

Effectiveness of a Nurse-Led Educational Intervention on Knowledge and Practice Regarding Prevention of Central Line-Associated Bloodstream Infection (CLABSI) Among Nurses

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Abstract

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Introduction: Central line-associated bloodstream infection (CLABSI) is a serious healthcare-associated infection that can increase patient morbidity, mortality, length of hospital stays, and healthcare costs. Nurses play a vital role in preventing CLABSI through appropriate central line insertion, maintenance, and infection prevention practices. Structured educational interventions can improve nurses' knowledge and adherence to evidence-based CLABSI prevention practices. **Objective:** To assess the effectiveness of a nurse-led educational intervention on nurses' knowledge and clinical practice regarding CLABSI prevention. **Methodology:** A quasi-experimental pre-test and post-test study was conducted among 64 registered nurses. A structured educational intervention focusing on evidence-based CLABSI prevention measures was provided to the participants. Nurses' knowledge was assessed before and after the intervention using a structured knowledge questionnaire, while clinical practice was evaluated using an

observational checklist. Pre-intervention and post-intervention scores were analyzed and compared to determine the effectiveness of the educational intervention. **Results:** The findings demonstrated a significant improvement in nurses' knowledge and clinical practice following the educational intervention. The mean knowledge score increased from 16.84 ± 4.21 in the pre-test to 25.91 ± 2.67 in the post-test, with a mean improvement of 9.07 points ($p < 0.001$). Similarly, the mean practice score increased from $61.72 \pm 9.35\%$ before the intervention to $86.41 \pm 6.72\%$ after the intervention, representing an improvement of 24.69 percentage points ($p < 0.001$). **Conclusion:** The study concluded that the nurse-led educational intervention was effective in significantly improving nurses' knowledge and clinical practice regarding CLABSI prevention. Regular educational sessions, competency assessments, and continuous monitoring of evidence-based central line care practices are recommended to strengthen CLABSI prevention in clinical settings.

Introduction

Central line-associated bloodstream infection (CLABSI) is one of the most important preventable healthcare-associated infections (HAIs) among hospitalized patients with central venous catheters. CLABSIs occur when microorganisms enter the bloodstream through a central line and can result in serious complications, including sepsis, prolonged hospitalization, increased healthcare costs, and mortality. Despite substantial advances in infection prevention and control (IPC), CLABSI remains an important patient-safety challenge worldwide. Recent data from the United States National Healthcare Safety Network (NHSN) showed that 18,165 CLABSI events were reported by 3,739 general acute-care hospitals in 2024. Although the national standardized infection ratio (SIR) decreased from 0.72 in 2023 to 0.66 in 2024, continuous prevention efforts remain necessary. [1] Central venous catheter care involves multiple opportunities for infection transmission, including catheter insertion, dressing changes, hub or connector access, medication administration, line maintenance, and catheter removal. Therefore, consistent adherence to evidence-based infection-prevention practices by nurses is essential. The World Health Organization (WHO) 2026 guideline on central venous catheters emphasizes hand hygiene, aseptic technique, appropriate catheter insertion and maintenance, education and training of healthcare workers, care bundles, surveillance, and multimodal strategies as key components of CLABSI prevention. [2] Similarly, the Centers for Disease Control and Prevention (CDC) identifies adherence to standardized infection-prevention practices as fundamental to safe and high-quality healthcare delivery. [3] Nurses play a central role in preventing CLABSI because they frequently assess central lines, administer intravenous medications, perform dressing and access procedures, monitor insertion sites, and identify early signs of catheter-related complications. However, evidence indicates that knowledge alone does not always translate into appropriate clinical practice. A 2023 study involving 209 ICU nurses found that 50.72% had insufficient knowledge regarding CLABSI prevention, while workload, shortage of equipment, and lack of CLABSI-prevention workshops were identified as important barriers to implementation of evidence-based practices. [4] A 2024 study further reported that nurses' awareness and organizational culture were significant determinants of CLABSI-prevention practice, demonstrating that both individual knowledge and the clinical environment influence adherence. [5] Evidence also supports the effectiveness of structured nursing interventions. A 2023 quasi-experimental study among pediatric intensive-care nurses evaluated a CLABSI-prevention program specifically for improving nurses' knowledge and practice and reducing infection rates. [6] In another study, a dedicated CLABSI-prevention registered-nurse role incorporating daily central-line audits, real-time education, remediation, and support for dressing changes reduced the CLABSI rate from 1.4 to 0.4 per 1,000 central-line days ($P=.04$), while daily bathing compliance increased from 84.3% to 90.8% ($P=.004$). [7] Furthermore, a 2024 nurse-driven quality-improvement project involving 2,692 central-catheter rounds among 707 patients reported a reduction in CLABSI rates from 1.86 to 0 per 1,000 central-line days. [8] The importance of nurse-led education is particularly relevant in resource-limited healthcare settings, including Pakistan, where variations in nurses' knowledge, availability of resources, and adherence to standardized catheter-care practices may affect infection-prevention outcomes. A 2024 Pakistani study highlighted the need for targeted educational interventions focusing on aseptic technique, catheter maintenance, and regular refresher training among nurses. [9] Therefore, a structured nurse-led educational intervention may provide an effective approach to strengthening nurses' knowledge and translating evidence-based recommendations into routine clinical practice. Despite existing evidence supporting CLABSI-prevention bundles and educational interventions, there remains a need for context-specific research

evaluating whether a structured nurse-led educational intervention can produce measurable improvements in both knowledge and actual clinical practice among nurses. Therefore, the present study aims to determine the **effectiveness of a nurse-led educational intervention on knowledge and practice regarding the prevention of central line-associated bloodstream infection among nurses**. The findings may provide evidence for strengthening nursing education, improving adherence to central-line maintenance practices, and supporting hospital-based infection-prevention programs.

Methodology

A quasi-experimental, one-group pre-test and post-test study design was used to determine the effectiveness of a nurse-led educational intervention on nurses' knowledge and practice regarding the prevention of central line-associated bloodstream infection (CLABSI). The study was conducted in the selected clinical departments of a tertiary-care hospital in Karachi, Pakistan, where registered nurses were routinely involved in the care and maintenance of patients with central venous catheters. The study population consisted of registered nurses providing direct patient care in departments where central venous catheterization and maintenance were routinely performed. A convenience sampling technique was used to recruit eligible nurses who were available during the data-collection period and voluntarily agreed to participate. The sample size was calculated using OpenEpi based on a two-proportion comparison, with a 95% confidence level, 80% statistical power, an anticipated baseline adequate-practice proportion of 50%, and an expected post-intervention proportion of 75%. The calculated minimum sample was approximately 58 participants; therefore, after adding 10% to compensate for possible non-response or attrition, a final sample of 64 registered nurses was targeted. Participants were included if they were registered nurses, were currently providing direct patient care, had at least six months of clinical experience, were involved in central-line-related patient care, and were willing to participate in the study. Nurses working exclusively in administrative positions, nurses on extended leave during the intervention period, student nurses, nursing interns, and nurses who had recently completed formal CLABSI-prevention training were excluded. Data were collected using a structured questionnaire and an observational practice checklist. The questionnaire contained sections assessing participants' demographic and professional characteristics and their knowledge regarding CLABSI definition, risk factors, hand hygiene, aseptic technique, catheter insertion and maintenance, dressing changes, hub and connector disinfection, catheter access, daily assessment of catheter necessity, and recognition of infection-related signs and symptoms. Nurses' clinical practice was assessed using a structured observational checklist based on recommended central-line infection-prevention practices, including hand hygiene, use of personal protective equipment when indicated, maintenance of aseptic technique, appropriate dressing care, disinfection of catheter hubs/connectors, safe medication and fluid administration, maintenance of catheter integrity, and appropriate documentation. Before the intervention, all eligible participants completed the baseline knowledge assessment and were observed during routine central-line care to determine their pre-intervention practice scores. Following the pre-test, a structured nurse-led educational intervention was delivered by the researcher. The intervention consisted of interactive lectures, PowerPoint-based teaching, demonstrations, return demonstrations, case-based discussions, and question-and-answer sessions. The educational content focused on evidence-based CLABSI-prevention practices and emphasized correct hand hygiene, aseptic non-touch technique, catheter-site assessment, dressing management, hub disinfection, safe catheter access, and early recognition of infection. The intervention was delivered through multiple structured sessions over a planned period, and participants were provided with educational material for reinforcement. After

completion of the intervention, the same knowledge questionnaire was administered as a post-test, and participants' clinical practice was reassessed using the same observational checklist. The pre-test and post-test scores were compared to determine changes in nurses' knowledge and practice following the educational intervention. Data were entered and analyzed using IBM SPSS Statistics. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize demographic characteristics and study variables. The normality of continuous variables was assessed before inferential analysis. A paired-samples t-test was used to compare normally distributed pre-test and post-test knowledge and practice scores, while the Wilcoxon signed-rank test was considered when the data did not meet parametric assumptions. Statistical significance was considered at a p-value of <0.05, and the mean difference with a 95% confidence interval was reported where appropriate. Ethical approval was obtained from the relevant institutional ethical review committee before commencement of the study, and permission was obtained from the hospital administration and nursing management. Written informed consent was obtained from all participants after the purpose, procedures, potential benefits, voluntary nature of participation, and confidentiality of the information had been explained. Participants were informed that they could withdraw from the study at any stage without any effect on their employment or professional standing. No personally identifiable information was included in the analysis or reporting, and all collected data were kept confidential and used solely for research purposes.

Results

A total of **64 registered nurses** participated in the study. The demographic and professional characteristics of the participants were analyzed according to age, gender, educational qualification, and clinical experience. The findings are presented separately in the following tables.

Table 1: Age Distribution of Participants

The mean age of the participants was **29.64 ± 4.83 years**, with the majority of nurses (**40.6%**) belonging to the 26–30 years age group. Nurses aged 31–35 years represented 28.1% of the sample, while 18.8% were aged 20–25 years and 12.5% were aged 36 years or above.

Age group (years)	Frequency (n)	Percentage (%)
20–25	12	18.8
26–30	26	40.6
31–35	18	28.1
≥36	8	12.5
Total	64	100.0

Table 2: Gender Distribution of Participants

Regarding gender, the majority of participants were female nurses (**59.4%**), whereas male nurses constituted **40.6%** of the study sample.

Gender	Frequency (n)	Percentage (%)
Male	26	40.6
Female	38	59.4
Total	64	100.0

Table 3: Educational Qualification of Participants

The educational background of participants showed that **43.8%** of nurses had completed a BSN/BScN degree, while 37.5% held a General Nursing Diploma with a post-basic qualification. A smaller proportion (**18.8%**) had completed a Master's degree in Nursing or a related field.

Educational qualification	Frequency (n)	Percentage (%)
Diploma/Post-RN	24	37.5
BSN/BScN	28	43.8
MSN/MScN or higher	12	18.8
Total	64	100.0

Table 4: Clinical Experience of Participants

With regard to clinical experience, the largest proportion of nurses (**39.1%**) had 1–5 years of experience. Nurses with 6–10 years of experience represented 32.8%, while 28.1% had more than 10 years of clinical experience.

Clinical experience	Frequency (n)	Percentage (%)
1–5 years	25	39.1
6–10 years	21	32.8
>10 years	18	28.1
Total	64	100.0

Knowledge Scores

The participants' knowledge regarding CLABSI prevention was assessed before and after the nurse-led educational intervention. The pre-test findings demonstrated a moderate level of knowledge, with a mean score of **16.84 ± 4.21 out of 30**. Following the educational intervention, the mean knowledge score increased substantially to **25.91 ± 2.67 out of 30**, indicating an improvement in knowledge after the intervention.

Table 5: Comparison of Pre-Test and Post-Test Knowledge Scores

Knowledge assessment	Mean ± SD	Minimum	Maximum
Pre-test	16.84 ± 4.21	8	24
Post-test	25.91 ± 2.67	19	30
Mean difference	9.07		

Practice Scores

The nurses' clinical practice regarding CLABSI prevention was assessed using a structured observational checklist. Before the intervention, the mean practice score was **61.72 ± 9.35%**. After completion of the educational intervention, the mean practice score increased to **86.41 ± 6.72%**, demonstrating substantial improvement in adherence to recommended CLABSI-prevention practices.

Table 6: Comparison of Pre-Intervention and Post-Intervention Practice Scores

Practice assessment	Mean ± SD (%)	Minimum	Maximum
Pre-intervention	61.72 ± 9.35	43	79
Post-intervention	86.41 ± 6.72	69	97
Mean difference	24.69		

Statistical Comparison

A paired-samples t-test was performed to determine whether the observed improvement in knowledge and practice scores following the nurse-led educational intervention was statistically significant. The analysis demonstrated a statistically significant increase in both knowledge and practice scores after the intervention (**p < 0.001**). The findings indicated that the educational intervention was effective in improving nurses' knowledge and observed practices related to CLABSI prevention.

Table 7: Paired Comparison of Knowledge and Practice Scores

Outcome	Pre-test/Pre-intervention Mean ± SD	Post-test/Post-intervention	Mean Difference	t-value	p-value
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		Mean ± SD			
Knowledge score (30)	16.84 ± 4.21	25.91 ± 2.67	9.07	16.42	<0.001
Practice score (%)	61.72 ± 9.35	86.41 ± 6.72	24.69	18.37	<0.001

Overall Finding

Overall, the results demonstrated a marked improvement in both **knowledge and clinical practice** following the nurse-led educational intervention. Knowledge increased from **56.1% of the maximum possible score to 86.4%**, while practice performance increased from **61.7% to 86.4%**. The statistically significant findings ($p < 0.001$) supported the effectiveness of the educational intervention in improving nurses' CLABSI-prevention knowledge and practice.

Discussion

The present study demonstrated a substantial improvement in nurses' knowledge regarding CLABSI prevention following the nurse-led educational intervention. The mean knowledge score increased from **16.84 ± 4.21 in the pre-test to 25.91 ± 2.67 in the post-test**, with a mean difference of **9.07 points**. The paired-samples t-test showed a statistically significant difference between pre-test and post-test knowledge scores ($p < 0.001$), indicating that the educational intervention was effective in improving nurses' knowledge regarding CLABSI prevention.

These findings are consistent with **Gaur and Natha (2023)**, who evaluated a skills competency Programme among critical care nurses in India. The experimental group achieved a post-test knowledge score of **23.75 ± 1.75**, compared with **12.55 ± 2.57** in the control group. The difference between groups was statistically significant ($t = 22.78$, $p = 0.0001$). The present study similarly demonstrated a marked improvement in knowledge following structured education, supporting the effectiveness of competency-based educational interventions in improving nurses' CLABSI-related knowledge (10).

Similarly, **Alzoubi et al. (2025)** reported a significant improvement in CLABSI-related knowledge among ICU nurses following an educational intervention. Their mean knowledge score increased from **37.34 ± 16.95 before the intervention to 79.49 ± 21.73 after the intervention**, representing a mean improvement of **42.15 points** ($p < 0.001$). Although the scoring system differed from the present study, the direction and statistical significance of the findings were similar. Both studies demonstrate that structured educational interventions can produce substantial improvements in nurses' knowledge regarding CLABSI prevention (11).

The present findings are further supported by **İskender and Karadeniz (2025)**, who examined the effect of evidence-based central venous catheter care training among ICU nurses. The study demonstrated a statistically significant increase in knowledge following the training ($p < 0.001$). Care practices were also evaluated before and after training, supporting the use of structured evidence-based education to improve competency in central venous catheter care (12).

Likewise, **Notshe et al. (2025)** evaluated an 8-week educational intervention for critical care nurses in South Africa. Significant improvements in knowledge were observed in both groups ($p < 0.0005$), with the intervention group demonstrating a **33.7-point improvement during catheter insertion-related assessment** compared with a 23.8-point improvement in the comparison group. These findings are comparable with the significant knowledge improvement observed in the present study and further support the value of structured, repeated educational exposure (13).

A recent Pakistani study by **William et al. (2025)** also demonstrated improvement following an educational intervention. Before the intervention, **80% of nurses had**

moderate knowledge and only 10% had adequate knowledge. Following the intervention, **80% achieved adequate knowledge**, with no participants remaining in the inadequate category. These findings are consistent with the present study, in which the mean knowledge score increased substantially after the educational intervention (14).

In contrast, **Farooq et al. (2024)** reported persistent knowledge gaps among nurses regarding CLABSI prevention in a Pakistani tertiary-care setting. Important deficiencies were identified in aseptic technique, catheter maintenance, hand hygiene, and advanced preventive measures. Approximately **20% of participants also reported low confidence** in critical aspects of CLABSI prevention. Unlike the present intervention-based study, their cross-sectional design did not provide an educational intervention. This difference suggests that baseline knowledge gaps may be addressed more effectively when structured education and practical reinforcement are incorporated into the study design (15). The present study also demonstrated a marked improvement in observed clinical practice following the intervention. The mean practice score increased from **61.72 ± 9.35% before the intervention to 86.41 ± 6.72% after the intervention**, representing a mean improvement of **24.69 percentage points**. The difference was statistically significant (**p < 0.001**), indicating that the intervention was associated with improved adherence to recommended CLABSI-prevention practices.

The present finding is strongly supported by **Gaur and Natha (2023)**, who assessed clinical practice using an objective structured clinical examination. The experimental group achieved a post-test practice score of **38.90 ± 2.02**, compared with **21.82 ± 5.13** in the control group. The difference was statistically significant (**t = 19.59, p = 0.0001**). The substantial difference between the intervention and control groups supports the present finding that structured educational and competency-based interventions can improve nurses' clinical performance related to CLABSI prevention (10).

Similarly, **İskender and Karadeniz (2025)** evaluated nurses' care practices before and after evidence-based central venous catheter care training and reported a significant improvement following the training (**p < 0.001**). This finding closely corresponds with the present study, in which practice scores increased from 61.72% to 86.41%. Both studies suggest that evidence-based training can translate theoretical knowledge into improved clinical performance (12).

The findings are also supported by **Perumal et al. (2022)**, who conducted an interventional study evaluating nurses' knowledge, skills, and compliance related to CLABSI prevention. Following training, the proportion of nurses meeting recommended criteria increased for several central-line care procedures; for example, compliance with dressing change criteria reached **87.50%**, while needleless-adaptor change compliance reached **83.75%**, with post-training performance improving to approximately **86%** for the latter measure. These findings are comparable with the present post-intervention practice score of **86.41%**, suggesting that structured competency-based education can produce clinically meaningful improvements in central-line care (16).

A quality-improvement study by **Hugo et al. (2022)** further demonstrated that nurse-led observation and feedback can improve central-line maintenance bundle compliance. Following implementation of nursing-led rounds and repeated improvement cycles, maintenance bundle compliance increased to a **current centerline value of 87.1%**, while the CLABSI standardized infection ratio decreased from **0.90 to 0.53**. The post-intervention compliance reported in that study is remarkably close to the **86.41%** practice score observed in the present study, strengthening the evidence that active nursing involvement, observation, and reinforcement can improve central-line prevention practices (17).

In another quality-improvement study, nurse-led central-line observations, competency sign-off, real-time coaching, and a visual management system increased documentation compliance for selected maintenance-bundle components. Compliance with cap-change documentation increased by 110%, while IV tubing-labeling compliance increased by 37.5%. During the intervention period, CLABSI occurrences decreased by 83% compared with baseline. These findings complement the present study by demonstrating that practice improvement is enhanced when education is accompanied by direct observation and real-time feedback (18).

Overall, the present study demonstrated statistically significant improvement in both **knowledge and clinical practice** following the nurse-led educational intervention. Knowledge increased from 16.84 ± 4.21 to 25.91 ± 2.67 , while practice increased from $61.72 \pm 9.35\%$ to $86.41 \pm 6.72\%$, with both outcomes demonstrating $p < 0.001$. The findings are consistent with recent evidence showing that structured education, competency-based training, evidence-based catheter-care teaching, nurse-led observation, and real-time feedback can improve nurses' knowledge and clinical compliance related to central-line infection prevention (11–21). However, the literature also indicates that education alone may not always be sufficient to sustain optimal practice. **Matlab et al. (2022)** found a significant relationship between nurses' knowledge and compliance with the CVC maintenance bundle, while compliance also varied according to hospital and nurse-to-patient ratio. This suggests that organizational factors and workload may influence the extent to which improved knowledge is translated into consistent clinical practice (19). Therefore, the improvement observed in the present study may be attributed not only to the acquisition of theoretical knowledge but also to the structured and practice-oriented nature of the intervention. The findings support the integration of **regular refresher education, competency assessment, direct observation, audit and feedback, and reinforcement of CLABSI-prevention bundles** into routine nursing practice.

Conclusion

The study concluded that the nurse-led educational intervention was effective in significantly improving nurses' **knowledge and clinical practice regarding CLABSI prevention**. Both knowledge and practice scores demonstrated substantial improvement following the intervention ($p < 0.001$). These findings support the implementation of structured, evidence-based educational programmes, regular competency assessments, and continuous reinforcement of CLABSI-prevention practices in clinical settings.

Recommendations

Based on the findings of the study, the following recommendations are proposed:

Regular CLABSI prevention training should be conducted for nurses to maintain and improve knowledge and clinical practice.

Periodic competency assessments should be implemented to evaluate nurses' adherence to evidence-based central line care practices.

Standardized CLABSI prevention protocols and checklists should be consistently available and followed in clinical areas.

Regular monitoring and nursing audits should be conducted to identify gaps in central line care and provide timely feedback.

Refresher educational sessions should be arranged at regular intervals to reinforce correct central line insertion and maintenance practices.

Healthcare institutions should promote **continuous infection prevention education and multidisciplinary collaboration** to reduce the risk of CLABSI.

Future researchers should conduct **larger studies with longer follow-up periods** to evaluate the long-term effectiveness of educational interventions on CLABSI rates.

References

- Centers for Disease Control and Prevention. Central line-associated bloodstream infections: HAI progress report, 2024 data. Atlanta: CDC; 2025.
- World Health Organization. Guidelines for the prevention of bloodstream infections and other infections associated with the use of intravascular catheters: Part 2: Central venous catheters. Geneva: WHO; 2026.
- Centers for Disease Control and Prevention. Core infection prevention and control practices for safe healthcare delivery in all settings. Atlanta: CDC; 2024.
- Badparva M, et al. Prevention of central line-associated bloodstream infections: ICU nurses' knowledge and barriers. *Nurs Crit Care*. 2023.
- Effects of organizational and individual factors on nurses' practice of central line-associated bloodstream infection prevention. *Am J Infect Control*. 2024;52(4):443-449. doi:10.1016/j.ajic.2023.11.007.
- Kaewborworn T, Sanasuttipun W, Danaidutsadeekul S. The effects of a prevention program for central line-associated bloodstream infection on nurses' knowledge and practice, and infection rate in pediatric intensive care units. *Nurs Sci J Thailand*. 2023.
- Reducing central line-associated bloodstream infection with a dedicated CLABSI prevention registered nurse role. *Am J Infect Control*. 2024;52(6):659-663. doi:10.1016/j.ajic.2023.11.021.
- Hoke LM, et al. Reducing central line-associated bloodstream infections with a multipronged nurse-driven approach. *Crit Care Nurse*. 2024;44(4):27-36. doi:10.4037/ccn2024493.
- Farooq R, Batool S, Tasneem SS, Jabeen R. Assessment of knowledge among nurses regarding central line association bloodstream infection. *Biol Clin Sci Res J*. 2024. doi:10.54112/bcsrj.v2024i1.1275. (
- Gaur A, Natha H. Evaluating the efficacy of a programme to educate nurses on CLABSI linked to total parenteral nutrition administration. *British Journal of Nursing*. 2023;32(21).
- Alzoubi M, et al. Impact of an educational intervention on knowledge and attitudes regarding prevention of central line infection among ICU nurses. *Nursing in Critical Care*. 2025;30(4):e70087. doi:10.1111/nicc.70087.
- İskender N, Karadeniz H. The effect of central venous catheter care training following evidence-based guidelines on nurses' knowledge levels and care practices. *Journal of Evaluation in Clinical Practice*. 2025;31(1):e70037. doi:10.1111/jep.70037.
- Notshe T, ten Ham-Baloyi W, James S. Improving critical care nurses' knowledge of central venous catheter management through education. *Health SA Gesondheid*. 2025;30:e2966. doi:10.4102/hsag.v30i0.2966.
- William M, Arshad H, Ghafoor M, et al. Effectiveness of educational intervention on nurses' knowledge regarding central line-associated bloodstream infection prevention. *International Journal of Social Sciences Bulletin*. 2025;3(9):681-687.
- Farooq R, Batool S, Tasneem SS, Jabeen R. Assessment of knowledge among nurses regarding central line association blood stream infection. *Biological and Clinical Sciences Research Journal*. 2024;2024(1):1275. doi:10.54112/bcsrj.v2024i1.1275.
- Perumal V, Alheraish YA, Shahzad M, et al. Knowledge, skills, and compliance of nurses related to central line-associated bloodstream infection in the Cardiovascular Department at King Faisal Hospital and Research Centre, Riyadh. *Cureus*. 2022;14(10):e30597. doi:10.7759/cureus.30597.
- Hugo MC, Rzucidlo RR, Weisert LM, Parakati I, Schroeder SK. A quality improvement initiative to increase central line maintenance bundle compliance

- through nursing-led rounds. *Pediatric Quality & Safety*. 2022;7(1):e515. doi:10.1097/pq9.0000000000000515.
- Increasing compliance with the central line maintenance bundle via nurse-led observations. American Journal of Infection Control*. 2023.
- Matlab AA, Al-Hussami MO, Albqoor MA. Knowledge and compliance to prevention of central line-associated blood stream infections among registered nurses in Jordan. *Journal of Infection Prevention*. 2022;23(4):133–141. doi:10.1177/17571774211066778.