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Original Research Article

A Comparative Assessment of Educational Deficits and Compliance Issues Affecting CVAD Practices among ICU Nurses in Tertiary Hospital in Eastern Province at KSA

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Abstract

Background: Central venous access devices (CVADs) are essential in intensive care settings for the administration of medications, fluids, parenteral nutrition, and hemodynamic monitoring. However, safe CVAD care depends on nurses' knowledge and adherence to evidence-based practices. Educational deficits and gaps in clinical compliance may increase the risk of CVAD-related complications and infections. ***Aim:*** This study aimed to assess intensive care unit (ICU) nurses' knowledge of evidence-based CVAD care and their adherence to recommended CVAD care and maintenance practices. ***Methods:*** A descriptive cross-sectional study was conducted among 120 registered nurses who provided direct care to patients with CVADs in intensive care units at a tertiary hospital in the Eastern Province of the Kingdom of Saudi Arabia. Participants were selected using a convenient sampling. Data were collected using a demographic questionnaire, a 10-item knowledge questionnaire, and a 16-item CVAD practice observation checklist covering four domains: hand hygiene and aseptic technique, catheter site and dressing care, line access and hub care, and tubing, administration set, and line maintenance. Descriptive and inferential statistics were used to analyze the data. ***Results:*** The mean age of participants was 32.95 ± 7.69 years, and 91.7% were female. The mean knowledge score was 6.5 ± 1.7/10 (65%), indicating satisfactory knowledge based on the ≥60% interpretive criterion. Knowledge gaps were particularly identified regarding antimicrobial ointment use (16.7% correct), administration-set replacement intervals (36.7%), and replacement of pressure transducers and tubing (42.5%). Bedside practice demonstrated high compliance with several practices, including avoidance of unnecessary line access (100%), appropriate dressing selection (99.2%), dressing changes according to protocol (98.3%), and hub disinfection before access (95.0%). However, compliance was lower for recommended hub scrub and drying time (35.8%), hand hygiene after CVC manipulation (55.8%), maintenance of a clean, dry, and intact dressing (69.2%), and tubing changes according to protocol (68.6%). No statistically significant differences in knowledge scores were identified according to recent CVAD-specific training ($p = 0.750$) or nursing experience ($p = 0.968$). ***Conclusion:*** The findings demonstrate moderate knowledge and variable adherence to evidence-based CVAD care and maintenance practices among ICU nurses. Specific gaps were identified in both knowledge and bedside practice, particularly in time-dependent and procedural aspects of CVAD care. The findings support the need for targeted competency-based education, regular practice observation, compliance monitoring, feedback, and ongoing competency validation to strengthen adherence to evidence-based CVAD practices.

Keywords: Central venous access device; CVAD; intensive care unit; ICU nurses; nursing knowledge; compliance; catheter care; clinical practice; CLABSI prevention.

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INTRODUCTION

Central venous access devices (CVADs) are essential tools in critical care settings for administering medications, fluids, parenteral nutrition, and hemodynamic monitoring. However, the safe and effective use of CVADs depends heavily on nurses' knowledge, technical skills, and adherence to evidence-based practice guidelines (Al Qadire & Hani, 2022; Chi *et al*., 2020; Labeau *et al*., 2009). In intensive care units (ICUs), where patient acuity is high and invasive devices are commonly used, deficiencies in nurses' knowledge and inconsistent adherence to recommended protocols remain important concerns in CVAD care (Al Qadire & Hani, 2022; Chi *et al*., 2020; Labeau *et al*., 2009).

Importantly, the study identified educational level and formal training through infection control units as significant predictors of higher knowledge scores. These findings suggest that structured education and institutional support play a critical role in strengthening nurses' competency in CVAD infection prevention. However, the presence of persistent knowledge gaps indicates that current educational approaches may not sufficiently translate theoretical knowledge into consistent clinical compliance. This has direct implications for ICU practice in Saudi tertiary hospitals, where high patient acuity and frequent CVAD use increase the risk of adverse outcomes. Another descriptive study was conducted across three tertiary hospitals affiliated with the Egypt Health Care Authority where a descriptive study conducted to evaluate nurses' knowledge and practice regarding central venous lines (CVL), The study utilized a convenience sample of 65 ICU nurses and employed both a structured knowledge questionnaire and an observational practice checklist. The findings revealed substantial educational and practice deficiencies, with 80% of nurses demonstrating unsatisfactory knowledge and 73.8% exhibiting inadequate CVL care practices. Importantly, a strong positive correlation was identified between nurses' knowledge and their observed practices ($r = 0.840$, $p < .001$), emphasizing the critical link between education and clinical compliance.

These findings suggest that inadequate educational preparation may contribute to suboptimal adherence to CVAD care standards. Despite the majority of nurses having attended infection control training, gaps persisted in both theoretical understanding and practical application. This suggests that traditional training approaches may be insufficient unless reinforced through continuous competency assessment, structured supervision, and practice-based education (Azem *et al*.,2025).

From a compliance perspective, the study by Azem *et al.,* (2025) underscores that nonadherence to CVL care guidelines is not solely a behavioural issue but is strongly rooted in educational deficits. Observational findings indicated poor compliance with critical components such as dressing care, hand hygiene, and infection prevention measures. These deficiencies are particularly concerning in ICU settings, where patients are highly vulnerable to catheter-related infections and associated morbidity and mortality.

Although this study was conducted in Egypt, its findings are highly relevant to ICU settings in tertiary hospitals within the Eastern Province of Saudi Arabia. Both contexts share similarities in high patient acuity, heavy nursing workloads, and reliance on multinational nursing staff with varied educational backgrounds.

Building on regional evidence from Saudi Arabia and Egypt, where cross-sectional studies have documented gaps between nurses' knowledge and their reported practices in central venous catheter care, researchers in China extended this line of inquiry to a broader international context.

In China, Chi *et al.,* (2020) examined intensive care unit (ICU) nurses' knowledge, attitudes, and practices regarding the prevention of central line-associated bloodstream infections (CLABSIs). The study involved nurses from multiple tertiary hospitals, enhancing the representativeness of ICU settings. Data were collected using a structured, self-administered questionnaire grounded in international evidence-based guidelines, assessing theoretical knowledge, attitudes toward infection prevention, and self-reported adherence to recommended central line care practices. The questionnaire surveys used in this study indicate that there is a fundamental gap between knowledge and practice in the care of central venous catheter (CVC) and prevention of CLABSIs by ICU nurses in China. Although guidelines have fully explained to ICU nurses the result, indicate that Chinese ICU nurses have only modest understanding of basic guidelines needed in preventing CLABSI.

Labeau *et al.,* (2008) developed and validated a structured questionnaire designed to assess critical care nurses' knowledge of evidence-based guidelines for preventing infections associated with central venous catheters (CVCs). The study was conducted in response to evidence suggesting that poor adherence to infection-prevention guidelines may be partly attributed to nurses' inadequate knowledge of recommended practices.

The questionnaire was developed based on the Centres for Disease Control and Prevention (CDC) guidelines for the prevention of intravascular catheter-related infections. Ten key nursing-related prevention strategies were identified, including catheter replacement frequency, dressing management, use of chlorhexidine for site disinfection, administration set replacement, and avoidance of antibiotic ointments. Each strategy was assessed using a multiple-choice question with four response options, including an "I do not know" option to reduce guessing.

The results revealed significant knowledge gaps and widespread misconceptions among ICU nurses, particularly regarding the use of antiseptic-coated catheters, appropriate dressing types, and correct chlorhexidine formulations for insertion-site disinfection. While nurses generally recognized that antibiotic ointments should not be used, many misunderstood the rationale behind this recommendation.

The authors concluded that the questionnaire is a reliable and valid instrument for assessing nurses' knowledge of evidence-based CVC infection-prevention strategies. They emphasized its usefulness in identifying educational needs, evaluating the effectiveness of training programs, and supporting quality improvement initiatives aimed at reducing central line–associated bloodstream infections (Labeau *et al*., 2008).

In conclusion, patient safety requires both nursing compliance with established protocols and adequate knowledge and skills. However, when nurses fail to follow safety practices, it is often unclear whether the cause is a compliance problem (nurses know what to do but choose not to or are influenced by workload and culture) or an educational gap (nurses lack the knowledge, skills, or confidence to perform correctly).

Without distinguishing between these two causes, hospitals risk applying the wrong interventions investing in repeated education where accountability is needed, or enforcing compliance when the actual problem is insufficient training. Both missteps can waste resources and fail to improve patient outcomes.

Therefore, assessing both nurses' knowledge and observed adherence to CVAD care practices may help identify specific gaps between knowledge and clinical practice that require targeted intervention.

This study aimed to assess intensive care unit (ICU) nurses' knowledge of evidence-based CVAD care and their adherence to recommended CVAD care and maintenance practices.

METHODOLOGY

Study Design

This descriptive cross-sectional study was conducted to assess knowledge and practice compliance related to central venous access device (CVAD) care and maintenance practices among nurses working in intensive care units (ICUs).

Study Setting

This study was conducted at King Fahad Specialist Hospital, a tertiary referral hospital located in the Eastern Province of the Kingdom of Saudi Arabia. The hospital provides comprehensive adult and pediatric critical care services and manages patients requiring short and long-term central venous access devices.

Study Population and Sampling

The study population consisted of registered nurses working in intensive care units who were directly involved in assisting physicians during insertion, maintenance, medication administration, and routine care of patients with central venous access devices.

A convenient sampling technique both for researchers and participants were used to recruit eligible nurses during the study period. In addition to nurses working in the Adult Intensive Care Unit (AICU), Cardiac Care Unit (CCU) and Pediatric Intensive Care Unit (PICU) were also eligible to participate because they rotated through the AICU as part of their clinical assignments. Nurses were invited to participate if they met the predefined inclusion criteria. The final study sample consisted of 120 nurses working in the participating intensive care units.

Inclusion Criteria

Inclusion criteria comprised registered nurses with more than six months of clinical experience in the intensive care units at King Fahad Specialist Hospital–Dammam (KFSH-D) who agreed to participate in the study and provided direct care to patients with central venous access devices.

Exclusion Criteria

The exclusion criteria included nursing interns and student nurses, newly appointed nurses with less than six months of intensive care unit experience, and nurses who declined to participate.

Study Instruments

Data were collected using two structured instruments developed from current international evidence-based recommendations for central venous access device care.

Part I: Demographic Questionnaire

Demographic information included age, gender, highest educational qualification, nursing position/ level, years of nursing experience, and recent training related to CVAD care and maintenance

Part II: Knowledge Questionnaire

Knowledge regarding evidence-based CVAD care and maintenance was assessed using a structured questionnaire consisting of ten multiple-choice questions. Each question included four response options with only one correct answer.

The questionnaire evaluated nurses' knowledge in several evidence-based practice areas, including guidewire exchange, catheter replacement, pressure transducer replacement, antiseptic skin preparation, dressing management, administration set replacement, antimicrobial catheter use, topical antimicrobial ointments, and prevention of catheter-related bloodstream infections.

Knowledge scoring and interpretation**:** Each correct response was assigned one point and each incorrect response was assigned zero points, resulting in a total possible score of 0 to 10. For interpretation of the overall knowledge score, the criterion reported by Azem *et al.,* (2025) was used as an interpretive reference, whereby a score of ≥60% was considered satisfactory knowledge and a score <60% was considered unsatisfactory knowledge.

Part III: CVAD Practice Observation Checklist

Compliance with CVAD care practices was evaluated using a structured observational checklist completed during routine nursing practice.

The checklist consisted of 16 evidence-based practice indicators grouped into four main domains: 1) Hand hygiene and aseptic technique; 2) catheter site assessment and dressing care; 3) line access, hub, and injection port disinfection; and 4) tubing, administration set, and line maintenance.

Each observational item was rated as "Met," "Not met," or "Not Applicable" according to predefined evidence-based criteria. Direct observation enabled objective assessment of nurses' adherence to recommend CVAD maintenance practices while minimizing self-report bias.

For the CVAD practice observations, each checklist item was coded as compliant ("Met") or non-compliant ("Not met"). Observations recorded as "Not Applicable" were excluded from the denominator for the corresponding item. Item specific compliance was summarized using frequencies and percentages. An overall CVAD practice compliance score was calculated by summing the number of checklist items rated as "Met," with a possible score ranging from 0 to 16. For interpretation of the overall practice compliance score, the criterion reported by Azem *et al.,*(2025) was used as an interpretive reference, whereby a score of ≥75% was considered satisfactory practice and a score <75% was considered unsatisfactory practice.

Instrument Validity and Reliability

The knowledge assessment questionnaire used in this study was adopted, with permission, from the validated instrument developed by Labeau *et al.,* (2008). The 10-item multiple-choice version used in the present study corresponds to the questionnaire applied by Labeau *et al.,* (2009) to assess ICU nurses' knowledge of ten recommendations for preventing central venous catheter-related infection based on the Centers for Disease Control and Prevention (CDC) guidelines. Each item had four response options, with one correct answer; one point was awarded for each correct answer, giving a total possible score of 0–10. The instrument had previously demonstrated face and content validity and reliability (Labeau *et al*., 2008).

The observational checklist used to assess nurses' compliance with CVAD care and maintenance practices was adapted from the central venous catheter maintenance bundle adherence checklist described by Quadros *et al.,* (2022) and modified to align with the hospital's clinical practice bundles. The modified checklist was reviewed by five researchers with relevant clinical and/or research expertise to assess the relevance and appropriateness of the items and their alignment with local clinical practice. Following the expert review, the checklist was considered appropriate for use in the current study. As the checklist was adapted and modified for the current study, formal psychometric testing of the modified checklist was not conducted

Data Collection Procedure

Following ethical approval, eligible ICU nurses were approached by convenient technique during their clinical duties to invite them to participate in the study.

The researchers explained the study purpose and procedures to participants using the study information sheet. After obtaining informed consent, participants completed the demographic questionnaire and knowledge assessment.

To maintain strict confidentiality, each nurse was assigned a unique identification code, which was used instead of the participant's name on the study forms. The same code was used on the CVAD practice observation checklist to link the observation data with the corresponding participant for follow-up purposes.

Clinical compliance with CVAD care and maintenance practices was assessed through direct observation using the standardized observational checklist. Observations were conducted during routine patient care without interfering with clinical practice. All collected data were coded and stored securely to ensure confidentiality. No personal identifiers were recorded on the study questionnaires or observation forms. Consent form, information sheet, and compliance skills checklists were kept in a sealed envelope with the principal investigator.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board prior to commencement of the study. Permission to conduct the study was also obtained from the hospital administration and the relevant nursing leadership.

Participation was entirely voluntary. Written informed consent was obtained from all participants before enrolment. Participants were informed of the study objectives, confidentiality measures, their right to withdraw at any stage without penalty, and that participation would not affect their employment or professional evaluation. Identity codes were used to keep

confidentiality throughout the study and securely storing all research data.

Statistical Analysis

Data were analyzed using descriptive and inferential statistical methods. Quantitative variables were summarized using means and standard deviations (SD) when approximately normally distributed, while categorical variables were summarized using frequencies and percentages.

The total knowledge score was calculated by assigning one point to each correct response and zero points to each incorrect response, resulting in a possible score ranging from 0 to 10. The distribution of the total knowledge score was assessed using graphical methods and the Shapiro–Wilk test. For approximately normally distributed scores, the mean and SD were reported. For the CVAD practice observations, each checklist item was coded as compliant ("Met") or non-compliant ("Not met"). Observations recorded as "Not Applicable" were excluded from the denominator for the corresponding item. Item-specific compliance was summarized using frequencies and percentages. An overall CVAD practice compliance score was calculated by summing the number of checklist items rated as "Met," with a possible score ranging from zero to 16.

Differences in total knowledge scores according to recent CVAD-specific training were assessed using an independent-samples t-test, while differences according to nursing experience categories were assessed using one-way analysis of variance (ANOVA). Statistical significance was assessed using a two-sided p-value <0.05. All analyses were performed using IBM SPSS Statistics, version 28.0 (IBM Corp., Armonk, NY, USA).

RESULTS

All 120 registered nurses caring for patients with central venous access devices (CVADs) completed the study instruments. All submitted questionnaires and observation checklists were complete and were included in the final analysis. Participant demographic characteristics, baseline knowledge of CVAD care and maintenance, and bedside skills compliance are presented in Tables 1 through 3.

Participant Characteristics

The mean age of participants was 32.95 ± 7.69 years. The sample was predominantly female (91.7%, n = 110), with male nurses comprising 8.3% (n = 10) of the cohort. Regarding educational preparation, the majority held a bachelor's degree (93.3%, n = 112), while a smaller proportion held a diploma (4.2%, n = 5) or a master's degree (2.5%, n = 3). All participants (100%, n = 120) were classified at the Staff Nurse I (SN1) level; no participants were categorized as PTAP nurses, nurse interns, or diploma trainees.

Working experience varied across the sample: 43.3% (n = 52) had less than five years of experience, 29.2% (n = 35) had five to ten years, 11.7% (n = 14) had ten to fifteen years, and 15.8% (n = 19) had more than fifteen years of nursing experience. With respect to recent CVAD-specific training, 66.4% (n = 79) of the 119 participants who provided this information had received training within the preceding year, whereas 33.6% (n = 40) had last been trained more than one year prior to data collection (Table 1).

Table 1: Participant Demographic Characteristics (N = 120)

Variable	Result
Age (years), mean ± SD	32.95 ± 7.69
Gender	
Male	10 (8.3)
Female	110 (91.7)
Education level	
Diploma	5 (4.2)
Bachelor's degree	112 (93.3)
Master's degree	3 (2.5)
Nursing level	
SN1	120 (100)
PTAP	0 (0)
Nurse Intern	0 (0)
Diploma Trainee	0 (0)
Working experience	
Less than 5 years	52 (43.3)
5 to 10 years	35 (29.2)
10 to 15 years	14 (11.7)
More than 15 years	19 (15.8)
Recent CVAD care and maintenance training (n=119)	
Less than one year	79 (66.4)
More than one year	40 (33.6)

Values are expressed as mean ± SD or n (%).

Knowledge of CVAD Care and Maintenance

Knowledge of evidence-based CVAD care and maintenance practices was variable across the ten items assessed (Table 2). Correct-response rates were highest for items addressing disinfection of the catheter insertion site (93.3%, n = 112) and replacement of the administration set following parenteral or lipid emulsion infusion (93.3%, n = 112), followed by the recommended dressing-changing interval (92.5%, n = 111) and the appropriate method of covering the catheter site (68.3%, n = 82).

Notable knowledge gaps were identified for several items. Only 16.7% (n = 20) of participants correctly identified that antimicrobial ointment should not be routinely applied to CVC insertion sites, indicating a widespread misconception on this point. Similarly, only 36.7% (n = 44) correctly identified the recommended interval for replacing administration sets used continuously for fluids other than lipid emulsions or blood products, and only 42.5% (n = 51) correctly identified recommendations regarding routine replacement of pressure transducers and tubing. Knowledge of guidewire exchange and routine CVC replacement practices was each answered correctly by 54.2% (n = 65) of participants.

The overall mean total knowledge score was 6.5 ± 1.7 out of 10 (65%) (Table 2.1). Using the ≥60% satisfactory-knowledge criterion reported by Azem *et al.,* (2025) as an interpretive reference, the mean score falls within the satisfactory knowledge category, although considerable item-level variability was observed, particularly regarding catheter and administration-set replacement intervals.

Comparative analyses demonstrated no statistically significant differences in knowledge scores according to recent CVAD-specific training (p = 0.750) or nursing experience (p = 0.968).

Table 2: Knowledge of CVAD Care and Maintenance (N = 120)

Knowledge item	Correct response, n (%)	Incorrect response, n (%)
Central venous catheters (CVCs) are routinely replaced	65 (54.2)	55 (45.8)
It is recommended to replace CVCs over a guidewire	110 (91.7)	10 (8.3)
It is recommended to replace pressure transducers and tubing routinely	51 (42.5)	69 (57.5)
Once a comprehensive strategy to reduce CLABSI rate is not effective, it is recommended to use a CVC coated or impregnated with an antimicrobial agent	74 (61.7)	46 (38.3)
Dressing-changing interval at the catheter insertion site	111 (92.5)	9 (7.5)
The recommended way to cover the catheter site	82 (68.3)	38 (31.7)
It is recommended to disinfect the catheter insertion site with	112 (93.3)	8 (6.7)
It is recommended to apply antimicrobial ointment to CVC insertion sites	20 (16.7)	100 (83.3)
When parenteral or lipid emulsions are administered through a CVC, the administration set should be replaced	112 (93.3)	8 (6.7)
When administration sets are used continuously for fluids other than lipid emulsions or blood products, it is recommended to replace the set within	44 (36.7)	76 (63.3)

Values are expressed as n (%).

Table 2.1: Overall, Knowledge Score of Participants

Variable	Score, mean (SD)
Total knowledge score	6.5 (1.7)

Values are expressed as mean (SD).

Bedside Skills Compliance

Direct observation of bedside practice across four domains; hand hygiene and aseptic technique, catheter site and dressing care, line access and hub care, and tubing/administration set maintenance revealed generally high compliance for several core infection prevention behaviours, alongside specific, actionable gaps (Table 3).

The mean overall CVAD practice compliance score was 13.2 ± 1.7 out of 16, equivalent to 82.5%. Using the ≥75% criterion reported by Azem *et al.,* (2025) as an interpretive reference, the mean score falls within the satisfactory practice category.

In Domain 1 (Hand Hygiene and Aseptic Technique), compliance was highest for appropriate use of clean or sterile gloves (95.0%, n = 114) and aseptic technique maintained throughout the procedure (71.7%, n = 86). Hand hygiene performed before CVC manipulation was met in 69.2% (n = 83) of observations; compliance was notably lower for hand hygiene performed after CVC manipulation, met in only 55.8% (n = 67) of observations.

In Domain 2 (Catheter Site and Dressing Care), compliance was consistently high: dressing type was appropriate to the clinical indication in 99.2% (n = 119) of observations, dressings were changed according to protocol or when soiled or loose in 98.3% (n = 118), and the catheter insertion site was inspected for signs of

infection in 88.3% (n = 106). Compliance was comparatively lower for maintaining a dressing that was clean, dry, and intact, met in 69.2% (n = 83) of observations.

In Domain 3 (Line Access, Hub, and Injection Port Care), unnecessary line access was avoided in 100% (n = 120) of observations, and disinfection of the hub or injection port before access (95.0%, n = 114) and use of the correct disinfectant (95.8%, n = 115) were both met with high frequency. However, adherence to the recommended scrub and drying time before access was met in only 35.8% (n = 43) of observations, representing the single lowest compliance rate observed across all four domains.

In Domain 4 (Tubing, Administration Sets, and Line Maintenance), central line necessity was reviewed or documented in 96.7% (n = 116) of observations, and the lumen was capped appropriately when not in use in 97.3% (n = 110) of applicable observations. IV tubing was labelled with date and time in 80.5% (n = 95) of observations, and tubing was changed according to protocol in 68.6% (n = 81).

Taken together, the skills compliance data indicate that structural and procedural safeguards including glove use, dressing selection, avoidance of unnecessary access, and documentation of line necessity were well embedded in bedside practice, whereas time-dependent and second-step behaviors, particularly post-manipulation hand hygiene and adherence to hub scrub/drying time, emerged as priority targets for practice improvement.

Table 3: Bedside Skills Compliance of CVAD Care and Maintenance (N = 120)

Domain 1: Hand Hygiene and Aseptic Technique			
Skills compliance item	**Met, n (%)**	**Not met, n (%)**	**Not applicable, n**
Hand hygiene performed before CVC manipulation	83 (69.2)	37 (30.8)	0
Hand hygiene performed after CVC manipulation	67 (55.8)	53 (44.2)	0
Appropriate use of clean/sterile gloves	114 (95.0)	6 (5.0)	0
Aseptic technique maintained throughout	86 (71.7)	34 (28.3)	0
Domain 2: Catheter Site and Dressing Care			
Skills compliance item	**Met, n (%)**	**Not met, n (%)**	**Not applicable, n**
Dressing is clean, dry, and intact	83 (69.2)	37 (30.8)	0
Dressing type appropriate (transparent/gauze as indicated)	119 (99.2)	1 (0.8)	0
Dressing changed according to protocol or when soiled/loose	118 (98.3)	2 (1.7)	0
Catheter insertion site inspected for signs of infection	106 (88.3)	14 (11.7)	0
Domain 3: Line Access, Hub, and Injection Port Care			
Skills compliance item	**Met, n (%)**	**Not met, n (%)**	**Not applicable, n**
Disinfection of hub/injection port before access	114 (95.0)	6 (5.0)	0
Correct disinfectant used (e.g., alcohol / CHG-alcohol)	115 (95.8)	5 (4.2)	0
Scrub time and drying time respected	43 (35.8)	77 (64.2)	0
Unnecessary line access avoided	120 (100)	0 (0)	0
Domain 4: Tubing, Administration Sets, and Line Maintenance			
Skills compliance item	**Met, n (%)**	**Not met, n (%)**	**Not applicable, n (%)**
IV tubing labelled with date/time	95 (80.5)	23 (19.5)	2
Tubing changed according to protocol	81 (68.6)	37 (31.4)	2
Lumen capped appropriately when not in use	110 (97.3)	3 (2.7)	7
Central line necessity reviewed/documented	116 (96.7)	4 (3.3)	0

Values are expressed as n (%).

Table 3.1: Overall Bedside Skills Compliance of CVAD Score (N = 120)

Variable	**Score, mean (SD)**
Total compliance score	13.2 (1.7)

Values are expressed as mean (SD).

DISCUSSION

The present study found that nurses demonstrated a satisfactory overall level of knowledge regarding evidence-based CVAD care and maintenance practices, with a mean knowledge score of 6.5 ± 1.7 out of 10 (65%). Based on the ≥60% criterion reported by Azem *et al.,* (2025), this score falls within the satisfactory knowledge category. Nevertheless, substantial item-level knowledge gaps were identified in several specific areas of CVAD care.

However, knowledge varied considerably across the individual practices assessed. Participants demonstrated particularly strong knowledge regarding disinfection of the catheter insertion site, replacement of administration sets following parenteral or lipid

emulsion infusion, and the recommended dressing-changing interval. In contrast, substantial knowledge gaps were identified in relation to antimicrobial ointment use, administration-set replacement intervals for continuous infusions, replacement of pressure transducers and tubing, and catheter replacement practices. These findings suggest that although nurses were familiar with several fundamental aspects of CVAD care, knowledge was less consistent for practices involving specific replacement intervals and catheter-management recommendations.

This pattern is consistent with the findings of Alshammari *et al.,* (2025), who reported notable knowledge deficits among critical care nurses in relation to the prevention of central venous catheter-related infections, despite relatively higher knowledge in procedural areas such as dressing changes and catheter site selection. The present findings are also comparable with those reported by Sham *et al.,* (2023) in Malaysia, who assessed 203 critical care nurses across seven critical care units in a teaching hospital. Their study reported a mean knowledge score of 5.85 ± 1.29 across 11 questions related to evidence-based CLABSI prevention, with none of the participants answering all knowledge questions correctly. The similarity between these findings suggests that nurses may have stronger knowledge of familiar, routine CVAD care procedures while experiencing greater difficulty with specific evidence-based recommendations and less frequently encountered maintenance practices.

Nevertheless, Conner *et al* (2023) in their study examined ICU nurses' perceptions and beliefs regarding central line maintenance bundle adherence stated that knowledge does not necessarily translate into consistent bedside practice.

Bedside Skills Compliance

The present study demonstrated satisfactory overall CVAD practice compliance, with a mean score of 13.2 ± 1.7 out of 16 (82.5%). Using the ≥75% criterion reported by Azem *et al.,* (2025) as an interpretive reference, the overall score falls within the satisfactory practice category. However, substantial variation was observed across individual practice items, with particularly low compliance for adherence to hub scrub and drying time (35.8%) and hand hygiene after CVC manipulation (55.8%).

Zhou *et al* (2025) reported in a recent multicentre study involving ICU nurses from 22 hospitals, with 22,000 central-line days. The average adherence to evidence-based CVC maintenance procedures was 87.4%. Importantly, lower-adherence areas included hand hygiene, catheter/insertion-site assessment, and hub disinfection.

Direct observation of bedside practice in the present study demonstrated variable compliance across the four domains assessed, with specific and actionable gaps identified in several core CVAD care and infection-prevention practices. Particularly high compliance was observed for appropriate dressing selection (99.2%), dressing changes according to protocol (98.3%), avoidance of unnecessary line access (100%), and disinfection of the catheter hub or injection port before access (95.0%). These findings indicate that several fundamental CVAD care practices were well established in routine clinical practice. However, compliance was considerably lower for practices requiring adherence to specific procedural steps. Most notably, the recommended scrub and drying time before line access was achieved in only 35.8% of observations, representing the lowest compliance rate across all domains. Hand hygiene after CVC manipulation (55.8%), maintenance of a clean, dry, and intact dressing (69.2%), and tubing changes according to protocol (68.6%) also represented areas requiring improvement.

The relatively high overall compliance observed in the present study contrasts with the findings of Azem *et al.,* (2025), who reported that 73.8% of ICU nurses demonstrated inadequate CVL care practices. Their observational findings identified deficiencies in critical components including hand hygiene, dressing care and infection-prevention measures. The higher compliance observed in the present study may reflect differences in institutional policies, availability and implementation of standardized CVAD protocols; clinical supervision, staff competency, or the local emphasis placed on infection-prevention practices. Nevertheless, the persistence of specific gaps in the present study indicates that high compliance with routine practices does not necessarily translate into consistent adherence to every component of evidence-based CVAD care.

This finding is also supported by Chi *et al.,* (2020), who identified a fundamental gap between knowledge and practice among ICU nurses in China, with nurses demonstrating only modest understanding of essential guidelines for CLABSI prevention despite the availability of established recommendations. Similarly, Labeau *et al.,* (2008) identified significant knowledge gaps and misconceptions among critical care nurses regarding several evidence-based CVC infection-prevention strategies. Together, these findings suggest that the availability of evidence-based guidelines alone may be insufficient to ensure consistent implementation at the bedside. In the present study, the particularly low compliance with the recommended hub scrub and drying time may reflect the difficulty of translating knowledge of a guideline into consistent performance of a time-dependent procedural step.

Importantly, the findings also support the need to distinguish between knowledge gaps and compliance-related barriers when addressing deviations from CVAD standards. A nurse may fail to perform a recommended practice because of insufficient knowledge or skills, or

because of contextual factors such as workload, time pressure, competing clinical priorities, or established unit practices. Therefore, interventions should extend beyond repeated didactic education and incorporate direct observation, competency-based assessment, real-time feedback, clinical supervision, and reinforcement of specific high-risk practices.

CONCLUSION AND CLINICAL IMPLICATIONS

Overall knowledge was satisfactory based on the ≥60% interpretive criterion, although important item specific knowledge gaps and variable bedside compliance were identified.

Overall CVAD practice compliance was satisfactory based on the ≥75% interpretive criterion, although important gaps were identified in specific practices, particularly hub scrub and drying time, hand hygiene after CVC manipulation, maintenance of a clean, dry, and intact dressing, and tubing changes according to protocol.

The findings indicate that education alone may not be sufficient to ensure consistent adherence to evidence-based CVAD care practices. This highlights the need to complement educational interventions with regular practice observation, compliance monitoring, competency validation, feedback, and evidence-based root-cause analysis to identify and address underlying factors contributing to gaps between knowledge and clinical practice.

Therefore, education alone may not be sufficient to ensure consistent adherence to evidence-based CVAD care practices. This highlights the need to complement educational interventions with regular practice observation, compliance monitoring, competency validation, feedback, and evidence-based root-cause analysis to identify and address the underlying factors contributing to gaps between knowledge and clinical practice. Based on the findings, the following recommendations are proposed:

1. Implement regular practice observation and compliance monitoring using a standardized CVAD care checklist to identify specific areas of non-compliance.
2. Develop individualized learning plans for nurses who demonstrate knowledge or practice deficiencies, incorporating targeted education and competency-based training and reassessment according to their identified needs.
3. Strengthen the involvement of unit leadership, including nurse managers, charge nurses, and team leaders, in conducting random monthly compliance audits and providing timely feedback to staff (Bao Hamdan *et al*, 2025). Active collaboration between unit leadership and the Unit-Based Clinical Practice Council is essential to develop a culture of evidence-based root-cause analysis, where identified gaps are systematically investigated to determine their underlying causes and appropriate interventions, rather than relying primarily on general education and training. This approach can support more targeted, sustainable, and practice-focused improvements in CVAD care.
4. Establish a CVAD/CLABSI task force to coordinate monthly monitoring, review audit findings, identify recurring gaps between knowledge and clinical practice, and provide feedback to clinical units. Not all components of CLABSI prevention bundles may be necessary to achieve an effect on CLABSI rates. More data are needed to determine which components of the maintenance bundle are essential in reducing risk (Buetti *et al*, 2022).

Rather than focusing compliance monitoring solely on the hospital-approved CLABSI bundle elements (Buetti *et al*, 2022), it is recommended that each unit develop and routinely use a unit-based CVAD practice assessment checklist incorporating all relevant CVAD care and maintenance practices outlined in KFSH-D policies and procedures. This comprehensive approach would enable more systematic assessment of bedside practice, identification of specific gaps, and targeted interventions to improve adherence to evidence-based CVAD care.

5. Enhance the role of the Unit-Based Clinical Practice Council in monitoring and evaluating improvements in CVAD-related knowledge and bedside practice, rather than focusing solely on CLABSI incidence rates.
6. Incorporate CVAD care practices into peer-to-peer evaluation and ongoing competency monitoring to promote accountability, reinforce evidence-based practice, and sustain improvements in clinical performance.
7. Ensure appropriate nurse patient ratio and limit the use of float nurses in ICUs (Buetti *et al*, 2022)

These strategies may help bridge the gap between knowledge and clinical practice, strengthen adherence to evidence-based CVAD care, and ultimately contribute to improved patient safety and CLABSI prevention.

Study Limitations

This study has some limitations. First, the study was conducted in a single tertiary hospital, which may limit the generalizability of the findings to other hospitals or healthcare settings. Second, although bedside practices were assessed through direct observation after informed consent, the presence of observers may have influenced nurses' behaviour. Third, the cross-sectional design provides a description of nurses' knowledge and

clinical practice at one point in time and does not allow causal relationships to be established.

REFERENCES

- Al Qadire, M., & Hani, A. M. (2022). Nurses' and physicians' knowledge of guidelines for preventing catheter-related blood stream infections. Nursing in Critical Care, 27, 594–601. https://doi.org/10.1111/nicc.12577
- Alshammari, B. S., Alsaqri, S. H., Alkubati, S. A., Llego, J. H., Al-Sadi, A. K., Ali, A. Z., Elsayed, W. A., Balawi, A. M., Nageeb, S. M., & Hamed, L. A. (2025). Critical care nurses' knowledge regarding prevention of central venous catheter-related infection in Saudi Arabia: A cross-sectional study. Belitung Nursing Journal, 11(2), 224–231. https://doi.org/10.33546/bnj.3729
- Azem, A. K. A., Shebl, A. M., & El-Rahman, M. A. (2025). Nurses' knowledge and practice regarding care of central venous line in intensive care units. Port Said Scientific Journal of Nursing, 12(3), 25–44.
- Bou Hamdan, D., Hatahet, S., Khalil, H., & Yousef, K. M. (2025). Strategies to enhance nurses' adherence to central line-associated bloodstream infection prevention bundles in the ICU setting: A systematic review. *Heart & Lung, 71*, 98–105. https://doi.org/10.1016/j.hrtlng.2025.02.009
- 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., Wolf, J., Yokoe, D., & Mermel, L. A. (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
- Chi, X., Guo, J., Niu, X., He, R., Wu, L., & Xu, H. (2020). Prevention of central line-associated bloodstream infections: A survey of ICU nurses' knowledge and practice in China. Antimicrobial Resistance & Infection Control, 9, 186. https://doi.org/10.1186/s13756-020-00833-3
- Connor, L., Zadvinskis, I. M., Roberts, H., & Melnyk, B. M. (2023). Nurses' perceptions of adherence to the central line maintenance bundle: Linkages to thoughts, emotions, and behaviour. *Research in Nursing & Health*.
- Labeau, S., Vereecke, A., Vandijck, D. M., Claes, B., & Blot, S. I. (2008). Critical care nurses' knowledge of evidence-based guidelines for preventing infections associated with central venous catheters: An evaluation questionnaire. American Journal of Critical Care, 17(1), 65–71. https://doi.org/10.4037/ajcc2008.17.1.65
- Labeau, S., Vandijck, D., Rello, J., Adam, S., Rosa, A., Wenisch, C., Bäckman, C., Agbaht, K., Csomos, A., Seha, M., Dimopoulos, G., Vandewoude, K., Blot, S., & EVIDENCE Study Investigators. (2009). Centers for Disease Control and Prevention guidelines for preventing central venous catheter-related infection: Results of a knowledge test among 3405 European intensive care nurses. Critical Care Medicine, 37(1), 320–323. https://doi.org/10.1097/CCM.0b013e3181926489
- Sham, F., Sulaiman, N. H., Seman, A., Shohor, N. A., & Choo, Y. M. (2023). Intensive care nurses' knowledge, practice and attitude in prevention of central line-associated bloodstream infection (CLABSI). *Journal of Health and Translational Medicine, Special Issue 2*, 102–110. https://doi.org/10.22452/jummec.sp2023no2.12
- Quadros, A. I. de, Stocco, J. G. D., Cristoff, C., Alcantara, C. B. de, Pimenta, A. M., & Machado, B. G. S. (2022). Adherence to central venous catheter maintenance bundle in an intensive care unit. *Revista da Escola de Enfermagem da USP, 56*, e20220077. https://doi.org/10.1590/1980-220X-REEUSP-2022-0077en
- Zhou, T., *et al.,*(2025). Evidence-based practice in maintenance of central venous catheters among intensive care unit nurses: A cross-sectional multi-centre study. *Journal of Clinical Nursing*.