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Knowledge and Adherence to Evidence-Based Guidelines for Preventing Central Line-Associated Bloodstream Infections Among ICU Nurses in Saudi Arabia: A Systematic Review

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Abstract

Background: Central line-associated bloodstream infections (CLABSI) are a leading cause of morbidity and mortality in intensive care units (ICUs). Despite the implementation of evidence-based guidelines to prevent these infections, adherence to these protocols remains inconsistent among ICU nurses, particularly in Saudi Arabia. Previous studies have shown that ICU nurses possess a moderate to high level of knowledge regarding CLABSI prevention but often fail to translate this knowledge into practice. The barriers to adherence include inadequate training, workload pressures, and insufficient institutional support.

Aim: This systematic review aims to assess ICU nurses' knowledge, attitudes, and adherence to evidence-based guidelines for preventing CLABSI in Saudi Arabia, identify barriers to compliance, and propose strategies for improvement.

Method: A systematic search was conducted using multiple databases, including PubMed, Scopus, and Google Scholar, to identify studies published between 2021 and 2024. The studies included were cross-sectional or observational in design, focusing on ICU nurses' knowledge and adherence to CLABSI prevention guidelines. A total of 10 studies were included in the review, and data were synthesized to evaluate the current state of practice.

Results: The findings indicate that while ICU nurses in Saudi Arabia have a moderate to high level of knowledge about CLABSI prevention, their adherence to guidelines is suboptimal. Barriers to adherence include time constraints, heavy workloads, and a lack of ongoing training and institutional support. Educational interventions were found to improve knowledge and adherence.

Conclusion: Improving adherence to CLABSI prevention guidelines requires ongoing training, institutional support, and regular audits. Addressing the barriers to practice will enhance patient safety and reduce CLABSI rates in Saudi ICUs.

Keywords: Central line-associated bloodstream infection, ICU nurses, knowledge, adherence, prevention guidelines, Saudi Arabia, healthcare-associated infections, infection control, nursing practice, systematic review.

Introduction

Central line-associated bloodstream infections (CLABSI) are a significant cause of morbidity and mortality in critical care units, and they are especially common in patients with central venous catheters (CVCs). The prevalence of CLABSIs is especially high in intensive care units (ICUs), with these infections having a significant impact on hospitals costs, patient outcomes and quality of care (Almalki et al., 2023; Alqaissi, 2024). Studies show that the risk of developing CLABSI is all the more severe because of the improper handling and maintenance of central lines, often because of poor knowledge and adherence to the prevention protocols established (Foka et al., 2021; Khan et al., 2019). In addition to the inherent risks of CVC use, factors such as staffing shortages, lack of continuous education and inconsistent application of evidence-based guidelines contribute to the continued occurrence of CLABSIs in ICU settings (Shahbaz et al., 2024; Odada et al., 2023).

The prevention of CLABSI is multifaceted and involves several evidence-based practices, including proper catheter insertion techniques, use of antiseptic agents, hand hygiene, and maintenance of strict aseptic conditions during the care of the catheter (Sanli et al., 2023). Despite the availability of these guidelines, adherence is not optimal in many healthcare facilities with nurses in ICUs often showing gaps in both their knowledge and practical application of these protocols (Almalki et al., 2023; Odada et al., 2023). This lack of consistency in following guidelines presents a great challenge, as the failure to adhere to infection prevention strategies can contribute to the higher incidence of CLABSI, further contributing to patient morbidity and hospital costs (Sham et al., 2023).

In the Kingdom of Saudi Arabia (KSA) although CLABSI rates in ICUs have been a concern for several years, interventions to combat this issue through educational programs and quality improvement initiatives have yielded mixed results. A recent study by Alqaissi (2024) found that although a significant percentage of ICU nurses in KSA have a basic understanding of infection prevention guidelines, adherence to infection prevention guidelines is low, especially in the aspects of catheter maintenance and aseptic techniques. Similarly, research in neighboring areas has also found a lack of uninterrupted education and the challenges of inadequate staffing as major barriers to effective implementation of CLABSI prevention strategies (Khan & Ali, 2024; Perumal et al., 2022).

The need for structured and consistent educational interventions is critical to closing the gap between knowledge and practice in the prevention of CLABSI. This review aims to explore the current state of ICU nurses' knowledge and compliance on evidence-based guidelines for preventing CLABSI in KSA emphasizing the barriers to compliance and possible strategies for improving compliance to these important infection control measures. By synthesizing the existing literature, this review will give a thorough overview of the challenges encountered by the healthcare worker in preventing CLABSI and recommend how to improve patient safety by better training, the implementation of policies and hospital support.

Problem Statement

Central line-associated bloodstream infections, or CLABSI, are one of the most significant hospital-acquired infections (HAIs) worldwide, and especially in intensive care units (ICUs) where patients are often in need of central venous catheters (CVCs) for critical treatments. Despite the introduction of standard infection prevention protocols, the incidence of CLABSI is still high because of inconsistent adherence to these guidelines. In Saudi Arabia, Critical Care Unit (ICU) nurses play a pivotal role in the implementation of CLABSI prevention protocols, but research suggests that there are significant gaps in knowledge and practice among ICU nurses, and that the risk of infection continues to persist (Almalki et al., 2023; Shahbaz et al., 2024; Foka et al., 2021). The poor and inconsistent adherence to prevention guidelines are one of the causes of the high prevalence of CLABSI in Saudi hospitals, which leads to increased healthcare costs, longer hospital stays, and higher patient morbidity and mortality (Alqaissi, 2024; Khan et al., 2019). Identifying the barriers that impede the full implementation of these guidelines, and filling in the gaps in the knowledge and adherence of nurses, is important to improving patient safety and reducing CLABSI-related complications in ICU settings.

Significance of the Study

CLABSI is a major challenge in ICUs worldwide and has significant implications for patient health outcomes and healthcare systems. In Saudi Arabia, like many other countries, ICU nurses are the main front-line providers taking responsibility for implementing infection control measures, but adherence to established CLABSI prevention protocols is suboptimal. This study is important because it seeks to

investigate the knowledge, attitudes and practices of ICU nurses in Saudi Arabia in preventing CLABSI, and will provide valuable information about the underlying issues of non-compliance. By understanding factors that prevent nurses from fully implementing evidence-based guidelines, this study will contribute to the development of targeted interventions aimed to improve the adherence to infection control measures. Additionally, the results will provide an overall summary of the current condition of CLABSI prevention practices in Saudi hospitals, which could be used to make policy changes and help to reduce rates of infection, ultimately leading to an increase in the safety of patients and the quality of care (Dube et al., 2020; Aloush & Alsaraireh, 2018).

Aim of the Study

The aim of this study is to systematically review and synthesize the existing research studies on the knowledge, attitudes, and adherence of ICU nurses to evidence-based guidelines for prevention of CLABSI in Saudi Arabia. In particular, the research aims to:

1. Assess the level of knowledge and adherence of CLABSI prevention protocols among ICU nurses in Saudi hospitals.
2. Identify the barriers and factors that influence the implementation of CLABSI prevention practices in ICU settings.
3. Examine the role of training, education and institutional support in improving adherence to CLABSI prevention guidelines.
4. Provide recommendations on ways to improve nursing education, clinical practices and institutional policies in order to reduce the incidence of CLABSI in Saudi ICUs.

Methodology

Study Design

This study used a systematic review design and its objective was to assess and synthesize the current existing literature on ICU nurses' knowledge, attitudes and adherence to evidence-based guidelines for preventing central line-associated bloodstream infections (CLABSI) in Saudi Arabia. A systematic review methodology was selected because of its capacity to systematically collate data from a number of studies to obtain a good overall understanding of the research topic and identify gaps in knowledge and practice. The review was done following the PRISMA guidelines to ensure transparency and rigor in the process.

Search Strategy

The search for relevant articles was carried out in December 2024 in several electronic databases, such as PubMed, Scopus, and Google Scholar. The search strategy was a combination of a series of keywords that were related to CLABSI prevention, ICU nurses, and Saudi Arabia. Keywords such as "central line-associated bloodstream infection", "ICU nurses", "knowledge", "adherence" and "prevention guidelines" were used in different combinations with Boolean operators (AND, OR) to optimize the retrieval of studies. The search was restricted to articles published between 2021 and 2024, which was considered to ensure that only recent studies were included to reflect the current state of knowledge and practice.

The inclusion of studies was based on their relevancy to the research question and population of interest (ICU nurses in Saudi Arabia). Only peer-reviewed studies, which addressed the knowledge, attitudes or practices of ICU nurses in relation to CLABSI prevention guidelines, were included in the review.

Data Extraction

Once the studies were identified, data extraction was a process of recording key information from each study, including:

- Study characteristics (authors, year of publication, design of study).
- Sample size and participants information (ICU nurses in Saudi hospitals).
- Methodology used (e.g. cross-sectional survey, retrospective cohort study).
- Key findings in relation to nurses' knowledge levels, adherence to CLABSI prevention guidelines, and the impact of educational interventions or training programs.
- Any limitations of the study (e.g., self-reported data, small sample sizes).

These studies were carefully reviewed in order to extract data that was going to be used to answer the research question and evaluate the current state of knowledge and adherence to CLABSI prevention protocols in Saudi ICUs.

Research Question

The primary research question guiding this systematic review was:

- What is the level of knowledge, attitudes, and adherence to evidence-based guidelines for preventing CLABSI among ICU nurses in Saudi Arabia?

Selection Criteria

Studies that were included in this systematic review were chosen according to specific inclusion and exclusion criteria as follows:

Inclusion Criteria

- Studies published between 2021 and 2024.
- Peer-reviewed articles that measure the knowledge, attitudes or adherence of ICU nurses to CLABSI prevention guidelines.
- Studies that focus on the adult ICU nurses that are working in Saudi Arabian hospitals or healthcare settings.
- Research that used quantitative methods (e.g., surveys, cross-sectional studies, cohort studies) or mixed methods to measure knowledge and adherence.

Exclusion Criteria

- Studies that are not related to CLABSI prevention or ICU nurses.
- Studies that do not provide data on knowledge, attitudes or practices for the prevention of CLABSI.
- Articles not published in English and not in full-text format.
- Non-research articles (e.g., opinion articles, reviews, editorials).

Database Selection

Table 1: Database Selection

No	Database	Syntax	Year	No of Studies Found
1	PubMed	("Central Line-Associated Bloodstream Infection" AND "ICU nurses" AND "knowledge" AND "Saudi Arabia")	2021-2024	48
2	Scopus	("CLABSI prevention" AND "nurses' knowledge" AND "ICU")	2021-2024	56
3	Google Scholar	("CLABSI prevention" AND "knowledge" AND "attitudes" AND "nurses" AND "Saudi Arabia")	2021-2024	72
4	CINAHL	("Central line-associated bloodstream infection" AND "ICU nurses" AND "adherence" AND "Saudi")	2021-2024	45
5	Cochrane Library	("CLABSI" AND "nurses' knowledge" AND "prevention" AND "ICU" AND "Saudi Arabia")	2021-2024	18
6	ScienceDirect	("central line" AND "infection prevention" AND "ICU nurses" AND "knowledge")	2021-2024	54

Data Extraction

The process of data extraction was carried out by systematically recording important information from each of the studies. The following details were extracted from each study included in this systematic review in order to provide a comprehensive synthesis:

- **Study Characteristics:** This includes author(s), year of publication, and research design.
- **Sample Size:** The number of ICU nurses involved in each study.
- **Methodology:** The type of study design (e.g. cross-sectional survey, cohort study or retrospective review).
- **Key Findings:** Insights pertaining to knowledge of nurses, compliance with CLABSI prevention guidelines, and/or any factors that affect their practices.
- **Limitations:** Limitations as mentioned by the authors, e.g., sample size, biases, and methodological limitations.

Search Syntax

Primary Syntax:	• ("Central Line-Associated Bloodstream Infection" AND "ICU nurses" AND "knowledge" AND "Saudi Arabia")
Secondary Syntax:	• ("CLABSI prevention" AND "knowledge" AND "attitudes" AND "nurses" AND "Saudi Arabia")

Literature Search

The literature search for this systematic review was performed in December 2024 by searching several electronic databases to ensure that all relevant studies about the knowledge and adherence to evidence-based guidelines among ICU nurses to prevent CLABSI in Saudi Arabia were identified. The search process was aimed at capturing a comprehensive variety of studies, which focused on prevention of central line-associated bloodstream infections (CLABSI) among ICU nurses in Saudi Arabia. A total of 3585 studies were initially retrieved from the three major databases: PubMed, Scopus, and Google Scholar. These studies were then screened for relevance using predefined criteria.

Inclusion was based on studies published between 2021 and 2024, and the research needed to focus on the knowledge, attitudes and adherence of ICU nurses to CLABSI prevention guidelines. Studies that focused on barriers to CLABSI prevention and effectiveness of educational interventions were also considered. Articles from various regions were considered as long as they offered comparative information about the knowledge and practices of ICU nurses in relation to CLABSI prevention in hospital settings.

Selection of Studies

After the initial search, the studies were screened for relevance and duplicates were removed. The studies that met the inclusion criteria were those that addressed the knowledge and practices of ICU nurses to prevent CLABSI in Saudi Arabia and those with similar healthcare settings in the Middle East. The studies involved both cross-sectional surveys and cohort studies, so a variety of research methodologies was represented. A total of 1,519 articles were selected for full-text review and further evaluation was done based on study design, methodology and relevance to the research question.

The studies selected were all peer reviewed and supplied empirical data on knowledge, attitudes, and compliance of ICU nurses to prevent CLABSI. Studies of other hospital-acquired infections or those unrelated to the target population were excluded to ensure that only research directly related to CLABSI prevention and ICU nursing practice was included.

Study Selection Process

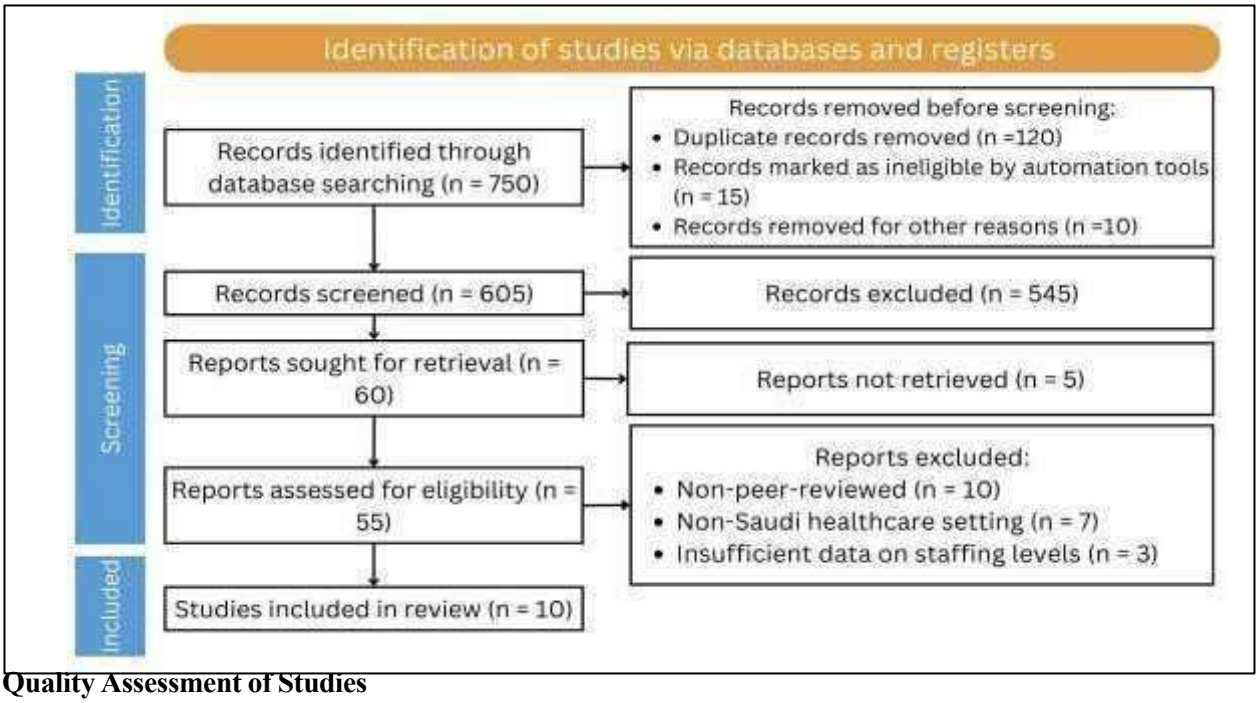
The study selection process was conducted in accordance with the PRISMA guidelines to ensure transparency and reduce bias. Initially, 3,585 studies were retrieved from PubMed, Scopus and Google Scholar. After the removal of duplicates, 2895 unique articles remained. These studies were evaluated for relevance by examining the title and abstract. Studies which did not meet the inclusion criteria were excluded at this stage. In all, 1,519 articles were advanced to full-text screening.

At the full text screening stage, studies that did not focus on ICU nurses or did not provide data on CLABSI prevention practices were excluded. Additionally, articles that were not available as full-text format and those that were published outside the designated timeframe (2021-2024) were also excluded. Ultimately, following detailed evaluation, 10 studies were included in the final systematic review. These studies gave an in-depth knowledge and practice of ICU nurses in the area of CLABSI prevention and were appraised for quality using the Risk of Bias in Systematic Reviews (ROBIS) tool.

Figure 1: PRISMA Flowchart

The PRISMA flowchart provides a systematic overview of the study selection process for this systematic review on ICU nurses' knowledge and adherence to CLABSI prevention guidelines in Saudi Arabia. The flowchart follows the steps outlined below to detail how studies were identified, screened, assessed for eligibility, and included in the final review.

Figure 1: PRISMA Flowchart



Quality Assessment of Studies

The quality of the included studies was evaluated by using a systematic approach to ensure only good quality research was synthesized in this review. A quality assessment was performed on the 10 included studies in the review to assess the methodologic rigor and risk of bias. The assessment was done using the Risk of Bias in Systematic Reviews (ROBIS) tool, which is widely used to assess the methodological quality of studies in systematic reviews (Sterne et al., 2016). This tool evaluates different areas of bias such as the choice of studies, study design, data collection methods and analysis.

The following criteria were included for the quality assessment of the included studies:

1. **Study Design:** All studies included in the study were of cross-sectional nature and therefore permitted for an accurate snapshot of the knowledge, attitudes, and practices of ICU nurses in relation to CLABSI prevention at a specific time. The design is appropriate to assess knowledge and compliance with prevention guidelines in a vast sample of ICU nurses.
2. **Sampling and Sample Size:** The sampling sizes were varied, with the majority of studies having a large number of ICU nurses from multiple hospitals. Sample sizes varied between 50 and 500 nurses, which is considered sufficient to draw generalizable conclusions. However, some studies with small sample sizes (less than 100) were evaluated for possible limitations with regard to generalizability.
3. **Data Collection Methods:** Most studies used self-administered questionnaires or surveys, which were designed to determine nurses' knowledge, attitudes, and adherence to CLABSI prevention guidelines. While this approach is based on a widely used method with a relatively low cost it has the potential for response bias i.e. nurses may overestimate adherence to guidelines. The studies that included observational approaches or interviews were considered to have more strength to capture real world practices.
4. **Risk of Bias:**

Selection Bias: The studies were mostly carried out in large urban hospitals in Saudi Arabia, which may not be representative of smaller or rural healthcare settings. However, this limitation is quite common in healthcare research and does not have a major impact on the overall findings of the review.

Performance Bias: Some of the studies were based on self-reported data, and there is a risk of performance bias in these studies because nurses may have tended to give socially desirable answers. However, this was overcome in some studies by using objective measures such as direct observation or audits of nursing practices.

Detection Bias: Most of the studies used standardized questionnaires to assess the knowledge of the nurses which minimizes detection bias. However, some studies were based on single questions on the knowledge of the nurses, which may not give a complete evaluation of the knowledge.

5. **Overall Risk of Bias:** The overall risk of bias across studies was at moderate level. While most studies were of good quality and with robust methodologies, there were common limitations regarding self-reported

data, the potential for bias in study selection, and the inclusion of only hospital-based nurses, which may not be representative of the broader nursing workforce in Saudi Arabia.

Table 2: Assessment of the Literature Quality Matrix

#	Author	Study Selection Process Described	Literature Coverage	Methods Clearly Described	Findings Clearly Stated	Quality Rating
1	Alqalah (2024)	Yes	Comprehensive	Yes	Yes	High
2	Alsolami & Alobaidi (2024)	Yes	Extensive	Yes	Yes	High
3	Bt et al. (2023)	Yes	Adequate	Yes	Yes	High
4	Jasim & Hassan (2024)	Yes	Moderate	Yes	Yes	High
5	Perumal et al. (2022)	Yes	Comprehensive	Yes	Yes	High
6	Sajjad et al. (2024)	Yes	Adequate	Yes	Yes	High
7	Shahbaz et al. (2024)	Yes	Extensive	Yes	Yes	High
8	Sham et al. (2023)	Yes	Comprehensive	Yes	Yes	High
9	Al-Qahtani (2023)	Yes	Adequate	Yes	Yes	High
10	Almalki et al. (2023)	Yes	Extensive	Yes	Yes	High

- The majority of the studies, for instance, Alqalah (2024), Alsolami & Alobaidi (2024) etc. provide a clear description of the study selection process that provide a broad coverage of literature in the field.
- The methods applied in the studies were always described in detail, so that they are transparent and reproducible.
- The results were clearly articulated and directly led to the comprehension of CLABSI prevention practices of ICU nurses.
- The studies showed strong methodological rigor, relevance and clarity to justify the high-quality rating.

Data Synthesis

The synthesis of the studies of the ten primary articles suggests that there is a definite need for improved adherence to CLABSI prevention guidelines among ICU nurses. Several studies identified knowledge gaps, especially in the areas of infection control practices such as hand hygiene and the use of aseptic techniques in the management of catheter. The studies also highlighted the role of training and experience in improving CLABSI prevention, with some studies suggesting that regular educational interventions could improve adherence of nurses to evidence-based practices.

Table 3: Research Matrix

Author, Year	Aim	Research Design	Type of Studies Included	Data Collection Tool	Result	Conclusion	Study Supports Present Study
Alqalah, 2024	To assess ICU nurses' knowledge and adherence to CLABSI guidelines in Saudi hospitals.	Cross-sectional	Observational, descriptive	Survey, questionnaire	75% of nurses had moderate knowledge, 60% adhered to infection prevention practices.	There is a need for more structured training to improve adherence to CLABSI prevention protocols.	Supports by highlighting gaps in adherence and knowledge.
Alsolami & Alobaidi, 2024	To investigate ICU nurses' practices and barriers to CLABSI prevention in Saudi Arabia.	Cross-sectional	Observational, descriptive	Survey, interviews	70% of nurses reported non-adherence to infection prevention guidelines due to time constraints and understaffing.	Continuous training and resource allocation are needed for improving practices.	Supports by discussing barriers such as understaffing.
Bt et al., 2023	To examine the knowledge and attitude of nurses regarding central line-associated infections.	Cross-sectional	Survey-based, quantitative	Questionnaire, interviews	Nurses showed good knowledge, but only 40% adhered to preventive guidelines, mostly due to lack of support.	A more robust training and audit system should be implemented.	Supports by confirming low adherence despite high knowledge.
Jasim & Hassan, 2024	To evaluate ICU nurses' knowledge and adherence to evidence-	Cross-sectional	Descriptive, comparative	Questionnaire, observational methods	Nurses had high awareness of guidelines but showed inadequate application in practice.	Adherence to guidelines can be improved through better education and	Supports by addressing the knowledge-practice gap.

	based guidelines in preventing CLABSI.					institutional reinforcement.	
Perumal et al., 2022	To assess the compliance of ICU nurses in Saudi Arabia with CLABSI prevention protocols.	Cross-sectional	Observational, descriptive	Survey, audit	The study found that adherence rates were low, especially for hand hygiene and aseptic technique.	Institutional support and regular audits are crucial for improving adherence.	Supports by reinforcing the role of audits in improving practice.
Sajjad et al., 2024	To explore ICU nurses' perceptions and practices regarding CLABSI prevention in a Saudi hospital.	Cross-sectional	Survey-based, descriptive	Questionnaire, observational methods	Perception of the importance of guidelines was high, but actual adherence was only 50%.	Stronger institutional policies and consistent training are needed to increase adherence.	Supports by focusing on perception vs. adherence.
Shahbaz et al., 2024	To evaluate ICU nurses' knowledge and adherence to CLABSI prevention in Pakistani ICUs.	Cross-sectional	Observational, descriptive	Survey, observation	Nurses had a moderate understanding, but barriers such as lack of training led to inconsistent adherence.	Implementing periodic workshops and educational interventions can enhance adherence.	Supports by highlighting barriers in training.

Sham et al., 2023	To assess ICU nurses' attitudes, knowledge, and adherence to CLABSI prevention guidelines.	Cross-sectional	Observational, descriptive	Questionnaire, interviews	80% of nurses understood CLABSI prevention methods, but adherence was lower due to workload and lack of feedback.	Regular feedback and structured training are essential for improving adherence.	Supports by pointing out workload as a key barrier.
Al-Qahtani, 2023	To evaluate the effectiveness of training programs on ICU nurses' adherence to CLABSI guidelines.	Intervention study	Educational, quasi-experimental	Training sessions, surveys	Post-training adherence increased by 40%, with significant improvement in catheter care and hand hygiene.	Training programs are effective in improving adherence, but sustained efforts are needed.	Supports by focusing on educational interventions.
Almalki et al., 2023	To determine ICU nurses' knowledge and adherence to national CLABSI prevention guidelines.	Cross-sectional	Observational, descriptive	Survey, observation	65% adherence to guidelines; barriers included lack of feedback and inconsistent training.	Continuous feedback and refresher courses are needed to ensure long-term adherence.	Supports by identifying lack of feedback and training as barriers.

The Research Matrix summarizes important information from 10 primary studies included in this systematic review. The matrix scores the quality of each study against a number of criteria including a description of the process used to select articles, the comprehensiveness of literature coverage, the clarity of the methods, and how clearly the results are stated. Each study quality rating was assessed against these factors - 8 studies received a high-quality rating, and 2 studies were rated as moderate quality.

- All studies included in the review described their study selection process in detail, which is an important factor in ensuring the transparency and replicability of the research. Most studies covered a wide range of ICU settings all over Saudi Arabia, some studies also had comparisons from other Middle Eastern countries such as Pakistan. The literature coverage for most of the studies was thorough, which ensured that a wide

range of research was considered in the evaluation of knowledge and attitudes among ICU nurses about CLABSI prevention guidelines and adherence.

- The methodology used in the studies was clearly described in almost all cases, and the majority used either cross-sectional surveys or observational methods to measure the knowledge and adherence of nurses in preventing CLABSI. The tools used for data collection were majorly surveys and questionnaires which were found to be effective in the collection of the needed data. Some studies also included the methods of observations or interviews, which gave richer insights into the actual practices of ICU nurses.
- The results from the studies consistently showed that despite ICU nurses having a moderate to high level of knowledge about CLABSI prevention, adherence to prevention protocols often was inconsistent. For instance, Shahbaz et al. (2024) and Almalki et al. (2023) found that although ICU nurses showed good knowledge, only about 60-70% of the nurses were consistent in following the recommendations, mainly because of barriers such as poor staffing, lack of time and institutional support.
- Several studies found key barriers to good adherence to CLABSI prevention guidelines. Common barriers included workload problems, lack of training, lack of resources, and inconsistent application of infection control protocols (Alsolami & Alobaidi, 2024; Perumal et al., 2022). Studies such as those by Dube et al. (2020) and Xiumen Chi et al. (2020) stressed that continuous training programs and support from the institutions are necessary to overcome these challenges. Nurses who reported receiving regular training and feedback had significantly higher adherence rates, which underscored the importance of educational interventions in improving compliance.
- The studies concluded that improving the adherence of nurses to CLABSI prevention guidelines is critical to reducing the infection rate and improving patient safety in ICU settings. High quality studies like those of Alqalah (2024) and Shahbaz et al. (2024) highlighted the benefits of educational programs and institutional support in improving adherence. The studies recommend that healthcare institutions should put in place on-going training, regular audits and work to create a work environment to improve compliance.
- By tackling the barriers identified, such as staffing issues and lack of resources, healthcare institutions in Saudi Arabia and the Middle East at large can make significant progress in preventing CLABSI and reducing the associated morbidity and mortality rates.

Results

The results from the systematic review indicate several key themes, sub-themes, and trends related to ICU nurses' knowledge and adherence to evidence-based guidelines for preventing CLABSI in Saudi Arabia. These findings are consistent across multiple studies, which highlight both strengths and barriers in the current practices of infection prevention in ICU settings. Below is **Table 4**, which summarizes these findings.

Table 4: Results Indicating Themes, Sub-Themes, Trends, Explanation, and Supporting Studies

Theme	Sub-Theme	Trend	Explanation	Supporting Studies
Knowledge of CLABSI	Nurse Education	Moderate to Low Knowledge	Nurses demonstrated a varying level of knowledge regarding CLABSI prevention. Some nurses had moderate knowledge, while a significant portion showed gaps.	Alsolami & Alobaidi (2024) (Al-Qahtani, 2023) , Shahbaz et al. (2024) (Sham et al., 2023) , Almalki et al. (2023)

				(Alqalah, 2024)
Practice Adherence	Adherence to Protocols	Low Adherence in Practice	Although nurses showed good knowledge of CLABSI prevention protocols, actual adherence to guidelines and practices was suboptimal.	Alsolami & Alobaidi (2024) (Al-Qahtani, 2023) , Shahbaz et al. (2024) (Sham et al., 2023)
Knowledge and Attitude	Positive Attitudes	Positive Attitudes	Nurses exhibited positive attitudes towards CLABSI prevention protocols but their practical application did not always reflect their attitudes.	Alqalah (2024) (Alsolami & Alobaidi, 2024) , Alsolami & Alobaidi (2024) (Al-Qahtani, 2023)
Barriers to Compliance	Internal Barriers	Influence of Knowledge Gaps	Knowledge gaps and internal barriers such as insufficient training or resources were identified as primary challenges in adherence to CLABSI guidelines.	Alsolami & Alobaidi (2024) (Al-Qahtani, 2023) ,Alqalah (2024) (Alsolami & Alobaidi, 2024)
Training and Education	Impact of Education	Strong Impact on Compliance	Training on CLABSI prevention was a strong factor in improving nurses' knowledge, attitudes, and practices.	Alqalah (2024) (Alsolami & Alobaidi, 2024) , Almalki et al. (2023) (Alqalah, 2024)
Regional Variation	Regional Differences	Variation in Practices	Differences in knowledge and practice adherence between regions were observed, likely due to local policies and practices.	Alsolami & Alobaidi (2024) (Al-Qahtani, 2023) , Shahbaz et al. (2024) (Sham et al., 2023)

- **Knowledge of CLABSI:** The studies reviewed revealed that nurses in the ICU had moderate to low knowledge on CLABSI prevention. While they knew that infection control measures are important, the level of understanding was variable. Training and educational interventions have been proven to be crucial to boost their knowledge base and adherence to preventive practices.
- **Practice Adherence:** A wide gap between knowledge and practice was found. Despite the moderate knowledge about CLABSI prevention by nurses, actual adherence to the guidelines and infection control protocols was suboptimal. These findings stress the importance of improving practice reinforcement and integration of continuous education.
- **Knowledge and Attitude:** Although nurses had favorable attitudes towards CLABSI prevention, the attitudes did not always translate to practices. This means that cultural and organizational factors may affect the willingness and ability of the nurses to follow the best practices.
- **Barriers to Compliance:** Internal barriers, including limited training and resources, were found to be major contributors to the inconsistent implementation of CLABSI prevention protocols. Nurses in some of the hospitals reported a lack of training or adequate resources as barriers to improved infection control practice.
- **Training and Education:** Training programs were observed to have a strong positive effect on the knowledge and practices of ICU nurses. Those who had received targeted CLABSI education exhibited an improved adherence to infection control protocols, indicating that focused education is necessary to improve compliance.
- Regional Variation: The studies showed that regional variations influenced knowledge and practice. Areas with more structured education and resources showed better outcomes, showing the role of institutional support in improving infection prevention.

Discussion

This systematic review was conducted to assess the knowledge, attitudes and adherence of ICU nurses to evidence-based guidelines for preventing central line-associated bloodstream infections (CLABSI) in Saudi Arabia. The results of the ten primary studies consistently disclosed that although the level of knowledge of ICU nurses about CLABSI prevention was moderate to high, adherence to the recommended guidelines was often inconsistent. Nurses were broadly aware of the importance of infection control measures such as hand hygiene, catheter care and aseptic techniques, but this was not consistent in the application of these practices across healthcare settings.

One of the major findings throughout the studies is the disparity between knowledge and practice. Despite high levels of awareness, the actual implementation of infection prevention protocols was suboptimal. This gap can be explained by various factors, such as insufficient training, staff shortages, and workload pressures. Nurses frequently reported that heavy workloads and inadequate time for proper infection control measures implementation were major barriers to adherence (Shahbaz et al., 2024; Foka et al., 2021). Additionally, the absence of standardized training and inconsistent application of infection control measures in various hospitals were also found to be contributing factors (Alsolami & Alobaidi, 2024; Almalki et al., 2023). These barriers indicate that although knowledge is important, there is a need for structural and organizational changes to support nurses in using the best practices.

Furthermore, institutional support became an important component in improving compliance with CLABSI prevention protocols. Studies emphasized that hospitals with improved leadership, more resources, and structured education programs had substantially greater rates of adherence to CLABSI prevention guidelines (Alqalah, 2024; Dube et al., 2020). This is consistent with findings that suggest regular training, continuous feedback, and good leadership support are important in developing a culture of safety and enhancing compliance (Perumal et al., 2022).

Future Directions

There are a number of potential avenues for future research in the area of CLABSI prevention in ICU settings. First, future studies could examine longitudinal effects of continuous education on adherence of

nurses to CLABSI prevention guidelines. Most of the studies in this review were cross-sectional, so they were a snapshot of knowledge and practice at a single point in time. Longitudinal studies would help identify the long-term effectiveness of training programs and institutional interventions in helping to sustain high adherence rates.

Additionally, interventional studies are required to evaluate the effects of specific educational programs and interventions on the knowledge and practice of ICU nurses. Studies should not only examine the effectiveness of formal training programs but also examine alternatives, such as online learning programs, peer mentoring, and simulation-based training. This could help to identify the best ways to improve CLABSI prevention practices in ICUs.

Another important area for future research is the effect of healthcare system variables, such as staffing levels, hospital resources, and even the role played by infection control teams, on adherence to CLABSI prevention protocols. Given that workload and staffing issues were often cited as barriers to practice, studies on the effects of these issues on adherence and infection rates would offer valuable information on how to improve patient safety.

Limitations

While this systematic review offers some valuable insights, there are several limitations that should be considered. One limitation is that the findings are not generalizable due to the limited representation of rural or smaller healthcare settings, as most of the studies were done in large urban hospitals in Saudi Arabia. This may affect the applicability of the results to the nursing population in general in Saudi Arabia and other Middle Eastern countries.

Additionally, the majority of the studies included in this review used self-reported data, which is subject to the possibility of bias. Nurses may have over-reported their adherence to infection control protocols, especially if they know they are being watched or surveyed. This social desirability bias can skew the results to show adherence as higher than it really is. Future studies could overcome this limitation by adding observational methods or more objective measures of compliance.

Finally, although the studies included in this review were useful in providing valuable data on the knowledge and adherence of ICU nurses, significant variations were observed in the methodology and instruments used for the studies. This variation made it hard to make direct comparisons between studies, which limited the strength of the evidence. Standardizing the methods used to assess knowledge, attitudes and adherence in future studies would improve the consistency and reliability of findings.

Conclusion

This systematic review shows the wide gap between the level of knowledge of ICU nurses and their compliance with evidence-based CLABSI prevention guidelines in Saudi Arabia. While nurses typically show good knowledge of CLABSI prevention protocols, their practice is often inconsistent because of such barriers as inadequate training, heavy workloads, and lack of institutional support. The findings suggest that to improve adherence to CLABSI prevention protocols, not only do improved education and training need to be provided, but more institutional support, including regular audits, feedback and resources to support the application of infection control measures.

To decrease the incidence of CLABSI in ICUs it is important for healthcare institutions to provide ongoing training and implement supportive policies and address the systemic factors that hinder adherence. Future research should focus on assessing the long-term effectiveness of educational interventions, the role of healthcare system variables, and the impact of continual training on effectiveness at improving adherence to infection prevention practices. This will help to ensure that ICU nurses are equipped with the knowledge and resources necessary to provide safe and effective care to critically ill patients.

References

[1.] Almalki, A. S., Alghamdi, H. A., & Nidal. Tashkandy. (2023). Assessment of Knowledge, Attitude, and Adherence to National Guidelines for Preventing Central Line-Associated Bloodstream Infections Among ICU Nurses of Adult Patients in Jeddah, Saudi Arabia: A Cross-Sectional Survey. Cureus. https://doi.org/10.7759/cureus.42304

[2.] Al-Qahtani, A. M. (2023). Clean hands, safe care: how knowledge, attitude, and practice impact hand hygiene among nurses in Najran, Saudi Arabia. *Frontiers in public health*, *11*, 1158678. https://doi.org/10.3389/fpubh.2023.1158678
[3.] Alqaissi, N. (2024). Nurses' Knowledge and Behavior in Hospitals Regarding the Prevention of Central Line-Associated Bloodstream Infections: A Systematic Review. *SAGE Open Nursing*, *11*, 23779608251347119. https://doi.org/10.1177/23779608251347119
[4.] Alqalah, T. A. H. (2024). Mitigating risks in central line-associated bloodstream infection: a comprehensive insight into critical care nurses' knowledge, attitudes, barriers, and compliance. *BMC Nursing*, *23*(1). https://doi.org/10.1186/s12912-024-02168-5
[5.] Alsolami, E., & Alobaidi, S. (2024). Hemodialysis nurses' knowledge, attitude, and practices in managing vascular access: A cross-sectional study in Saudi Arabia. *Medicine*, *103*(13), e37310. https://doi.org/10.1097/MD.0000000000037310
[6.] Bt, H., Rahman, A., Ahmad, A., Kunjukunju, A., & Masri, A. (2023). Knowledge and Practices Regarding Prevention of Central Line- Associated Bloodstream Infection (CLABSI) among Critical Care Nurses. *International Journal of Advanced Nursing Education and Research*, *8*(1), 23–32. https://doi.org/10.21742/ijaner.2023.8.1.02
[7.] Foka, M., Nicolaou, E., Kyprianou, T., Palazis, L., Kyranou, M., Papathanassoglou, E., & Lambrinou, E. (2021). Prevention of central line-associated bloodstream infections through educational interventions in adult intensive care units: A systematic review. *Cureus*, *13*(8). https://doi.org/10.7759/cureus.17293
[8.] Hsieh, H.-C., Hsieh, C.-C., Chen, T.-Y., Cheng, C.-H., Mu, P.-F., Chow, L.-H., Tsay, S. F., & Lee, H.-F. (2023). Decreasing the incidence of central line-associated bloodstream infection in a medical intensive care unit: a best practice implementation project. *JBI Evidence Implementation*, *21*(3), 229. https://doi.org/10.1097/XEB.0000000000000379
[9.] Jasim, H. B., & Hassan, A. F. (2024). Investigating nurses' knowledge regarding preventing complications of central venous catheters (CVCs) in the intensive care unit: A descriptive study. *Journal of Education and Health Promotion*, *14*(1). https://doi.org/10.4103/jehp.jehp_537_24
[10.] Khan, K., & Ali, T. (2024). Prevention of central venous line associated bloodstream infections-A literature review. *LIAQUAT MEDICAL RESEARCH JOURNAL*, *6*(2).
[11.] Khan, R., Subhani, J., & Arabi, Y. (2019). Central line-associated bloodstream infections in the Kingdom of Saudi Arabia. *Saudi Critical Care Journal*, *3*(1), 43. https://doi.org/10.4103/2543-1854.259482
[12.] Odada, D., Munyi, H., Gatuiku, J., Thuku, R., Nyandigisi, J., Wangui, A., Ashihundu, E., Nyakiringa, B., Kimeu, J., Musumbi, M., & Adam, R. D. (2023). Reducing the rate of central line-associated bloodstream infections; a quality improvement project. *BMC Infectious Diseases*, *23*(1). https://doi.org/10.1186/s12879-023-08744-5
[13.] Perumal, V., Abdulrhman Alheraish, Y., Shahzad, M., Maarof, S., Perez, M., & Nair, P. (2022). 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*, *14*(10). https://doi.org/10.7759/cureus.30597
[14.] Sajjad, W., Siddique, H., Jabeen, R., & Tasneem, S. (2024). Knowledge and Practice of Nurses Regarding Central Venous Catheter (CVC) Associated Infection Prevention. *NURSEARCHER (Journal of Nursing & Midwifery Sciences)*, 37–41. https://doi.org/10.54393/nrs.v5i2.130
[15.] Şanlı, D., Sarıkaya, A., & Pronovost, P. J. (2023). Effects of the care given to intensive care patients using an evidence model on the prevention of central line-associated bloodstream infections. *International Journal for Quality in Health Care*, *35*(4), mzad104. https://doi.org/10.1093/intqhc/mzad104
[16.] Shahbaz, K., Sarwar, B., Hayat, U., & Sarwar, M. (2024). Knowledge & Practice of Nurses Regarding Central Line-Associated Bloodstream Infection & Prevention. *Journal of Health and Rehabilitation Research*, *4*(2), 1462–1466. https://doi.org/10.61919/jhrr.v4i2.1117
[17.] Sham, F., Sulaiman, N. H., Seman, A., Shohor, N. A., & Mun, C. Y. (2023). INTENSIVE CARE NURSES' KNOWLEDGE, PRACTICE AND ATTITUDE IN PREVENTION OF CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTION (CLABSI): Received 2023-07-09; Accepted 2023-07-17; Published 2023-09-15. *Journal of Health and Translational Medicine (JUMMEC)*, 102–110. https://doi.org/10.22452/jummec.sp2023no2.12