

# Outcomes of Using Nursing Practice Guidelines for Prevention of Central Line-Associated Bloodstream Infections in Critically Ill Patients: A Comparative Study

Anucha Taiwong<sup>1\*</sup>, Pookkwan Phase<sup>2</sup>, Phuttakanya Nartsilapa<sup>2</sup>, Yuwadee Waiyaphat<sup>2</sup>, Kamthorn Dana<sup>1</sup>

<sup>1</sup>Srimahasarakham Nursing College, Faculty of Nursing, Praboromarajchanok Institute, Phadungwitee Road, Mueang District, Mahasarakham 44000, Thailand

<sup>2</sup>Maha Sarakham Hospital, Mueang District, Mahasarakham 44000, Thailand

\*Corresponding Author's Email: [anucha@smnc.ac.th](mailto:anucha@smnc.ac.th)

## ABSTRACT

**Background:** Central Line-Associated Bloodstream Infections (CLABSI) are a major complication in critically ill medical patients who receive central line catheter insertion. Therefore, Nursing Practice Guidelines (NPG) are needed. **Objectives:** This study aimed to compare the incidence of CLABSI between the intervention group and the standard care group. **Methods:** The research design was a comparative study. A total of 92 critically ill medical patients were recruited and assigned to the standard care group (n = 46), which received only standardized care, and the intervention group (n = 46), which received the NPG. The research instruments included: 1) the NPG for preventing CLABSI, 2) the patient data and clinical outcomes recording forms, 3) the nursing practice assessment forms, and 4) the satisfaction assessment forms. The research was conducted in the medical intensive care unit of a tertiary hospital. Data analysis was performed using descriptive statistics, Chi-Square tests, and relative risk ratio. **Results:** The intervention group had a CLABSI incidence rate of 0.48 per 1,000 C-line days, compared with 3.25 per 1,000 C-line days in the standard care group. Moreover, the intervention group reduced the risk of CLABSI by 89.5% ( $p < 0.05$ ). Professional nurses adhered correctly and comprehensively to the guidelines in over 80% of all components with high levels of satisfaction (M=4.58, SD=0.32). **Conclusion:** The findings suggest that consistent adherence to NPGs can substantially reduce preventable infections and improve patient safety.

**Keywords:** Central Line-Associated Bloodstream Infections; Critically Ill Medical Patients; Nursing Practice Guidelines

## INTRODUCTION

Central Line-Associated Bloodstream Infections (CLABSI) are the most serious complications associated with central venous catheters among critically ill medical patients. It is defined as the recovery of a pathogen from a blood culture in a patient who had a central line at the time of infection or within 48 hours before the development of infection (Haddadin *et al.*, 2017; O'Grady, 2023). Reported CLABSI incidence rates in critically ill patients range from 1.51 to 4.16 times per 1,000 C-line days. The most common causative bacteria were gram-negative bacteria, especially *Klebsiella pneumoniae* and *Acinetobacter baumannii* (Darayon *et al.*, 2024; Rajandra *et al.*, 2025).

The occurrence of CLABSI not only significantly increases the morbidity and mortality rate of patients but also results in a prolonged hospital stay (Chovanec *et al.*, 2021) and a burden of healthcare costs. Literature reviews have identified various risk factors for CLABSI, including prolonged intensive care unit (ICU) stay, undergoing surgery, having multiple catheters (Rajandra *et al.*, 2025), underlying conditions such as diabetes mellitus and chronic kidney disease, and the type of catheter used (Lafuente Cabrero *et al.*, 2023). Therefore, CLABSI are not only a clinical problem but also an important indicator of the quality of care and patient safety. Preventing and reducing the incidence of CLABSI has become a major challenge for multidisciplinary teams, especially nursing teams, who play a key role in caring for patients with central venous catheters around the

Received: July 17, 2025 Received in revised form: February 15, 2026 Accepted: February 22, 2026

THE MALAYSIAN JOURNAL OF NURSING | VOL. 17 (4) March 2026 | 145

clock. Literature reviews show that comprehensive nursing practice to prevent CLABSI typically consists of five main components: 1) strict hand hygiene before and after touching the patient and catheter; 2) maximal barrier precautions during insertion, requiring the operator to wear a sterile cap, face mask, gown, and gloves, and to cover the patient with large sterile drapes (Hernández-Aceituno *et al.*, 2020; Mostafa *et al.*, 2022); 3) cleansing the skin area where the catheter will be inserted with chlorhexidine skin antisepsis (Akyol & Çavdar, 2022; Atia, 2020); 4) selecting the appropriate insertion site, avoiding femoral veins if possible (Suwannakeeree & Jullmusi, 2021; Uppanisakorn *et al.*, 2018); and 5) daily review of line necessity with prompt removal (Buetti *et al.*, 2022).

Moreover, registered nurses are the frontline personnel essential to the success of this practice, from equipment preparation and assisting physicians during catheter insertion to daily wound and catheter care and assessment for catheter removal. The nursing practice guideline needs to be developed based on evidence-based practice and adapted to the local context of care. Encouraging nurses to consistently follow the guidelines is one of the most effective strategies to reduce the incidence of CLABSI. The effectiveness of the guidelines for CLABSI prevention has been confirmed by many research studies (Davis *et al.*, 2024; Hernández-Aceituno *et al.*, 2020), but the successful implementation of the guidelines in a sustainable manner remains challenging in each hospital, which may have different factors such as resources, organizational culture, and patient characteristics (Madran, 2022). Although CLABSI bundles are recommended globally, adherence and contextual adaptation remain inconsistent in Thailand. This is especially true in medical intensive care units, where patients are complex and at high risk.

Therefore, it is important to study the outcomes of guideline use in the context of Thailand. In order to confirm the effectiveness and identify obstacles to their actual implementation, the researchers were interested in studying the results of using the NPG for prevention of CLABSI in medical critical care patients (Cribbs, 2020). The findings will provide important empirical data that can be used to improve the quality of critical care, reduce the rate of CLABSI, lower health care costs, and promote a culture of safety in hospitals.

## METHODOLOGY

### Study Design and Setting

A comparative study design (intervention group and standard care group) was applied in this research to compare the incidence of CLABSI between the intervention group and the standard care group (Lau & Holbrook, 2017). The research was conducted in the medical intensive care unit of a tertiary hospital in northeastern Thailand, from October 2023 to March 2024.

### Participants and Sample

The participants in this study consisted of two groups: 1) critically ill medical patients who received central venous catheters in the ICU of the study hospital and 2) professional nurses working in the same ICU. For patients, the inclusion criteria were as follows: (1) aged 18 years or older, (2) receiving a central venous catheter for treatment by a physician, and (3) willingness to participate in the study. The exclusion criteria were as follows: (1) patients with a central venous catheter for treatment by a physician from another hospital or ward, and (2) patients who died or were transferred out of the ward. The sample size was determined using G\*Power 3.1 software, based on effect sizes from previous similar studies. The odds ratio was set at 0.21 (Akyol & Çavdar, 2022) with an alpha level of 0.05 and power of 0.85, yielding a required sample size of 26 participants per group. This increased by 30% to account for potential dropouts, resulting in 46 participants per group. Recruitment was purposively conducted by sampling the intervention group and standard care group. Randomization was not feasible due to contamination risk in ICU practice. For nurses, 12 professionals were purposively selected. The criteria included at least 1 year of working in the medical intensive care unit, experience caring for patients with central venous catheters, and willingness to participate in the research.

### Research Instruments

The patient data and clinical outcome record form (PDCOF) was developed by PI to collect information on gender, age, initial diagnosis, underlying diseases, and the occurrence of CLABSI. The content validity was assessed by 5 experts. The Index of item objective congruence (IOC) value was calculated and reported as 1.00.

**The nursing practice assessment form (NPAF)** was developed by PI to observe nursing practice. This form consists of 15 items across 9 components based on the NPG for CLABSI prevention. Each item is scored dichotomously (1 = complete, 0 = incomplete/not done). Then, the score obtained in each activity component is calculated as a percentage. If the nursing practice score is 80% or higher, it means that the nursing practice is appropriate and comprehensive. The content validity was assessed by 5 experts. The IOC value was calculated and reported as 1.00. The inter-rater reliability of the NPAF was 0.88.

**The satisfaction assessment form (SAF)** was developed by PI to assess satisfaction for using the NPG. The SAF consists of 5 items. Responses for each item are based on a 5-point rating scale, ranging from 1 (dissatisfied) to 5 (most satisfied). The interpretation is based on the average total score, which is divided into 3 levels: an average of 3.68-5.00 points, which is highly satisfied; an average of 2.34-3.67 points, which is moderately satisfied; and an average of 1.00-2.33 points, which is lowly satisfied. The content validity was examined by 5 experts. The IOC was calculated and reported as 1.00. The Cronbach's alpha coefficient of the SAF was 0.82.

### **Data Collection Procedure**

After receiving approval from the Human Research and Ethics Committee, data were first collected from the standard care group, which received standard nursing care according to the hospital's CLABSI Bundle protocol. Only after completing data collection for the standard care group was the intervention group enrolled, to prevent contamination from nurses mixing standardized protocol and the NPG for Prevention of CLABSI (NPGs). In the intervention group, nursing practice adherence was assessed by the head nurse or the shift leader using the NPAF. Compliance to the NPGs was checked each shift, and overall scores were calculated based on the frequency of correctly performed activities for each component, ranging from 0 to 100%.

### **Intervention Group**

In the intervention group, professional nurses practiced according to the NPGs. This NPGs was developed by the PI based on the evidence-based practice model (Soukup, 2000) and the existing standardized protocol of the studied tertiary hospital (CLABSI Bundle). Content validity was confirmed by five experts for content accuracy, clarity, and language. The average evaluation score of the Appraisal of Guidelines for Research & Evaluation: AGREE II 2009 for all categories was 86.72%, and all experts agreed that the practice guidelines were applicable. It was piloted with five critically ill medical patients to ensure feasibility (Sabharwal et al., 2013). It included two phases of activities, as detailed below: 1) The central venous catheter insertion phase consists of five components: (1.1) planning the insertion site with a physician, prioritizing the internal jugular vein (IJV), and encouraging the ultrasound guidance with a sterile bag; (1.2) skin preparation with 2% chlorhexidine in alcohol; (1.3) use of full protective equipment by a physician, a nurse assisting, and another assistant; (1.4) hand washing with 4% chlorhexidine gluconate (CHG) using 7 steps for 20 seconds; and (1.5) maintaining a sterile field throughout the procedure. 2) The central venous catheter retention phase consists of four components: (2.1) scrubbing the hub with 2% chlorhexidine for at least 15 seconds and applying a transparent dressing, (2.2) assessing the indications for early catheter, (2.4) strictly washing hands both before and after nursing implementation, and (2.5) recording the data and following up on infection reports.

### **Standard Care Group**

In the standard care group, professional nurses practiced the nursing activity based on the standardized protocol of the studied tertiary hospital (CLABSI Bundle).

### **Data Analysis**

Data were processed and analyzed using statistical software. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to analyze demographic data. The chi-square statistic ( $\chi^2$ ) was applied to test the similarity of demographic characteristics between the intervention and comparative groups. The incidence rate of CLABSI was calculated per 1000 C-line days. Finally, relative risk ratio was used to compare the risk for CLABSI between the intervention and standard care groups. The significance level was established at 0.05 and a 95% confidence interval (CI).

## Ethical Considerations

This research received ethical approval from the Human Research Ethical Committee of Mahasarakham Hospital, Thailand, with reference number MSKH\_REC 66-01-100, COA No. 66-099, on 29<sup>th</sup> August, 2023.

## RESULTS

Most of the samples in both groups were male, aged no more than 60 years old. The experimental group had an average age of  $59.13 \pm 15.63$  years, while the control group had an average age of  $60.89 \pm 14.94$  years. Both groups had underlying diseases such as diabetes, hypertension, chronic kidney disease, and chronic obstructive pulmonary disease. Initial diagnoses included cardiovascular disease, respiratory system disease, nervous system disease, bloodstream infection, chronic kidney disease, and the use of blood pressure-stimulating drugs. The two groups had similar general characteristics ( $p > 0.05$ ) as shown in Table 1.

**Table 1: Comparison of Characteristics of the Participants between the Standard Care Group (n=46) and Intervention Groups (n=46)**

Characteristics	Standard care group (n=46) n (%)	Intervention group (n=46) n (%)	$\chi^2$	df	p-value
<b>Gender</b>					
Male	28 (60.87)	30 (65.22)	0.18	1	0.66
Female	18 (39.13)	16 (34.78)			
<b>Age</b>					
	(Mean = $59.13 \pm 15.63$ )	(Mean = $60.89 \pm 14.94$ )			
≤ 60 years	25 (54.35)	23 (50.00)	0.17	1	0.67
> 60 years	21 (45.65)	24 (52.17)			
<b>Underlying Disease</b>					
<b>Diabetes mellitus</b>					
Yes	18 (39.13)	22 (47.83)	0.70	1	0.40
No	28 (60.87)	24 (52.17)			
<b>Hypertension</b>					
Yes	14 (30.43)	13 (28.26)	0.05	1	0.81
No	32 (69.57)	33 (71.74)			
<b>Chronic Kidney Disease</b>					
Yes	14 (30.43)	17 (36.96)	0.43	1	0.50
No	32 (69.57)	29 (63.04)			
<b>Chronic Obstructive Pulmonary Disease</b>					
Yes	9 (19.57)	14 (30.43)	1.44	1	0.22
No	37 (80.43)	32 (69.57)			
<b>Diagnosis</b>					
Cardiovascular	6 (13.04)	12 (26.09)	4.29	4	0.36
Respiratory	17 (36.96)	14 (30.43)			
Neurology	5 (10.87)	7 (15.22)			
Sepsis	8 (17.39)	8 (17.39)			
Nephology	10 (21.74)	5 (10.87)			
<b>Inotropic Drug</b>					
Norepinephrine	37 (80.43)	40 (86.96)	3.56	3	0.31
Dobutamine	7 (15.22)	2 (4.35)			
Adrenaline	1 (2.17)	2 (4.35)			
Cordarone	1 (2.17)	2 (4.35)			

The results found that the intervention group (n = 46 patients) using the NPGs had an incidence rate of 0.48 per 1,000 C-line days. For the standard care group (n = 46 patients), there were CLABSI incidences of 3.25 per 1,000 C-line days. When calculating the relative risk ratio (RR), it was found that the intervention group using the NPG for prevention of CLABSIs could reduce the risk of CLABSIs by 89.5% (RR = 0.105, 95% CI =

0.012, 0.882,  $p < 0.05$ ), as shown in Table 2. In addition, absolute risk reduction (ARR) = 2.77/1,000 C-line days, and the number needed to treat (NNT) is about 361 C-line days.

**Table 2: Incidence of CLABSI in Standard Care Group (n=46) and Intervention Group (n=46)**

Group	Time of CLABSI	Number of C-line day	CLABSI incidence/ 1000 C-line day	Relative risk (95% CI)	p-value
Standard care group (n = 46)	8	246	3.25	0.105 (0.012, 0.882)	0.014*
Intervention group (n = 46)	1	208	0.48		

\* $p < 0.05$

In the intervention group that received the NPGs, from observing nursing practice according to this guideline, professional nurses achieved correct and comprehensive nursing practice in over 80% of all components, as shown in Table 3.

**Table 3: Percentage of Nursing Implementation Performed Correctly and Completely Based on Observation (n = 12)**

Nursing Practice		Percentage (%)
<b>Central venous catheter insertion phase</b>		
Component 1	Plan with physician regarding site for insertion	100.00
Component 2	Cleanse the skin with 2% CHG in Alcohol	100.00
Component 3	Wear protective equipment for both the inserter and the assistant	82.60
Component 4	Hand washing	
	4.1 Wash hands before performing the procedure with 4% CHG Hand Hygiene washing for 20 seconds, 7 steps for the inserter	86.96
	4.2 washes hands before performing the procedure with 4% CHG Hand Hygiene washing for 20 seconds, 7 steps for the assistant	89.60
Component 5	Kept the procedural area sterile during catheter insertion	84.32
<b>Retained the central venous catheter phase</b>		
Component 6	Scrubbing the hub and dressing	
	6.1 Scrub the hub using 2% CHG every shift and every time the hub uses 2% CHG for 15 seconds or more	100.00
	6.2 Use 2% CHG to wipe around the ALC before dressing the wound	100.00
	6.3 Clean the wound when it is moist or seeping, using 2% CHG to wipe around.	94.25
	6.4 Close the wound at the central venous catheter insertion site with a transparent material	100.00
Component 7	Assess indications for catheter removal once daily during the morning shift	87.60
Component 8	Strict hand washing before and after nursing implementation, completing 7 steps	100.00
Component 9	Recording and follow up	
	9.1 Record data on every catheter insertion and removal	84.93
	9.2 Follow up on infection reports in cases of culture	85.70
	9.3 CLABSI prevention checklist	100.00

Professional nurses who used the NPGs reported an overall satisfaction mean of 4.46 (SD = 0.40), which was at a high level. When considering each aspect, it was found that nurses had a high level of satisfaction in all items: clarity and ease of understanding of the nursing guidelines (Mean = 4.34, SD = 0.24), appropriateness of steps and practical application (Mean = 4.52, SD=0.22), appropriateness of the number of activities (Mean=4.47, SD=0.66), comprehensiveness of the guideline content (Mean = 4.57, SD = 0.26), and appropriateness of time required for implementation (Mean = 4.38, SD = 0.61), as shown in Table 4.

**Table 4: Opinions of Professional Nurses on Nursing Practice Guidelines (n = 12)**

Item	Mean	SD	Interpretation
1. Clarity and ease of understanding of nursing practice guidelines	4.34	0.24	High
2. Appropriateness of the procedure and practical application	4.52	0.22	High
3. The number of activities in the practice guidelines is appropriate	4.47	0.66	High
4. Comprehensiveness of the content of the practice guidelines	4.57	0.26	High
5. Time for implementing the practice guidelines is appropriate	4.38	0.61	High
Overall	4.46	0.40	High

## DISCUSSION

The main finding found that the intervention group using the NPGs had a lower incidence rate of CLABSI than the standard-care group. This result might indicate that nursing practices that adhere to the NPGs may reduce the risk of CLABSI by 89.5%. The observation of nursing practice adherence to the NPGs for Prevention of CLABSI in the intervention group showed a high and complete level of adherence to the NPGs, with an average nursing practice score of more than 80% in all activity categories. The nurse practices adhering to these NPGs with a rate as high as 100% in various activity categories. This finding suggested that the NPGs are clear, easy to understand, and can be practically applied by professional nurses. It may result in a high level of adherence to the NPGs and a reduction in the incidence of CLABSI. This result is consistent with a study in Thailand by Thupboocha (2020), which found that 63 patients using the nursing care model had no CLABSI incidence, while the group before the nursing care model had a CLABSI incidence of 5.2 times/1,000 C-line days. In addition, it was also found that professional nurses who used the NPGs had a high level of overall satisfaction with the NPGs (mean = 4.46, SD = 0.40), indicating the possibility that these NPGs will be used and adopted in other areas in the future. This is consistent with the study on the effectiveness of using NPG in caring for patients with central venous catheters by professional nurses, which found that nurses had the highest level of satisfaction at 93.30%, especially in terms of their convenience and ease of application (Phaisantum, 2022). The findings suggest that consistent adherence to the NPGs can substantially reduce preventable infections and improve patient safety.

All components of the NPGs are important nursing practices to reduce the incidence of CLABSI. The insertion site was prioritized for the IJV because it is a large vein that can be accessed easily and poses less risk of contamination from fecal matter and moisture in the groin area, which differs from the standardized protocol that simply recommends avoiding catheter insertion in the groin area. This finding is consistent with the systematic literature review and meta-analysis showing that catheterization in the femoral vein has a 1.63-fold risk of CLABSI (HR 1.63; 95% CI 1.34–1.97;  $p = 0.0001$ ) (Buetti *et al.*, 2021).

In addition, these NPGs indicated that before inserting a catheter, the physician, nurse assistants, or any other assistants must wash their hands with 4% CHG solution for 20 seconds following the 7-step technique strictly. This antiseptic approach offers proven benefits for CLABSI prevention (Kuroki *et al.*, 2025). This study emphasizes the importance of the healthcare provider regarding the duration of hand washing for 20 seconds, which is different from the standardized protocol that states that hands must be washed before the procedure. For this reason, it could be partly explained why the comparative group had a significantly higher incidence of CLABSI than the intervention group (Lau & Holbrook, 2017). It is consistent with the study of Davis *et al.* (2024), which found that hand washing with 4% CHG can reduce the occurrence of CLABSI by 43.2% in the ICU. In addition, washing hands for 15-20 seconds each time will help to make hand cleaning more effective (Toney-Butler *et al.*, 2023). Moreover, these NPGs are also concerned about the use of ultrasound-guided sterile bags combined with catheter insertion to increase accuracy and reliability and reduce the number of insertions and complications of catheter insertion. It aligns with the systematic review and meta-analysis of Takeshita *et al.* (2022), which found that use of ultrasound during intravenous catheterization reduces the incidence of CLABSI.

Moreover, the site of the catheter was cleaned with 2% CHG once per shift or when damp, scrubbing the hub

with 2% CHG for at least 15 seconds, and then wrapped with gauze. This procedure differs from the standard protocol, which typically does not use gauze. Moreover, the wound dressing varies based on international normalized ratio (INR) values: if  $INR < 1.5$ , Tegaderm® without gauze is used; if  $INR > 1.5$ , Tegaderm® with gauze is applied. The results differ from the study of Eyuboglu *et al.* (2024). They found that closing the catheter site with a clear dressing and cleaning the wound with 2% CHG did not reduce the incidence of CLABSI and was more expensive than closing the wound with gauze. However, professional nurses were significantly more satisfied with observing the catheter insertion site with the clear dressing than with gauze (mean = 4.7, SD = 0.4 vs mean = 1.33, SD = 0.4;  $p < 0.001$ ). It might be because this study indicated cleaning the catheter joint by scrubbing with 2% CHG, which may allow for effective cleaning of the joint area and reduce the CLABSI.

This NPGs requires all teams who assisted during catheterization to wear complete body protection to reduce the chance of contamination (Rosenthal *et al.*, 2024). It also mandates single-use 30 mL containers of 2% CHG per patient to prevent cross-contamination. In addition, it is required to separate the items used by each patient, including urine bottles, cleaning tanks, and treatment cars. Separating equipment and items for each person will help reduce contamination and the spread of infection between patients. (Rosenthal *et al.*, 2024)

### Limitations

This intervention research has some limitations. First, the study was a comparative study conducted in a single tertiary hospital, which may limit the ability to generalize the results to other settings with different contexts and patient characteristics. Second, the data collection was compared between the intervention group and the standard care group. Third, the sample was selected at a specific time, which may have had uncontrollable confounding factors that could affect the results. Finally, the potential Hawthorne effect, as nurses knew they were being observed, may have influenced adherence.

### CONCLUSION

This study concluded that the use of the NPGs for CLABSI prevention was highly effective in the care of critically ill medical patients. The results clearly showed that the intervention group had a significantly reduced incidence of CLABSI, with a rate of only 0.48 per 1,000 C-line days, compared to the standard care group with a high rate of 3.25 per 1,000 C-line days. Compliance with the guidelines of professional nurses could reduce the risk of CLABSI by 89.5%. In addition, the fact that professional nurses were able to follow the guidelines correctly and comprehensively more than 80% in all components and had a high level of satisfaction with the guidelines (mean score of 4.46) confirmed that the guidelines were clear, easy to understand, and could be implemented in practice in clinical practice. Further research in a multi-center study should be conducted to confirm the effectiveness of the guideline in various contexts and increase the reliability of the results. In addition, a longitudinal study should be conducted to assess the sustainability of the guideline adherence and its impact on the rate of CLABSI in the long term.

### Recommendations

This nursing practice guideline should be expanded to serve as a standard for the care of patients with central venous catheters in medical intensive care units and other critical care units within the hospital. Regular training and review of knowledge should be provided to maintain the quality of practice.

### Conflict of Interest

The authors declare that they have no competing interests.

### ACKNOWLEDGEMENT

The researchers extend their heartfelt gratitude to all the participants for their valuable participation and to everyone who contributed to the successful completion of this study and the preparation of the manuscript. participants

## REFERENCES

- Akyol, E., & Çavdar, İ. (2022). The impact of care bundle approach in preventing central line-associated bloodstream infections in surgical intensive care units. *Turkish Journal of Intensive Care*, *20*(3), 138-147. <https://doi.org/10.4274/tybd.galenos.2021.44154>
- Atia, G. (2020). Effect of central venous catheter care bundle implementation on outcomes of critically ill Patients. *Evidence-Based Nursing Research*, *2*(1), 28-39. <https://doi.org/10.47104/ebnrojs3.v2i1.93>
- Buetti, N., Marschall, J., Drees, M., Fakih, M. G., Hadaway, L., Maragakis, L. L., Monsees, E., Novosad, S., O'Grady, N. P., & Rupp, M. E. (2022). Strategies to prevent central line-associated bloodstream infections in acute-care hospitals: 2022 update. *Infection Control & Hospital Epidemiology*, *43*(5), 553-569. <https://doi.org/10.1017/ice.2022.87>
- Buetti, N., Mimos, O., Schwebel, C., Ruckly, S., Castry, M., Dupuis, C., Souweine, B., Lucet, J.-C., & Timsit, J.-F. (2021). Insertion site and infection risk among peripheral arterial catheters. *American Journal of Respiratory and Critical Care Medicine*, *203*(5), 630-633. <https://doi.org/10.1164/rccm.202007-3008LE>
- Chovanec, K., Arsene, C., Gomez, C., Brixey, M., Tolles, D., Galliers, J. W., Kopaniasz, R., Bobash, T., & Goodwin, L. (2021). Association of CLABSI with hospital length of stay, readmission rates, and mortality: A retrospective review. *Worldviews on Evidence-Based Nursing*, *18*(6), 332-338. <https://doi.org/10.1111/wvn.12548>
- Cribbs, K. A. (2020). Investigating the Impact of the Nursing Practice Environment (NPE) on Central Line-Associated Bloodstream Infections (CLABSI) among Older Adults in the Intensive Care Unit (ICU). [https://academicworks.cuny.edu/sph\\_etds/44](https://academicworks.cuny.edu/sph_etds/44)
- Darayon, R., Komet, O., & Nuchu, Y. (2024). Incidence of central line-associated bloodstream infection: A 6-year report in the Medical Intensive Care Unit at a University Hospital. *Thai Journal of Nursing and Midwifery Practice*, *11*(1), 53-63. <https://he02.tci-thaijo.org/index.php/apnj/article/view/266778>
- Davis, T., Wittmann, S., Prairie, B. A., Dugan, N., Reiser, P., Goclano, L., & Dziobak, R. (2024). Implementing a compliance monitoring process to promote chlorhexidine gluconate bathing and hand hygiene: An initiative to decrease central line-associated bloodstream infections. *Patient Safety*, *6*(1), Article 121071. <https://doi.org/10.33940/001c.121071>
- Eyuboglu, M. O., İlçe, A. Ö., & Soysal, G. E. (2024). Effectiveness of transparent dressing with chlorhexidine gluconate for central venous catheter care in the Intensive Care Unit: A case control study. *Sağlık Bakım ve Rehabilitasyon Dergisi*, *3*(2), 1-12. <https://dergipark.org.tr/tr/download/article-file/4100460>
- Haddadin, Y., Annamaraju, P., & Regunath, H. (2017). Central line-associated blood stream infections. In *StatPearls [Internet]*. StatPearls Publishing.
- Hernández-Aceituno, A., Vega-Costa, V., Ruiz-Álvarez, M., Figuerola-Tejerina, A., Méndez-Hernández, R., & Ramasco-Rueda, F. (2020). Effectiveness of a bundle of measures for reducing central line-associated bloodstream infections. *Revista Española de Anestesiología y Reanimación (English Edition)*, *67*(5), 227-236. <https://doi.org/10.1016/j.redar.2019.11.014>
- Kuroki, M., Short, A. C., & Coombs, L. A. (2025). Chlorhexidine gluconate treatment adherence among nurses and patients to reduce central line-associated bloodstream infections. *Clinical Journal of Oncology Nursing*, *29*(2), E37-E46. <https://doi.org/10.1188/25.CJON.E37-E46>
- Lafuente Cabrero, E., Terradas Robledo, R., Civit Cuñado, A., García Sardelli, D., Hidalgo López, C., Giro Formatger, D., Lacueva Perez, L., Esquinas López, C., & Tortosa Moreno, A. (2023). Risk factors of catheter-associated bloodstream infection: Systematic review and meta-analysis. *PLoS One*, *18*(3), Article e0282290. <https://doi.org/10.1371/journal.pone.0282290>

- Lau, F., & Holbrook, A. (2017). Methods for comparative studies. In *Handbook of Health evaluation: An Evidence-based approach*. University of Victoria.
- Madran, B., Keske, Ş., Bakır, V. O., & Ergönül, Ö. (2022). The effectiveness of bundle applications in the prevention of central line-associated bloodstream infections: Nine years of observation. *Infectious Diseases & Clinical Microbiology, 4*(1), 40-46. <https://doi.org/10.36519/idcm.2022.114>
- Mostafa, F. A., Alnafee, K., Al Shanqiti, K., Siddiq, N., Alshuhri, S., & Badawi, D. (2022). Reducing central-line-associated bloodstream infections (CLABSI): An improvement project in a specialized tertiary hospital. *Global Journal on Quality and Safety in Healthcare, 5*(4), 84-92. <https://doi.org/10.36401/JQSH-22-4>
- O'Grady, N. P. (2023). Prevention of central line-associated bloodstream infections. *New England Journal of Medicine, 389*(12), 1121-1131. <https://doi.org/10.1056/NEJMra2213296>
- Phaisantum, P. (2022). The effectiveness of Nursing care protocol for patients with central line of professional nurses. *Journal of Nursing Division, 49*(2), 86-99. <https://he01.tci-thaijo.org/index.php/JND/article/download/264817/178519/1087884>
- Rajandra, A., Yunos, N. a. M., Teo, C. H., Kukreja, A., Suhaimi, N. A., Mohd Razali, S. Z., Basri, S., Teh, C. S. J., Leong, C. L., & Ismail, I. (2025). Incidence, compliance, and risk factor associated with central line-associated bloodstream infection (CLABSI) in Intensive Care Unit (ICU) patients: A multicenter study in an upper middle-income country. *Antibiotics, 14*(3), Article 271. <https://doi.org/10.3390/antibiotics14030271>
- Rosenthal, V. D., Memish, Z. A., Shweta, F., Bearman, G., & Lutwick, L. I. (2024). Preventing central line-associated bloodstream infections: A position paper of the International Society for Infectious Diseases, 2024 update. *International Journal of Infectious Diseases, 150*, Article 107290. <https://doi.org/10.1016/j.ijid.2024.107290>
- Sabharwal, S., Patel, V., Nijjer, S. S., Kirresh, A., Darzi, A., Chambers, J. C., ... & Athanasiou, T. (2013). Guidelines in cardiac clinical practice: evaluation of their methodological quality using the AGREE II instrument. *Journal of the Royal Society of Medicine, 106*(8), 315-322. <https://doi.org/10.1177/0141076813486261>
- Suwannakeeree, W., & Jullmusi, O. (2021). Prevention of central line-associated bloodstream infection. *Journal of Nursing and Health Sciences, 15*(2), 14-26. <https://doi.org/10.1016/j.idc.2021.07.004>
- Takeshita, J., Tachibana, K., Nakajima, Y., & Shime, N. (2022). Incidence of catheter-related bloodstream infections following ultrasound-guided central venous catheterization: A systematic review and meta-analysis. *BMC Infectious Diseases, 22*(1), Article 772. <https://doi.org/10.1186/s12879-022-07760-1>
- Thupboocha, J. (2020). Development of central line associated bloodstream infection (CLABSI) prevention model. *Buddhachinaraj Medical Journal, 37*(2), 149-158. <https://he01.tci-thaijo.org/index.php/pnc/article/view/261386>
- Toney-Butler, T. J., Gasner, A., & Carver, N. (2023). Hand hygiene. In *Stat Pearls [Internet]*. Stat Pearls Publishing.
- Uppanisakorn, S., Pochanakij, C., & Boonyarat, J. (2018). The effects of the program to prevent central line-associated bloodstream infection (CLABSI) in Medical ICU. *Journal of Medical Sciences Region 11, 32*(2), 1095-1104. <https://he02.tci-thaijo.org/index.php/Reg11MedJ/article/view/156874/113804>