

Critical Care Nurses' Compliance with Central Line Maintenance Bundle



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ABSTRACT

Background: Central venous catheterization is a routine treatment carried out for patients who are critically ill. Therefore, to prevent major complications from central venous catheterization in intensive care units, critical care nurses should be educated on evidence-based guidelines such as the central line maintenance bundle. **Aim:** This study aimed to assess critical care nurses' compliance with central line maintenance bundle. **Method:** A descriptive observational research design was conducted using a convenience sample of 60 nurses working in four intensive care units. Data was collected using participant nurses' compliance with central line maintenance bundle and factors affecting nurses' compliance with central line maintenance bundle assessment sheets. **Results:** The study showed that 76.3% of the participating nurses had negative central line maintenance bundle compliance with a mean SD of 3.680±132, and approximately two-thirds 65% had unsatisfactory levels regarding central line maintenance bundle. There was a strong negative relation (76.3%) between the level of total central line maintenance bundle of the participant nurses and the total level of factors affecting their compliance with central line maintenance bundle. **Conclusion:** The current study concluded that most nurses had unsatisfactory levels regarding central line maintenance bundle. As well as the majority of them also had unsatisfactory levels regarding the total level of factors affecting their compliance with central line maintenance bundle. **Recommendation:** The critical care nurses need more training program applications to improve their compliance with central line maintenance bundle to prevent complications of central venous catheterization and improve patients' outcome.

Keywords: Central Line Maintenance Bundle, Critical Care, Nurses' Compliance,

Introduction:

Central venous access is one of the most often used procedures in intensive care units (ICUs). A key factor in determining the quality of patient outcomes and the safety of patients in the intensive care unit is the proficiency of critical care nurses (CCNs) in providing care for patients with central venous catheters (CVCs) (Iraizoz-Iraizoz et al. 2022). One of the most fundamental and important aspects of patient care is the central venous catheter (CVC). The CVC is a hollow tube that is put into the internal jugular vein, axillary vein, femoral vein, or arm's peripheral vein (Tajani & Fields, 2020).

The CVC is used to obtain venous blood samples, provide long-term IV therapy, administer large amounts of IV fluid rapidly, medications and hypertonic solutions such as total parental nutrition (TPN), and administer solutions with extreme pH values, like vancomycin (Wang & Sun, 2022). Central line-associated bloodstream infection (CLABSI) is associated with a significant increase in morbidity, mortality, and duration of hospital

stay, as well as increasing the cost of healthcare services (Blot, Hammami, Blot, Vogelaers, & Lambert, 2022). The frequency of CLABSI among adult ICU patients ranged from 1.6 to 44.6 instances per 1,000 central line days, with a death rate ranging from 2.8 to 9.5 (Abbadly, Gaballah, Abotakia, & Sherif, 2019).

A central line maintenance bundle (CLMB) is now recommended to reduce the risk of CLABSI. To raise the standard of patient care, the Institute for Healthcare Improvement developed the concept of care bundles (Wolfhagen, Boldingh, Boormeester, & de Jonge, 2022). A bundle is a limited group of evidence-based therapies for a specific patient care need (Awad, Ahmed, & Kandeel, 2022). Ten interventions make up the CLMB: removing the central line or determining when to remove it; teaching medical staff how to manage central lines; changing gauze and tape dressings every day; changing transparent dressings every seven days; using sterile gloves; washing hands; using 0.5 percent or higher chlorhexidine in alcohol solution;

allowing chlorohexidine to dry; using the pulsated flushing technique; and, lastly, using a dedicated lumen when parenteral nutrition is used (Saibertová, Klugarová, Klugar, & Pokorná, 2022).

Compliance denotes that the appropriate action has been taken (Powell-Jackson et al., 2020). The CCN plays an important role in infection prevention efforts, and they are an important population to study in terms of knowledge, performance, and compliance with infection control (Abdalla, Renukappa, & Suresh, 2022). Nursing interventions can greatly lower the patient's risk of CLABSI by ensuring proper maintenance and care of a CVD (Muntean, Stoica, Gillick, & Puri, 2023). The most crucial element in increasing compliance is having a positive physician-patient relationship (Gesse, Haile, & Woldearegay, 2022).

Significant of the study

Bundle interventions are broadly accepted as the standard model for prevention of CLABSIs with concentrated strategies on physician and patient preparation. Therefore, the present study will be carried out in an attempt to investigate the effectiveness of central line maintenance bundle on reducing CLABSIs among intensive care unit patients using a clinical audit and feedback strategy on central line maintenance practices to promote healthcare change / evidence-based practice and better outcomes for patients.

Aim of the study

This study aimed to assess critical care nurses' compliance with central line maintenance bundle.

Research Questions

What is the extent of Critical Care Nurses' compliance with central line maintenance bundle?

What are factors affecting Critical Care Nurses' compliance with central line maintenance bundle?

Methods

Research design

A descriptive research design was used to conduct this study. It was the most appropriate design for the current study, as it aimed to assess CCNs' compliance with CLMB. Direct observation was the most comprehensive method to ascertain how nurses performed in a real-life situation (Scolari, Soncini, Ramelet, & Schneider, 2022).

Setting

The study was carried out at four intensive care units affiliated to Mansoura New General Hospital (MNGH), which provides health services to patients from the surrounding area at Dakhlia governorate. The unit occupied with advanced equipment and facilities required for adult patient care.

Sample

A convenience sample of 60 CCNs employed in the above-mentioned ICUs who were involved in direct care and had at least one year of work experience in the ICUs.

Tools of Data Collection

Tool I: Participant Nurses' Compliance with Central Line Maintenance Bundle

This tool was adopted from JBI (2014). It consists of two main parts:

Part 1: Socio-Demographic Characteristics of Participant Nurses such as the nurses' age, gender, educational level, place of employment, years of experience, and participation in CVC care training programs.

Part 2: Central Line Maintenance Bundle Observational Checklist. It was adopted from JBI (2014) and CDC (2014). It was used to assess nurses' performance regarding CLMB. It consists of ten interventions, including checking the records of inpatients with CVC removal programming during daily rounds, educating healthcare staff on how to manage with central lines, changing dressings made with gauze and tape daily, and changing transparent dressings every seven days or sooner if they are no longer intact or moisture has collected under the dressing. Also, there must be handwashing immediately before manipulation of the CVC, wearing sterile gloves before central line usage, and cleaning the dressing area with 0.5% or higher chlorhexidine in an alcohol solution. The nurse must let 70% of the alcohol dry before accessing the central line. Using a pulsated flushing technique when the catheter is flushed and utilizing a dedicated lumen when parenteral nutrition is important.

Scoring system:

The scoring system was distributed as follows: "Done" was given 1 mark, and "Not done" was given 0. The total scoring system was classified into two categories; "Satisfactory" was $\geq 70\%$, and "Unsatisfactory" was $< 70\%$ (JBI 2014).

Tool II: Factors Affecting Nurses' Compliance with Central Line Maintenance Bundle

This tool was adopted from **JB1 (2014)**. It was used to evaluate factors influencing nurses' compliance with the central maintenance bundle. It consists of eight barriers: record of daily rounds , procedure for performing CVC dressings, knowledge among the nursing team about CVC care, protocol on CVC maintenance, adherence to hand hygiene immediately before CVC manipulation and technical problems with transparent film curative (loose, small).

Scoring system:

The scoring system was distributed as follows: "Present" was given 1 mark, and "Absent" was given 0. Two categories were identified for the overall rating system, "Satisfactory" was $\geq 70\%$, and "Unsatisfactory" was $< 70\%$ (**JB1 2014**).

Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee (REC) of the Faculty of Nursing, Mansoura University. Eligible nurses were informed about the study's purpose, benefits, and risks . The nurses were told that they might leave at any time and that their participation was completely optional. A consent form was had to be signed by nurses who agreed to participate in the study. Nurses were informed that there was no connection between their personal information and publicly available data. The confidentiality of personal data was ensured by coding all data . The information gathered was used only for the purposes of this study.

Pilot study

Six nurses, or 10% of the sample as a whole, participated in a pilot study to evaluate the clarity, objectivity, and applicability of data collection tools. The pilot study participants were not included in the main study. As a result, the necessary adjustments were made before the data collection process.

Content Validity

A group of five experts in CCN and Medicine evaluated the tool's content validity. These experts were affiliated with the Critical Care and Emergency Nursing Department at Mansoura University's Faculty of Nursing. They reviewed the tools for clarity, relevance, and applicability. Their corrections were carried out as planned.

Reliability:

The Cronbach's Alpha test was used to test the overall reliability of the tools, which indicates how well the items in each tool fit together conceptually. When the test produced the same result each time under identical circumstances, it was considered reliable. The tool's reliability was 0.827, which indicates that the tool is reliable. Suggestions were made in response.

Data Collection Process

This study was carried out in two stages: preparation and implementation. Preparation phase:

- The REC provided ethical approval.
- Permission to conduct the study will be obtained after outlining its goals to the relevant authorities in the study setting.
- The primary investigator (PI) interviewed the healthcare team in the selected ICUs, introduced herself, explained the purpose and nature of the study, and invited them to participate in the study.
- The nurses who took part gave their informed consent.

Implementation phase:

- After the nature and goal of the study were described, data was collected over three shifts (morning , afternoon, and night shifts).
- Part I of the Tool I used to gather Nurses' demographic data.
- Part II of Tool I used to gather the researcher observed nurses' performance in terms of central line maintenance bundle three times during their care of ICU patients.
- Finally, in Tool II the researcher observed factors influencing critical care nurses' compliance with the central line maintenance bundle.

Analytical Statistics

Version 26 of the statistical computer program SPSS was used to arrange, tabulate, and statistically analyze the data that had been gathered. The range, mean , and standard deviation were computed for quantitative data. To compare qualitative data, the Chi-square test (χ^2) was employed.

Results

Table 1 presents the socio-demographic characteristics of the nurses. It represented that 48.3% of them aged between 30 and less than 40 years, with a mean of 32.6 ± 5.3 , and above (78.3%) of the nurses were female. Concerning qualifications, half of the studied nurses had a

bachelor's degree in nursing science and were on the morning shift. Additionally, 63.3% of them worked in the general ICU.

Regarding the job title, 43.3% of the studied nurses were staff nurses, and 41.7% were head nurses. The findings revealed that 38.3% had more than 10 years, with a mean of 8.8 ± 3.2 . Moreover, 41.7% of the studied nurses attended educational training programs related to CVC care just once.

Table 2 shows the percentage distribution of the participant nurses regarding CLMB. It was shown that the task of cleaning the dressing area with an alcohol solution containing 0.5% or more chlorhexidine was not completed 100% of the time. Only 40% of the studied nurses checked the records of inpatients with CVC removal programming during daily rounds, and 35% of them educated healthcare staff on how to manage with central lines.

The domain of changing dressing with gauze and tape daily was done by 48.3% and changing transparent dressing every seven days was done by 38.3%. Additionally, most nurses

(85%) wore sterile gloves before central line usage, and 63.3% of them washed their hands immediately before the manipulation of the CVC, respectively.

As well as the domains of letting 70% alcohol dry before the central line accessing and using a pulsated flushing technique when the catheter is flushed, were done by about 53.3% and 35%, respectively. Only 30% of the studied nurses use a dedicated lumen when parenteral nutrition is administered.

Table 3 shows factors affecting participants' compliance with CLMB. It was discovered that factors such as knowledge among the nursing team about CVC care and technical problems with transparent film curative (loose, small) were present by 35.0% for each of them. Regarding the record of daily rounds and the procedure for performing CVC dressings, 40.0% and 56.7% were present, respectively. Protocol on CVC maintenance was absent by 66.7%, and adherence to hand hygiene was present by 61.7%.

Table 1: *Socio-Demographic Characteristics of Participant Nurses*

Nurses' socio-demographic characteristics	n=60	
	Frequency	%
Age		
• 20 – <30	20	33.3
• 30 – <40	29	48.3
• 40 – <50	7	11.7
• 50 – 60	4	6.7
Mean \pmSD	32.6 \pm 5.3	
Gender		
• Male	13	21.7
• Female	47	78.3
Qualifications		
• Technical nursing school	16	26.7
• Bachelor of nursing science	30	50.0
• Post – Graduate degree	14	23.3
Workplace		
• General ICU	38	63.3
• Surgical ICU	11	18.3
• Medical ICU	11	18.4
Job Title		
• Staff Nurse	26	43.3
• Head Nurse	25	41.7
• Nursing Supervisor	9	15.0
Work Experience in ICU (Years)		
• 1 – < 5	16	26.7
• 5 – <10	21	35.0
• > 10	23	38.3
Mean \pmSD	8.8 \pm 3.2	

Working Shift		
• Morning Shift	30	50.0
• Afternoon Shift	23	38.3
• Night Shift	7	11.7
Attended previous educational training programs		
• None		
• One	21	35.0
• Two	25	41.7
• Three or More	12	20.0
	2	3.3

Table 2: Distribution of the Participant Nurses' Regarding CLMB

CLMB Domains	Done		Not Done	
	N	%	N	%
•Checking the records of inpatients with CVC removal programming during daily rounds.	24	40.0	36	60.0
•Educating healthcare staff how to manage with central lines	21	35.0	39	65.0
•Changing dressing made with gauze and tape daily.	29	48.3	31	51.7
•Changing transparent dressing every seven days or sooner if it is no longer intact or moisture collected under the dressing.	23	38.3	37	61.7
•Washing hands immediately before manipulation of the CVC.	38	63.3	22	36.7
•Wearing sterile gloves prior to using the central line.	51	85.0	9	15.0
•Cleaning the dressing area with 0.5 or higher chlorhexidine in alcohol solution.	0	0.0	60	100.0
•Letting 70 alcohol to dry prior to accessing the central line.	32	53.3	28	46.7
•Using a pulsated flushing technique when the catheter is flushed.	21	35.0	39	65.0
•Utilizing a dedicated lumen when parenteral nutrition is administered.	18	30.0	42	70.0

Table 3: Percentage Distribution of the Participant Nurses' Regarding Factors Affecting Their Compliance with CLMB

Factors	Present		Absent	
	N	%	N	%
•Record of daily rounds	24	40.0	36	60.0
•Procedure for performing CVC dressings	34	56.7	26	43.3
•Knowledge among the nursing team about CVC care	21	35.0	39	65.0
•Protocol on CVC maintenance	20	33.3	40	66.7
•Adherence to hand hygiene immediately prior to CVC manipulation	37	61.7	23	38.3
•Technical problems with transparent film curative (loose, small)	21	35.0	39	65.0

Discussion:

Section I: Socio-demographic Characteristics of Participant Nurses

According to the current study, half of them were nursing science bachelor's degree holders. It's possible that hospitals favor hiring highly skilled nurses, particularly in the intensive care unit and critical department, so they can handle the demanding nursing duties and improve standard care (Randa & Phale, 2023). This finding agrees with Matlab et al. (2022) and Al Qadire, and Hani (2022) who found that the most studied nurses had a bachelor's degree in nursing. This finding is also in line with Aloush and Alsaraireh (2018), who revealed that the majority of the investigated nurses having a bachelor's degree in

nursing cared for patients with central lines. Conversely, Kadium, (2015); and El-sol and Badawy, (2017) discovered that the majority of the sample under study held a general nursing diploma.

In terms of years of experience, the current study showed that over one-third of the nurses who participated had more than ten years of experience. This result is consistent with the findings of Deshmukh & Shinde, (2014), who noted that almost all of the nurses in their study who were giving patient care had more than 20 years of experience.

However, this conclusion contradicts the findings of Woods-Hill et al., (2021) ; Akinwale, (2015), who reported that most of the sample under study had four to five years of experience. These

results are further contradicted by **Emad Mahmoud et al., (2021)** ; **Kadium, (2015)**, who indicated that the majority of the study group had expertise spanning more than 6 years.

According to the researcher's perspective, years of experience improved the quality of care given, but it was also discovered that more seasoned nurses' knowledge was based more on customs and opinions than on evidence-based recommendations. Therefore, while years of experience may seem to be a crucial factor in a nurse's professionalism and competence, other qualifications such as ongoing education, ethics, communication, and decision-making weigh heavily against years of experience in determining a nurse's knowledge and practice.

Section II: Participant nurses' compliance with CLMB

According to recent study, related to first domain we found that less than two thirds of the participating nurses didn't check patients' record for CVC during their daily rounds. These findings agree with those of **Al Qadire and Hani (2022)** who stated that only 40% of the study sample had knowledge of the recommendation for routine replacement of CVC. On the contrary, **Emad Mahmoud et al. (2021)** found that 61.6 percent of the studied sample needed more knowledge about CVC. According to the study, having a sufficient record in the patient's medical file indicates the caliber of treatment and may even be a sign of increased productivity at work.

Additionally, regarding to educated healthcare staff domain these results revealed that above one-third of them were educated on how to manage with central lines. These results corroborate those of **Emad Mahmoud et al., (2021)**, who concluded that staff education regarding the CVC care bundle is crucial. It is evident that maintaining knowledge and skills through central line care package training has become essential to preventing bloodstream infections associated with central lines. According to the researcher, staff education regarding the CVC care bundle is crucial and plays a significant part in their training. It also gives them access to necessary supplies and equipment and helps monitor nurses' compliance, all of which lower the risk of infection and improve the standard of care.

Among the different activities related to participant nurses' practices regarding CLMB, above half of participant nurses don't change dressings with gauze and tape daily domain. In contrast to a study carried out by **Aloush and Alsaraireh (2018)**, who found that most nurses showed sufficient compliance with changing

dressings with gauze and tape daily. From the researcher Point of view, The findings suggest that additional training programs and ongoing compliance monitoring are necessary for staff nurses to effectively apply bundle items, thereby reducing infection rates and improving care quality.

Before donning sterile gloves and following any contact with a potentially contaminated location, it is imperative to wash hands. Hand cleanliness is emphasized in all CVC care standards (**Gulnur & Kazan, 2021**). Because nursing professionals have low compliance, educational sessions should focus on the second instant, which is before the aseptic treatment. This is because nursing professionals occasionally do several procedures on the same patient without washing their hands—instead, they just change their gloves. In order to promote hygiene, the ICU provides alcohol dispensers adjacent to patient beds in addition to sinks that are equipped with soap and water (**Sichieri et al., 2018**).

The current results show that most of the participant nurses' performed CVC care using sterile gloves. It could be recommended by basic nursing textbooks (**Taylor et al., 2014**) to use sterile gloves in CVC care. In addition, nurses found that using sterile gloves and an antiseptic solution was more practical. These results are consistent with those of **Snarski et al. (2015)**, who found a higher rate of use of sterile gloves among the studied nurses.

Additionally, in line with **Valencia et al., (2016)** who conducted a study on inadequate adherence to recommendations for preventing central line-associated bloodstream infections (CLABSI), the results of a global survey revealed that over three-fourths of nurses followed PPE standards during insertion. According to the researcher's perspective, ongoing instruction, supervision, and training improved adherence to PPE and hand cleanliness during CVC care.

Also, the results of the current study revealed that all participating nurses didn't comply the domain with cleaning the dressing area with 0.5% or higher chlorhexidine in an alcohol solution. This may have contributed to the fact that chlorhexidine wasn't used in the hospital. From a view of point, this could be explained by the lack of an appropriate solution in hospitals because it is so expensive. It is recommended that chlorhexidine gluconate be used for cauterization sites (**Lin et al., 2022**). However, the nurses mostly used povidone and iodine; the reasons for this might be lower cost, accessibility, or hospital policy.

Furthermore, the majority of participant nurses applied dressing without letting the solution dry. It could be that the nurses needed to be motivated to let the solution dry, and it is simple but significant in preventing infection. This result agrees with **Gerceker, Yardimci, and Aydinok (2017)** who stated that the nurse's sample did not perform this step. Also, **Arslan et al. (2020)** report that a few studied samples were observed to be disinfected with alcohol and subsequently waited for it to dry. In contrast, studies by **Balla et al. (2018)**, **Mutlu and Senturan (2017)** and **Lai et al. (2018)** indicated that the rate of letting alcohol dry among nurses' samples is high.

These results found that more than three quarters of the studied nurses have negative compliance with CLMB, while less than one-third have positive compliance with CLMB. From the researcher view of point, this may be due to many factors such as absent of record of daily rounds, nurses' knowledge about CVC care and absent of CVC maintenance protocol. This result agrees with studies by **Alkubati, Ahmed, Mohamed, Fayed, and Asfour (2015)** and **Valencia et al. (2016)**.

On the other hand, a study done by **Aloush and Alsaraireh (2018)** showed sufficient nurses' compliance. As well, there was a substantial sufficiency in bundle compliance in the study done by **Gupta et al. (2021)**, who evaluated the bundle technique in an adult cardiac intensive care unit to attain zero central line-associated bloodstream infections. The current study revealed that more than half of the participant nurses had unsatisfactory levels regarding CLMB. There could be an imbalance in the number of patients and nurses because of a staffing deficit, work overload, a lack of hospital protocols of care, particularly for central line care, a lack of educational opportunities and workshops, and a lack of collaboration amongst the members of the multidisciplinary team.

Paying attention to the nurses' workload is of the most importance to maintain patients' safety and improve outcomes. To ascertain the true level of adherence to every item in the bundle and to look into the causes of non-adherence, research is required. Innovative and imaginative technology is required to ensure full compliance with all of the bundle components (**Burke et al., 2021**). These findings agree with the study conducted by **Lai et al. (2018)**, who stated that compliance was lowest among the studied nurses. However, it was highlighted by **Aloush & Alsaraireh, (2018)** that over 50% of nurses complied with central line bundles competently. According to the researcher's perspective, this outcome suggests that staff nurses

require additional training and ongoing supervision.

Section III: Distribution of the Participant Nurses' Regarding Total Level of Factors Affecting Their Compliance with CLMB

As regards participant nurses' factors affecting their compliance with CLMB. The work environment, where clear instructions help CCNs use CLMB effectively, the presence of infection control techniques at the work setting, and ongoing training are some of the numerous elements that influence nurses' performance when it comes to providing CLMB care. However, issues including overwork and shortages of nursing staff. These findings are consistent with other studies done by **Buetti et al. (2022)** who assessed the role of understaffing in CLABSI and indicated that nursing staff reductions were below a critical level. It was found that factors like records of daily rounds and procedures for performing CVC dressings were absent by more than two-thirds of nurses for both. Lack of adherence to hand hygiene immediately prior to CVC manipulation was not present in about two-thirds of nurses.

According to study findings regarding factors affecting participants compliance with CLMB found that more than one third of participating nurses illustrated that affecting factors such as knowledge among the nursing team about CVC care and technical problems with transparent film curative (loose, small) for each of them Consistency with **Jaslina Gnanarani, (2018)**, who studied the effectiveness of central line bundle care upon the knowledge and compliance staff nurses who stated that the majority of nurses had an inadequate level of knowledge regarding CVC care and the level of practice of nurses during CVC insertion study was also considered to be poor. On contrary, **Almahmoud et al. (2020)** reported that physicians and nurses who participated in the study had generally high knowledge and compliance of central line bundles. From the researcher view of point, these results related to deficiency of educational program regarding CVC bundle.

In relation to the procedure for performing CVC maintenance, more than two thirds of participating nurses reveals that, perform CVC dressing every seven days or sooner if it is no longer intact or moisture collected under it. These results are in line with a study conducted by **Saggu, Asmat, Margrate, and Ahmed, (2018)** which found that nurses' adherence to CDC guidelines significantly reduced the risk of central line infections in patients.

Section IV: Correlation between the study variables

The findings of the present study showed that there was a statistically significant relation between the socio-demographic characteristics of the participant nurses' regarding qualifications, job title, work experience in the ICU, and previous educational training programs related to CVC care. This result was consistent with that of **Eskander et al. (2013)**, who reported that the only significant statistical variations in mean knowledge scores were found in connection to years of experience and age.

There was no statistically significant relation between the socio-demographic characteristics of the participant nurses regarding age, gender, workplace, and working shift ($p\text{-value} > 0.05$). This result was in line with the findings of **(Ali, 2013)** who found no statistically significant correlation between the age and years of ICU experience of the nurses under study and their attendance at training sessions, workshops, and scientific conferences.

There was a statistically significant relation between socio-demographic characteristics of the studied nurses on their total mean score of factors affecting their compliance with CLMB regarding workplace, qualifications, job title and attending previous educational training programs related to CVC care as ($p\text{-value} > 0.05$). There was no statistically significant correlation regarding gender, age, work experience in ICU (in years) and working shift as ($p\text{-value} < 0.05$).

Although there is no statistically significant correlation between the factors pertaining to nurses and the domains of nursing performance, the researcher believes that these factors—such as the lack of nursing staff, job satisfaction, and the frequency with which nurses are assessed for their knowledge of central line associated bloodstream infection—have a significant impact on nursing performance.

According to our study the majority of the studied nurses had unsatisfactory level regarding total factors level and were noncompliant to CLMB. And only 23.7% of the studied nurses were satisfied and compliant regarding total factors affecting nurses' compliance with CLMB.

In contrast to **Aloush & Alsaraireh's, (2018)** study about nurses' compliance with central line-associated bloodstream infection prevention guidelines, which demonstrated that more than half of nurses had competent compliance with bundles, the study by **Emad Mahmoud, Salah El-Dien Al-Rafay, & Salah Ismail, (2021)** supports this claim. It indicated that the majority of the studied nurses

were not in compliance with care bundles.

Conclusion:

Based on the findings of the current study, it can be concluded that participant nurses' total compliance score level with CLMB was unsatisfactory. Two-thirds (65%) of them had unsatisfactory levels regarding CLMB. There was a strong negative relation (76.3%) between the level of total CLMB of the participant nurses and the total level of factors affecting their compliance with CLMB. This highlights the need for continuous training programs to improve nurses' compliance with CVC care.

Recommendations:

A. For Critical Care Nurses

Implementing the CLMB as a part of routine care for CIPs in ICUs

Attending training programs on the CLMB bundle to update CCNs' knowledge and practice

B. For the Hospital's Administrator

Providing written guidelines and posters about CVC care in ICUs to enhance the quality of care delivered to CIPs

Providing recent Arabic resources about CVC care in the ICUs for CCNs to encourage them to improve their knowledge and skills

Periodically organizing continuous training programs and refreshing workshops about the CLMB for CIPs in ICUs to motivate them to update their knowledge and skill levels

C. For Further Research

Replication of the study on a larger probability sample from various sites in Egypt to provide strong evidence about the effectiveness of the CLMB in reducing the complications of central lines and enriching this area of patients' care

Assessment of nurses' compliance regarding the CLMB implementation for CIPs in the ICUs

Evaluation of the barriers affecting implementation of the CLMB in ICUs

Investigating the effect of applying CLMB on patients' outcomes and reducing complications

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Declaration of Conflicting of Interests

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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 (4), 594-601. DOI: [10.1111/nicc.12577](https://doi.org/10.1111/nicc.12577)
- Alkubati, S. A., Ahmed, N. T., Mohamed, O. N., Fayed, A. M., & Asfour, H. I. (2015). Health care workers' knowledge and practices regarding the prevention of central venous catheter-related infection. *American journal of infection control*, 43 (1), 26-30. DOI: [10.1016/j.ajic.2014.09.021](https://doi.org/10.1016/j.ajic.2014.09.021)
- Almahmoud, R. S., Alfarhan, M. A., Alanazi, W. M., Alhamidy, F. K., Balkhy, H. H., Alshamrani, M., ... & Bahron, S. A. (2020). Assessment knowledge and practices of central line insertion and maintenance in adult intensive care units at a tertiary care hospital in Saudi Arabia. *Journal of Infection and Public Health*, 13 (11), 1694-1698. DOI: [10.1016/j.jiph.2020.07.009](https://doi.org/10.1016/j.jiph.2020.07.009)
- Aloush, S. M., & Alsaraireh, F. A. (2018). Nurses' compliance with central line associated blood stream infection prevention guidelines. *Saudi medical journal*, 39 (3), 273. DOI: [10.15537/smj.2018.3.21497](https://doi.org/10.15537/smj.2018.3.21497)
- Arslan GG, Ozden D, Alan N, Yilmaz I, Ayik C, Goktuna G.(2020). Examination of nursing drug administration practices via central venous catheter: An observational study. *J Vasc Access* 2020;21:426-33. DOI: [10.1177/1129729819880979](https://doi.org/10.1177/1129729819880979)
- Balla, K. C., Rao, S. P., Arul, C., Shashidhar, A., Prashantha, Y. N., Nagaraj, S., & Suresh, G. (2018). Decreasing central line-associated bloodstream infections through quality improvement initiative. *Indian Pediatrics*, 55, 753-756. Retrieved from: <https://pubmed.ncbi.nlm.nih.gov/30345978/>
- Blot, K., Hammami, N., Blot, S., Vogelaers, D., & Lambert, M. L. (2022). Gram-negative central line-associated bloodstream infection incidence peak during the summer: Anational seasonality cohort study. *Scientific reports*, 12 (1), 1-7 .Retrieved from <https://doi.org/10.1038/s41598-022-08973-9>
- Bolis, D., D'Arrigo, S., Bartesaghi, A., Panzeri, C., Pelegalli, P., Steffanoni, A., ... & Pittiruti, M. (2022). Prospective clinical study on the incidence of catheter-related complications in a neurological intensive care unit: 4 years of experience. *The Journal of Vascular Access*, 11297298221097267. DOI: [10.1177/11297298221097267](https://doi.org/10.1177/11297298221097267)
- Buetti, N., Marschall, J., Drees, M., Fakih, M. G., Hadaway, L., Maragakis, L. L., ... & 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. DOI: [10.1017/ice.2022.87](https://doi.org/10.1017/ice.2022.87)
- Burke, C., Jakub, K., & Kellar, I. (2021). Adherence to the central line bundle in intensive care: An integrative review. *American journal of infection control*, 49 (7), 937-956. DOI: [10.1016/j.ajic.2020.11.014](https://doi.org/10.1016/j.ajic.2020.11.014)
- Center for Disease Control and Prevention (2014). Retrieved from: <https://www.cdc.gov/index.htm>
- Deshmukh, M., & Shinde, M. (2014). Impact of structured education on knowledge and practice regarding venous access device care among nurses. *Int J Sci Res*, 3 (5), 895-901. Retrieved from: <https://www.ijsr.net/archive/v3i5/MDIwMTMxOTYw.pdf>
- Dyk, D., Matusiak, A., Cudak, E., Gutysz-Wojnicka, A., & Mędrzycka-Dąbrowska, W. (2021). Assessment of Knowledge on the Prevention of Central-Line-Associated Bloodstream Infections among Intensive Care Nurses in Poland—A Prospective Multicentre Study. *International Journal of Environmental Research and Public Health*, 18(23), 12672. DOI: [10.3390/ijerph182312672](https://doi.org/10.3390/ijerph182312672)
- El-Sol, A., & Badawy, A. (2017). The effect of a designed teaching module regarding prevention of central-line associated blood stream infection on ICU nurses' knowledge and practice. *American Journal of Nursing Science*, 6 (1), 11-18. DOI: [10.11648/j.ajns.20170601.12](https://doi.org/10.11648/j.ajns.20170601.12)
- Emad Mahmoud, S., Salah El-Dien Al-Rafay, S., & Salah Ismail, S. (2021). Nursing Knowledge and Compliance regarding Central Line Associated Blood Stream Infection Bundle in Neonatal Intensive Care Units: An Assessment Study. *Egyptian Journal of Health Care*, 12 (3), 1762-1781. DOI: [10.21608/ejhc.2021.213855](https://doi.org/10.21608/ejhc.2021.213855)
- Esposito, M. R., Guillari, A., & Angelillo, I. F. (2017). Knowledge, attitudes, and practice on the prevention of central line-associated bloodstream infections among nurses in oncological care: A cross-sectional study in an area of southern Italy. *PLoS One*, 12 (6), 0180473. DOI: [10.1371/journal.pone.0180473](https://doi.org/10.1371/journal.pone.0180473)

- Frith, J., Hampton, D., Pendleton, M., Montgomery, V. L., & Isaacs, P. (2020). Impact of Kamishibai card process on compliance with the central venous line maintenance bundle. *Journal of Nursing Care Quality*, 35 (1), 34-39. DOI: [10.1097/NCQ.0000000000000405](https://doi.org/10.1097/NCQ.0000000000000405)
- Golubenko, D. V., Manin, A. D., Wang, Y., Xu, T., & Yaroslavtsev, A. B. (2022). The way to increase the monovalent ion selectivity of FujiFilm® anion-exchange membranes by cerium phosphate modification for electrodialysis desalination. *Desalination*, 531, 115719. Retrieved from: <https://doi.org/10.1016/j.desal.2022.115719>
- Gulnur, K. A. R., & KAZAN, E. E. (2021). Evaluation of skills of intensive care nurses regarding central venous catheter care: An observational study. *Marmara Medical Journal*, 34 (3), 298-306. Retrieved from: <https://doi.org/10.5472/marumj.1012090>
- Jardim, J. M., Lacerda, R. A., Soares, N. D. J. D., & Nunes, B. K. (2013). Evaluation of practices for the prevention and control of bloodstream infections in a government hospital. *Revista da Escola de Enfermagem da USP*, 47, 38-45. DOI: [10.1590/s0080-62342013000100005](https://doi.org/10.1590/s0080-62342013000100005)
- Joanna Briggs Institute. (2014). The Joanna Briggs Institute reviewers manual 2014: the systematic review of prevalence and incidence data. Adelaide: Joanna Briggs Institute. Retrieved from: <https://doi.org/10.1590/1518-8345.2885.3074>
- Kadium, M. J. (2015). *Improving nurses' knowledge to reduce catheter-related bloodstream infection in hemodialysis unit* (Doctoral dissertation, Walden University). Retrieved from: <https://scholarworks.waldenu.edu/dissertations/1623/>
- Lai, C. C., Cia, C. T., Chiang, H. T., Kung, Y. C., Shi, Z. Y., Chuang, Y. C., ... & Hsueh, P. R. (2018). Implementation of a national bundle care program to reduce central line-associated bloodstream infections in intensive care units in Taiwan. *Journal of microbiology, immunology and infection*, 51 (5), 666-671. Retrieved from: <https://doi.org/10.1016/j.jmii.2017.10.001>
- Macey, A., O'Reilly, G., Williams, G., & Cameron, P. (2022). Critical care nursing role in low and lower middle-income settings: a scoping review. *BMJ open*, 12(1), 055585. Retrieved from: [http://dx.doi.org/10.1136/bmjopen-2021-055585](https://doi.org/10.1136/bmjopen-2021-055585)
- Matlab, A. A., Al-Hussami, M. O., & Alkaid Albqoor, M. (2022). Knowledge and compliance to prevention of central line-associated blood stream infections among registered nurses in Jordan. *Journal of Infection Prevention*, 23 (4), 133-141. DOI: [10.1177/17571774211066778](https://doi.org/10.1177/17571774211066778)
- Mazzotta, C. P. (2022). (Re) evaluating Critical Care Nurse Support Program (s) in a Tertiary Care Hospital: Intersecting the Art and Science of Nursing. Retrieved from <https://ir.lib.uwo.ca/oip/293>
- Mehri, F., Babaei-Pouya, A., & Karimollahi, M. (2022). Intensive care unit nurses in Iran: occupational cognitive failures and job content. *Frontiers in Public Health*, 10, 786470. DOI: [10.3389/fpubh.2022.786470](https://doi.org/10.3389/fpubh.2022.786470)
- Moursy, A., & Sharaf, A. (2017). Vascular access care at hemodialysis unit; nurses compliance to infection prevention and control practices. *IORS Journal of Nursing and Health Science*, 6 (2), 6-10. DOI: [10.9790/1959-0602036169](https://doi.org/10.9790/1959-0602036169)
- Myatra, S. N. (2019). Improving hand hygiene practices to reduce CLABSI rates: nurses education integral for success. *Indian journal of critical care medicine: peer-reviewed, official publication of Indian Society of Critical Care Medicine*, 23 (7), 291. DOI: [10.5005/jp-journals-10071-23200](https://doi.org/10.5005/jp-journals-10071-23200)
- Patanè, D., Morale, W., Bonomo, S., Failla, G., Santonocito, S., Camerano, F., ... & Stefano, A. (2022). Complex central venous catheter for dialysis: interventional radiology experience in insertion and management of their complications. *The Journal of Vascular Access*, 11297298221103209. DOI: [10.1177/11297298221103209](https://doi.org/10.1177/11297298221103209)
- Randa, M. B., & Phale, J. M. (2023). The effects of high nurses' turnover on patient care: Perspectives of unit managers in critical care units. *International Journal of Africa Nursing Sciences*, 19, 100580. Retrieved from: <https://doi.org/10.1016/j.ijans.2023.100580>
- Rocha, R. D. P. F. (2022). Patient safety in hemodialysis. *Multidisciplinary Experiences in Renal Replacement Therapy*, 67. DOI: [10.5772/intechopen.101706](https://doi.org/10.5772/intechopen.101706)

- Saggu, Y., Asmat, K., Margrate, M., & Ahmad, N. (2018).** Preventing Central Line Infections among Hemodialysis Patients: Nurses' Knowledge and Practices in Accordance With Center for Disease Control and Prevention (CDC) Guidelines. *Isra Medical Journal*, 10 (2).
- Shaw, C., Ward, C., Gordon, J., Williams, K., & Herr, K. (2022).** Characteristics of elderspeak communication in hospital dementia care: Findings from The Nurse Talk observational study. *International journal of nursing studies*, 132, 104259. Retrieved from <https://doi.org/10.1016/j.ijnurstu.2022.104259>
- Sichieri, K., Iida, L. I. S., Garcia, P. C., Santos, T. R., Peres, E., Shimoda, G. T., ... & de Araújo Püschel, V. A. (2018).** Central line bundle maintenance among adults in a university hospital intensive care unit in São Paulo, Brazil: a best practice implementation project. *JB I Evidence Synthesis*, 16(6), 1454-1473. DOI: 10.11124/JBISIRIR-2017-003561
- Stern, R. A., Harris, B. D., DeVault, M., & Talbot, T. R. (2022).** Identifying barriers to compliance with a universal inpatient protocol for *Staphylococcus aureus* nasal decolonization with povidone-iodine. *Infection Control & Hospital Epidemiology*, 1-4. DOI: <https://doi.org/10.1017/ice.2022.234>
- Snarski, E., Mank, A., Iacobelli, S., Hoek, J., Styczyński, J., Babic, A., ... & Johansson, E. (2015).** Current practices used for the prevention of central venous catheter-associated infection in hematopoietic stem cell transplantation recipients: a survey from the Infectious Diseases Working Party and Nurses' Group of EBMT. *Transplant Infectious Disease*, 17 (4), 558-565. Retrieved from: <https://doi.org/10.1111/tid.12399>
- Tajani, A., Au, A., & Fields, J. M. (2020).** Ultrasound-guided central venous access. *The Ultimate Guide to Point-of-Care Ultrasound-Guided Procedures*, 81-98. Retrieved from: https://doi.org/10.1007/978-3-030-28267-7_6
- Taylor, J. E., McDonald, S. J., & Tan, K. (2014).** Prevention of central venous catheter-related infection in the neonatal unit: a literature review. *The Journal of Maternal-Fetal & Neonatal Medicine*, 28 (10), 1224-1230. Retrieved from: <https://doi.org/10.3109/14767058.2014.949663>
- Wang, Y., & Sun, X. (2022).** Reevaluation of lock solutions for Central venous catheters in hemodialysis: a narrative review. *Renal Failure*, 44 (1), 1501-1518 . DOI: [10.1080/0886022X.2022.2118068](https://doi.org/10.1080/0886022X.2022.2118068)
- Wolfhagen, N., Boldingh, Q. J., Boermeester, M. A., & de Jonge, S. W. (2022).** Perioperative care bundles for the prevention of surgical-site infections: meta-analysis. *British Journal of Surgery*, 109 (10), 933-942. DOI: [10.1093/bjs/znac196](https://doi.org/10.1093/bjs/znac196)
- Woods-Hill, C. Z., Papili, K., Nelson, E., Lipinski, K., Shea, J., Beidas, R., & Lane-Fall, M. (2021).** Harnessing implementation science to optimize harm prevention in critically ill children: a pilot study of bedside nurse CLABSI bundle performance in the pediatric intensive care unit. *American journal of infection control*, 49 (3), 345-351. Retrieved from <https://doi.org/10.1016/j.ajic.2020.08.019>
- Zeyada, F. Y. M., El-Hay, A., Seham, A., & Al-Metyazidy, H. A. (2021).** Effect of Educational Guidelines on Nurses' Knowledge and Practice Regarding Central Line Associated Blood Stream Infection at Intensive Care Unit. *Tanta Scientific Nursing Journal*, 23 (4), 160-187. DOI: [10.21608/tsnj.2021.208735](https://doi.org/10.21608/tsnj.2021.208735)