 hours for gauze dressings (The Asia Pacific Society of Infection Control, 2024).

CVC dressing replacement is important because the dressing protects the catheter insertion site and prevents microorganism colonization. Waterproof dressings are recommended because they reduce the risk of dampness and contamination (Quadros *et al.*, 2022). Transparent dressings are also recommended because they allow observation of the insertion site. Antiseptic-containing dressings may also be considered because they inhibit microorganism growth and absorb exudate around the insertion site (Nurhayati, 2020).

PHMB dressings can prevent infection, particularly around the CVC insertion site, and are therefore recommended (Pearse *et al.*, 2022). PHMB has broad activity against biofilm formation without causing resistance. It is also considered a useful surface disinfectant and anti-infective agent because of its antimicrobial activity, chemical stability, and low toxicity (Szkoluda and Karpiński, 2020). In ICU patients with CVCs, PHMB dressings may be used as an alternative to chlorhexidine (Pearse *et al.*, 2022). However, PHMB use may increase treatment costs and require more time for dressing application than standard care.

Impact of Central Line Care Bundles

A care bundle is a set of structured steps based on evidence-based practices designed to improve nursing processes and patient outcomes. The CVC bundle can improve patient satisfaction, shorten hospital stay, and substantially reduce CLABSI incidence (Sun *et al.*, 2020). Wei *et al.* (2021) supported this finding, showing that CLABSI cases decreased after comprehensive interventions related to CVC insertion and maintenance, particularly through the CVC care bundle.

Isaifan *et al.* (2021) reported that CLABSI cases decreased by 77% after the CVC care bundle was implemented. This finding shows that the bundle is effective in reducing CLABSI incidence. Nurse compliance is essential in implementing the bundle because poor adherence may increase infection risk and harm patients. In addition, CVC care bundle components may differ between hospitals; therefore, nurses must follow local standards of practice (Basri and Nurhayati, 2020).

Actions included in the CVC care bundle include performing hand hygiene before touching the CVC, disinfecting the connector with 70% alcohol at each use, changing dressings regularly, and assessing the CVC daily, including patency and dressing condition (Quadros *et al.*, 2022). CVC care bundles should be implemented as routine protocols to prevent CVC-associated infection. The implementation of a central line bundle is effective in reducing CLABSI incidence (Sun *et al.*, 2020).

Nurse adherence is crucial to the effectiveness of care bundles. High adherence to bundle components, including hand hygiene, hand-rub disinfection, routine dressing changes, and daily catheter evaluation, has been strongly associated with reduced infection rates (Atia, 2020; Quadros *et al.*, 2022). Conversely, poor adherence can reduce the effectiveness of care bundles in preventing infection. These findings highlight the importance of monitoring and evaluating nurses' adherence to bundle protocols.

This study has several limitations. First, the systematic review was not prospectively registered in a systematic review registry such as PROSPERO. However, the review process strictly followed the PRISMA guidelines to ensure transparency and methodological rigor. Second, the literature search was limited to three

primary databases: PubMed, ScienceDirect, and Google Scholar. The exclusion of other specialized databases, such as CINAHL, the Cochrane Library, or Embase, may have resulted in the omission of relevant studies. Third, the inclusion of only nine articles represents a relatively small body of evidence, which may affect the generalizability of the findings and highlights the need for further large-scale primary research. Finally, a meta-analysis could not be conducted because of the high heterogeneity among the included studies. Therefore, narrative synthesis was used. Future research should consider broader database coverage, protocol registration, and multilingual studies to improve the comprehensiveness and quality of evidence.

Conclusion

This review shows that CVC care is an important nursing responsibility for preventing infections, particularly CLABSIs. The findings indicate that daily bathing with 2% chlorhexidine and antiseptic of the insertion site using 1% or 2% chlorhexidine can reduce the risk of CLABSIs. Routine dressing changes every 3-7 days for transparent dressings and every two days for non-woven tape or gauze dressings, as well as immediate dressing changes when dressings are visibly soiled, contaminated, or detached, should be implemented as mandatory protocols. PHMB dressings may also reduce the risk and incidence of CLABSIs. Finally, CVC care bundles should be implemented consistently and adhered to by nurses to reduce CLABSI risk. These findings may help nurses optimize CVC care procedures to prevent CLABSIs.

Acknowledgments

The authors thank the researchers whose published studies formed the basis of this systematic review. Their work provided essential evidence for the analysis and interpretation of the findings. This study was conducted without financial assistance from external funding sources.

Declaration Of Generative Artificial Intelligence (AI) Use

Artificial intelligence tools namely Deeply Translator were used only to assist with translate the text, language refinement and grammar checking during manuscript preparation. Following the automated translation, the authors thoroughly reviewed, edited, and verified all scientific content and interpretation to ensure academic accuracy and conceptual consistency.

Funding source

This study did not receive external funding or specific grants from public, commercial, or non-profit funding organizations.

Availability of data and materials

All data used in this systematic review were derived from previously published articles available in public scientific databases. The article and its cited references provide the evidence required to support the study findings. No new or unpublished datasets were created or analyzed during the review process.

Authors' contributions

Rycco Darmareja (RD) served as the first author and was primarily responsible for the study. RD conceived and designed the study, prepared the research protocol, developed the research questions, and oversaw the systematic review process. RD also led the literature search, study selection, literature review, data extraction, data synthesis, interpretation of findings, and preparation and revision of the manuscript.

Galuh Nurulita Fitriani (GNF) reviewed the literature, extracted the data, and critically appraised the included studies. GNF also helped organize the data and provided important feedback during manuscript revision.

Nabilla Asmarany (NA) assisted with study selection and screening, supported data extraction, and contributed to the interpretation of the findings. NA also critically reviewed the manuscript to ensure its intellectual content.

Maulida Azzahra (MA) contributed to quality appraisal of the included studies, data organization, and manuscript revision and improvement.

All authors read the final version of the manuscript, provided critical feedback, and approved it.

Declaration of Interest

The authors declare that they have no conflicts of interest related to the publication of this article.

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How to cite this article: Darmareja, R., Fitriani, G. N., Asmarany, N., and Azzahra, M. (2026) 'Central Venous Catheter Care Interventions for Preventing Central Line-Associated Bloodstream Infections in Adult Intensive Care Units: A Systematic Review', *Jurnal Ners*, 21(2), pp. 278-287. doi: <http://dx.doi.org/10.20473/jn.v21i2.85387>

Table 3. Research Description and Main Results of the Studies

Author / Year / Country	Purpose of Research	Research Design	Treatment	Result
Kikuchi <i>et al.</i> / 2020 / Japan	Analyzing the effectiveness of CVC insertion site antiseptics in reducing the risk of Catheter-Related Bloodstream Infection (CRBSI) by comparing the use of 0.05% chlorhexidine with 1% chlorhexidine.	Experimental	Perform maintenance of the CVC insertion site through antiseptics procedures every 1 week or when the dressing is dirty/damaged. Antiseptics procedures are performed using swabs containing 0.05% chlorhexidine and 1% chlorhexidine.	CVC maintenance with 1% chlorhexidine antiseptics reduced the risk of CRBSI 20 days after CVC insertion. The CRBSI rate decreased from 3.64/1000 days of insertion to 1.77/1000 days of insertion.
Sun <i>et al.</i> / 2020 / China	Evaluating the effect of the Central Venous CRBSI prevention bundle and improving patient satisfaction.	Experimental (case and control group)	106 patients in the control group were fitted and treated with conventional techniques. 106 patients in the case group had CVC insertion and treatment with infection prevention bundles, including: <ol style="list-style-type: none"> 1. Hand washing in accordance with hand hygiene guidelines at healthcare facilities.; 2. Use sterile PPE for staff and sterile drapes for patients during the catheterization and disinfect the skin area before insertion using alcohol and povidone-iodine; 3. Evaluate the condition of the CVC every day is the catheter has come loose, is kinked, twisted, or blocked; 4. Use strict aseptic technique when changing infusion tubes, caps, or connectors; 5. Wipe the catheter tip with an alcohol swab for 30 seconds every time it is changed or opened; 6. Check the catheter for tightness and blockages every day; 7. Change the dressing every 3 days or immediately when there is seepage, contamination, or blood. 	The CRBSI rate or the number of episodes of CRBSI per 1000 catheter insertion days decreased after the infection prevention bundle intervention in the case group (5.6) compared to the control group (14.8).
Paquet, Morlese and Frenette / 2021 / Canada	To determine whether dry dressings can be more effective in reducing CLABSIs compared to transparent dressings and improving dressing change compliance in ICU trauma.	Experimental	Changing CVC dressings from transparent dressings (changed every seven days or when dirty and loose) to sterile gauze and non-woven tape dressings that are changed every 48 hours. In addition, all patients with central lines were given chlorhexidine.	There was a reduction in the rate of CLABSIs from 1.36/1000 catheter days to 0. The results suggest that dry dressings are more appropriate in the patient population with central lines especially CVCs in the jugular area, as it reduces the risk of leaving the dressing dirty, damp, or not adhering.
Scheier <i>et al.</i> / 2021 / Switzerland	Analyzing the effect of daily chlorhexidine baths on the incidence of CLABSIs in ICU patients.	Prospective study, uncontrolled before-and-after	A chlorhexidine bathing intervention was performed on 1547 patients in the ICU using ready-to-use chlorhexidine (Sinaqua Chlorhexidine 2%) outside of the standard CLABSIs prevention bundle (catheter insertion, skin disinfection, dressing changes, and IV handling).	The incidence of CLABSIs decreased from 2.45/1000 days of CVC use to 1.00/1000 days of CVC use after implementation (p=0.011).
Wei <i>et al.</i> / 2021 / United States of America	Reduced incidence of CLABSIs after comprehensive implementation of central line insertion and care bundles.	Retrospective study	Implementing a comprehensive bundle related to central lines, one of which is during treatment. Things to do include hand hygiene when performing actions related to CVCs; using only sterile equipment to access CVCs; immediately replacing dressings when wet, dirty, or dislodged; changing dressings routinely every week; bathing chlorhexidine daily in every patient with a CVC; disinfecting catheter ports.	The incidence of CLABSIs decreased by 42% after the bundle of infection prevention interventions, from 0.624 to 0.362 per 1000 CVC days.
Lin <i>et al.</i> / 2022 / Taiwan	Comparing the incidence of CRBSI and flora growth at CVC insertion	Prospective, open-label, crossover	Wipe the skin area to be inserted with an antiseptic solution and let it dry according to the standard protocol. At 2% CHG, forward and backward strokes	CHG 2% is superior to PVI 10% in the CVC treatment bundle to inhibit the growth of skin flora at the CVC

Author / Year / Country	Purpose of Research	Research Design	Treatment	Result
	sites using 2% Chlorhexidine Gluconate (CHG) or 10% Povidone-Iodine-Alcohol (PVI) in a CVC care bundle.		were performed and allowed to dry for 30 seconds and repeated only once. At 10% PVI, the swab is made in a circular motion and allowed to dry for 30 seconds and repeated three times. After insertion, the area is covered by a sterile, semi-permeable, transparent dressing or gauze (if localized fluid/exudate is visible). The gauze dressing is changed every 3 days and the transparent sterile dressing is changed every 7 days or sooner if it becomes soiled or wet. The same antiseptic solution is used for every dressing change.	insertion site. This was shown by the lower incidence of CRBSI in the CHG group (0/1000 days of CVC insertion) compared to the PVI group (2.15/1000 days of CVC insertion) with p-value = 0.001.
Pearse <i>et al.</i> / 2022 / Australia	Comparing PHMB discs with standard dressing without medication to prevent infection in patients with CVCs in critical areas.	Single-center pilot randomized controlled trial	CVC dressings were changed every 7 days or more frequently if indicated (e.g. dirty, loose, moist). 37 patients in the intervention group received dressings with PHMB and 43 patients in the control group received standard dressings without any medication.	None of the participants (n=80) experienced CLABSIs and localized infections, but 2 patients with standard dressings experienced primary bloodstream infection. The use of PHMB is safe and recommended to prevent infection at the CVC insertion area.
Reis <i>et al.</i> / 2022 / Brazil	Evaluating the effect of daily CHG bath on the incidence of CLABSIs in adult ICU patients.	Single-center, pragmatic, open, cluster-randomized, non-blinded trial	The control group (n=620) received bathing intervention with water and neutral pH soap. The intervention group (n=867) was treated with 2% CHG.	There was no difference between the intervention and control groups on the incidence of CLABSIs (p=0.125), but the density of enterobacteria triggering HAIs in the control group was higher (5.01) compared to the intervention (2.25) per 1000 patient days. Likewise, the mortality rate in the control group was higher (28.7%) than the intervention group (18.7%).
Denkel <i>et al.</i> / 2023 / Germany	Analyzed before-and-after comparisons to assess the effect of daily bathing with chlorhexidine, octenidine, or water and soap (control group) on CLABSIs rates.	Post-hoc analysis of a multicenter-randomized controlled trial	72 ICUs were tested over 12 months with each ICU randomized to 1 of 3 bathing regimens: daily bathing with water and non-antiseptic soap (control group, routine care), daily bathing with a cloth containing 2% chlorhexidine, and disposable washing gloves containing 0.08% octenidine.	In the chlorhexidine group, the incidence rate of CLABSIs decreased from 1.48 to 0.90 per 1000 days (p=0.0085). No reduction was observed in the octenidine group (p=0.8735) and the control group (p=0.3298).