Adherence of Pediatric Intensive Care Nurses to Central Venous Line Care Bundle

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Abstract

Background: *Central Venous Lines (CVLs) are crucial for managing critically ill children but are also associated with the risk of Central Line-Associated Bloodstream Infections (CLABSIs), which can lead to prolonged hospital stays, higher morbidity and mortality rates. Adherence to evidence-based care bundles by pediatric intensive care nurses is vital for reducing the incidence of CLABSI and improving outcomes for children with CVLs.* ***Aim:*** *The study aimed to assess adherence of pediatric intensive care nurses to central venous line care bundle.* ***Setting:*** *The study was conducted in Pediatric Intensive Care Unit (PICU) at Alexandria University Children's Hospital (AUCH) at El-Shatby.* ***Subjects and sampling:*** *Non probability convenience sampling technique was used to recruit all available pediatric nurses in PICU (25 nurses) who were responsible for providing CVL care bundle.* ***Tool:*** *One tool was used to collect necessary data: Adherence of Pediatric Intensive Care Nurses to Central venous line Care Bundle Observational Checklists.* ***Results:*** *More than half of the studied nurses (52%) had good adherence to wearing personal protective equipment, more than two-fifths of them (44%) obtained satisfactory score regarding adherence to hand hygiene. Less than three-quarters of nurses (72%) had obtained satisfactory score regarding removal of central venous line. While, 44% of them obtained unsatisfactory score regarding adherence to dressing of central venous line.* ***Conclusion:*** *It was concluded from this study that more than two-thirds of the studied nurses had overall "Satisfactory" adherence to central venous line care bundle.* ***Recommendations:*** *Based on the previous findings and conclusion: Training of nurses and health care providers on using CVL recent guidelines is recommended to improve their knowledge and practices of care provided for children with CVL.*

Keywords: Adherence, pediatric Nurses, Central Venous Line, Bundle, Pediatric Intensive Care.
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Introduction

Admission of pediatric patients with serious problems or complicated cases to Intensive Care Unit (ICU), usually needs insertion of devices to manage, control and treat the disease and its signs. One of the frequently used devices are Central Venous Access Devices (CVADs) (Chaiyakulsil & Pharadornuwat, 2021). Central Venous Line (CVL) is the most commonly used type of CVADs in the critical care units. It is used for wide spectrum of indications including medication administration as chemotherapy, vasopressors and hypertonic solution which can damage the peripheral vessels. It is also needed for administering large volumes of fluids as parenteral nutrition or intravenous antibiotics. In addition, CVL is highly suggested in case of difficult peripheral

cannulation, also used for special therapies as hemodialysis and plasmapheresis. Moreover, it is essential for monitoring of central venous pressure (Huygh et al., 2016).

The complications from CVL are numerous and serious despite the frequent advantages. The most common complication is the infection which is termed as Central Line Associated Blood Stream Infection (CLABSI). In Egypt, the prevalence of CLABSI is 14.1 per 1000 central line days in the Pediatric Intensive Care Unit (PICU), which represents about 60% of hospital acquired infection (Abdelmoneim et al., 2020). The CLABSI is responsible for long hospital stay, increasing the financial burden, morbidity and mortality rates among pediatrics. The long stay of sick children in PICUs demands meticulous care in handling connected devices and accesses to the child particularly CVL, in order to avoid the possible adverse events (Dias et al., 2022).

Central Venous Line care bundle was first emerged in 2011 by Healthcare Infection Control Practices Advisory Committee of Center for Disease Control and Prevention (CDC) and last updated in 2022 (CDC, 2023). The aim of the bundle was to unite the care provided to specific group of patients, to deliver the care with the highest quality. Central Venous Line care bundle consists of insertion bundle, maintenance and removal bundle (Khalifa et al., 2022). The maintenance bundle entails daily assessment of the line necessity, hand hygiene reinforced in every procedure related to CVL, the proper handling of personal protective equipment needed in the daily care. In addition, disinfection of the line ports with the recommended antiseptic solution, dressing change, proper administration set and needleless connector change also the prompt removal of the line when no more indicated (Abad et al., 2023).

Pediatric intensive care nurses play a significant role in adherence with evidence-based practices care bundle which is considered the most important tool in reducing the incidence of CLABSI and improving the children outcome (CDC, 2022). Subsequently, the adoption of CVL bundle policies and other practices, CLABSI rates among ICUs collectively have fallen nearly 60% in the past decade. However, in Egypt it is important to acknowledge that not all hospitals adopted central line bundle policies. Therefore, there is a forceful need to help nurses to compliance with the care bundle to decrease CLABSI rates (Edwards et al., 2015).

Aim of the study

The aim of the present study was to assess adherence of pediatric intensive care nurses to central venous line care bundle

Research question

What is the level of pediatric intensive care nurses' adherence to central venous line care bundle?

Materials and Method

Study design:

A descriptive research design was utilized in this study.

Setting:

The study was conducted at Pediatric Intensive Care Unit (PICU) in Alexandria University Children's Hospital (AUCH) at El-Shatby.

Subjects and Sampling

A non-probability convenience sampling technique was used to recruit all available

pediatric nurses in PICU (25 nurses) who were responsible for providing Central Venous Line (CVL) care bundle during morning shifts in the previously mentioned setting comprised the study subjects, regardless of their age, qualifications and years of experience.

Tool

One tool was used to collect the data: -

Adherence of Pediatric Intensive Care Nurses to Central Venous Line Care Bundle Observational Checklist: -

The tool was developed by the researcher after thorough review of recent and relevant literatures (O'Grady, 2011; CDC, 2017; American Society of Anesthesiologists [ASA], 2020) to assess adherence of PICU nurses to CVL care bundle. It consisted of two parts:

Part I: Socio-demographic characteristics of nurses:

It involved personal and professional data of the pediatric nurses such as; Age, sex, qualifications, years of experience, attendance of training courses related to care of CVL. It is also included attendance of discussions about care of CVL with infection control team in the unit and orientation about policy of CVL care bundle in the unit.

Part II: Adherence of nurses to central venous line care bundle observational checklists; which included the following procedures:

- Hand hygiene including hand washing and hand rub.
- Wearing personal protective equipment.
- Assessment of the central venous line.
- Dressing of central venous line.
- Administration of fluid /medication through the central venous line.
- Central venous line needleless connector change.
- Administration set change.
- Removal of the central venous line when no longer deemed clinically necessary.

Each step of each procedure was scored as follows; completely done (2), incompletely done (1) and not done (zero). Then the results number of each procedure was transformed into percentage.

The average percentage of all procedures was calculated and finally nurses` adherence classified as follows:

- Good adherence level = More than 80%
- Satisfactory adherence level = from 60% to 80%
- Unsatisfactory adherence level = less than 60%

Method

-Approval from Research Ethics Committee, Faculty of Nursing, Alexandria University was obtained before carrying out the study.

-Official letter was directed to the responsible authority of the chosen hospital.

- The tool was developed by the researcher after reviewing the current and relevant literatures.

- The developed tool was submitted to a jury of five experts in the pediatric nursing field to determine its applicability and content validity. The validity of the tool was 98.47%. Based on their comments, necessary modifications were done.

-Reliability of the tool was done using Cronbach Coefficient Alpha Test where r = 0.906.

- A pilot study was carried out on two nurses to ascertain the clarity and applicability of the tool. Accordingly, some modifications were

done. Those nurses were excluded from the study subject.

- Every nurse was observed individually in three morning shifts by the researcher while caring of the child with CVL and performing each step in the procedures related to CVL care bundle using part II of the tool (Total observations = 75).
- Every nurse was observed three times while performing CVL dressing change procedure and removal of CVL procedure. The observation was by the video recording camera that is present in PICU and provides filming for each bed in the unit 24 hours per day and seven days per week. As those procedures were done every seven days or as needed and usually done at the night shift.
- Each observation took an average of 6 hours for each shift. Nurses were not aware that the researcher observed their practices, and each observation checklist was filled out immediately while observing the nursing care.
- Data were collected over a period of eleven months from September 2022 to July 2023.
- After completion of data collection, the necessary statistical analysis was done to assess adherence of Pediatric Intensive Care Nurses to Central Venous Line Care Bundle.
- Every nurse was asked individually about her socio-demographic characteristics after completion of data collection in the nurses` office.

Ethical Considerations

1- Witness informed consent was obtained from the head nurse of PICU after explaining the aim of the study.

2- Confidentiality was ascertained during and after data collection for every studied nurse.

Statistical Analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. Qualitative data were described using number and percent. The Shapiro-Wilk test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level.

The used tests were

1 - Student t-test to compare between two studied categories.

2 - F-test (ANOVA) to compare between more than two categories.

Results

Table (I) summarizes the sociodemographic characteristics of studied nurses. It was found that more than half of the studied nurses (60%) aged from 25 years to less than 35 years, and more than one-quarter of them (28%) aged from 35 years to less than 45 years, with a mean age of 32.08 ± 6.92 years. Slightly less than two-thirds of nurses (64%) had bachelor degree of nursing, and one-fifth of them (20%) had technical institute of nursing diploma.

Regarding years of experience, more than half of the nurses (56.0%) had less than 5 years of experience in pediatric intensive care unit. While, near one-quarter of the nurses (24%) had an experience from 10 years and more, with a mean experience of 6.88 ± 7.64 years. It was also found that almost all the nurses (96%) did not attend courses related to CVL care bundle. It was clear from the table that all the nurses attended discussions about care of central venous line with infection control team members, and oriented about unit policy of

central venous line care bundle (100% for each).

Figure (I) sheds the light upon the percent scores of adherence of pediatric intensive care nurses to central venous line care bundle. More than two-thirds of the studied nurses (68%) obtained satisfactory adherence. While less than one-third of the nurses (32%) had unsatisfactory adherence and none of the them obtained good adherence.

Table (II) describes the distribution of the studied pediatric intensive care nurses` to their total percent score for adherence to central venous line care bundle. It was observed that the mean score to hand hygiene was 65.55 ± 16.50, and mean percent score for adherence of personal protective equipment was 78.67 ± 10.07. In addition, adherence of nurses to removal of central venous line with mean score, 68.67 ± 8.90. The total nurses 'adherence had a mean, 63.48 ± 7.27, with a median of 64.38.

The relationship between total percent scores of pediatric intensive care nurses` adherence to central venous line care bundle and their socio-demographic characteristics is presented in **Table (III)** It is obvious from the table that there is no statistically significant relationship between total percent scores of pediatric intensive care nurses` adherence to central venous line care bundle and their gender, age, the level of education as well as years of experience (P= 0.744, 0.971, 0.412& 0.382 respectively).

Discussion

Central Venous Line (CVL) is an advanced technology used widely in pediatric intensive care units (PICUs). It supports children lives and contributes to decrease the morbidity rates and deaths among critically ill children (Araújo et al., 2017). Worldwide, Central Line Associated Blood Stream Infection (CLABSI) is considered the most common and frequent occurred complication with CVL in pediatrics, which in role leads to lengthening patients` hospital stay, increasing morbidity and mortality rates (Croghan, 2023).

Achieving Zero CLABSI is considered a challenge to the health care organizations. However, it can be attained by simple measures collected in a care bundle and had been adhered to by the medical team and nursing staff (Alves da Silva et al., 2023). In such context, the present findings illustrated that slightly less than two-thirds of nurses had bachelor degree of nursing, while one-fifth of the nurses had technical institute of nursing diploma **(Table I)**. This finding could be attributed to the interest of the governmental hospitals to recruit bachelor nurses to work especially in the intensive care units for the purpose of achieving high quality of care and decreasing the financial burden on the health care sector. The present study coincided with Gulnur and Kazan (2021) who conducted an observational study in Istanbul, Turkey on intensive care nurses while performing CVL care and stated that about two-thirds of the nurses were with bachelor's degrees.

Concerning the years of experience, the present study clarified that slightly less than two-thirds of nurses had an experience less than five years **(Table I)**. This finding could be expounded by saying that those

studied nurses were recently graduated and most of them under two years of government mandate, and a lot of nurses after spending the government mandate they tend to move to private hospitals for more finance. Furthermore, PICU leans toward the freshly graduated nurses to work with contract to overcome the shortage in nursing staff. This result agreed with Alfar et al. (2020) who conducted a study at Kafr El Sheikh General Hospital in Egypt and reported that about two-thirds of the studied nurses had an experience less than five years.

As regard attendance of training courses about care of CVL. It definitely helps updating the nurses` knowledge and practices through carrying out continuing educational programs including recent evidence-based guidelines which will reflect on the quality of care provided to the patient (Zeyada et al., 2021). In the present study it was noticed that almost all of the nurses did not attend any training course about the care of CVL **(Table I).** This finding could be attributed to the shortage in nursing personnel and the heavy workload in PICU despite it is one patient to one nurse ratio most of the time, but the patient is critically ill and always needs a lot of work.

Another possible explanation for the present finding can be due to the emphasis of attending training courses placed on infection control team members rather than staff nurses. As the responsibility for training others in infection control practices falls primarily on the infection control team. The current finding relatively agreed with Bayoumi & Mahmoud (2017) who implemented a study of assessing effect of educational program on nurses' performance regarding care of CVL at Benha University Hospital, Egypt and found that three-quarters of the studied nurses did not attend any training programs related to care of CVL. One further study implemented in Ain Shams, Egypt by Said et al. (2020) mentioned that slightly less than two-thirds of the nurses working in critical care unit did not attend training courses.

In relation to the orientation of nurses about care bundle of CVL, the current finding highlighted that all nurses oriented about the presence of care policy in the unit **(Table I)**. The presence of an infection control team in PICU and their regular discussions and scheduled follow-ups with staff nurses may be a contributing factor to the current result. The present finding is in agreement with the results of worldwide survey which reported that the majority of the doctors and nurses working in intensive care units had awareness about CVL guidelines (Valencia et al., 2016).

For overall adherence, the findings of the present study revealed that high percentage of studied nurses, more than two-thirds of them, had overall satisfactory adherence to CVL care bundle **(Figure I)**. Several factors can explain this outcome. The presence of continuous monitoring and observation through the use of camera recording. This may motivate nurses to optimize the care provided. The awareness of being observed might have encouraged them to adhere to the CVL care bundle more diligently. As well, the supervision from infection control team about the proper technique for applying the PPE through

regular reminders and training sessions, which in turn improved adherence to the CVL care bundle. Meanwhile, the periodic discussions held among all staff nurses, led by the responsible infection control member, about the care of CVLs likely had a positive impact **(Table I)**. The present findings relatively aligned with those of de Quadros et al. (2022), whose study reported that all items related to CVL maintenance care in Curitiba, Brazil, scored less than 70%, while complete adherence was achieved at score of 100%. As well, a study conducted in Australia by Lin et al. (2022) who found that 60% compliance in post insertion management practices of CVL in almost all the items of care, while high adherence in their study scored at 95%. In Columbia, United States, 20% of ICUs reported excellent compliance with all elements, and 49% reported compliance at least usually, which scored at ≥75% (Furuya et al., 2016).

In contrast, this result contradicted the finding of Awad et al. (2019), who found that the majority of studied nurses had unsatisfactory practice regarding CVL maintenance bundle, as the scoring system in their study was unsatisfactory practice = less than 26% and satisfactory practice = from 26 to 75%. On the other extreme, Tripathi et al. (2023) assessed the CLABSI prevention bundle and found that the majority of observed bundle opportunities were compliant, with a compliance score of ≥95%. Despite the previously mentioned strong factors in the present study that helped the nurses adhere to the CVL care bundle, there was no good adherence percentage achieved in overall practice **(Figure I)**. The present finding was in dissimilarity with a cross-sectional survey in Jeddah, Saudi Arabia, which revealed that only 5% of the intensive care nurses scored complete adherence to the overall bundle, with complete adherence residing at 100% (Almalki et al., 2023).

It was observed that wearing PPE items occupied the first rank of nurses` adherence to CVL care bundle **(Table II)**. This may be due to focusing of the infection control team members to explain to the nursing staff the situations and procedures in which donning medical mask are needed with the appropriate practice to wear. These finding were partially in harmony with Dias et al. (2022) who concluded that the majority of the nurses adhered to wear medical mask whenever handling CVL. The present finding strongly agreed with Aloush & Alsaraireh (2018) who executed a study in Jordan, where it was displayed that nearly half of the nurses completely and accurately wear sterile gloves during CVL daily maintenance. In addition, the current result is also relatively consistent with Llapa-Rodríguez et al. (2020) who found in their observational study that all the nurses were completely adherent to wear sterile gloves in CVL daily care.

Assessment of CVL was the lowest item of adherence to central venous line care bundle **(Table II)**. It can be explained by saying that nurses may prioritize CVL functionality and longevity over conducting a thorough assessment of the line. In contrary, the majority of the intensive care nurses adhered to assess CVL necessity in a study conducted in Saudi Arabia (Almahmoud et al., 2020).

Furthermore, the present study illustrated that there were no statistically significant differences between nurses` gender, age, level of education as well as years of experience and their adherence to central venous line care bundle **(Table III)**. These findings align closely with a study conducted by Awad et al. (2019), which also reported no statistically significant differences between critical care nurses' mean practice scores concerning CVL care and their age, level of education, and years of experience. The current finding disagreed with a study conducted by Ferrara & Albano (2018) who concluded that nurses with higher number of years of experience were significantly associated with positive practice towards the utility of guidelines for preventing CLABSI.

Conclusion

According to the findings of the present study, it can be concluded that more than two-thirds of the studied nurses had overall "Satisfactory" adherence to central venous line care bundle, and none of the them (0%) obtained good adherence.

Recommendations Based on the previous findings, the following recommendations are suggested:

- Training of nurses on using CVL recent guidelines are recommended and should be included in the orientation of newly hired nurses.
- Availability and accessibility of videos related to CVL daily maintenance with very clear steps to all nurses who worked in ICU.
- Develop a checklist documentation for CVL care bundle for every patient.

Limitations

The study has limitation as it was conducted in a single institutional hospital with 25 nurses, which might limit the generalization of the results

Table (I): Socio-Demographic Characteristics of Studies Nurses

Items	Total (n = 25)	
	No.	%
Gender		
Male	**1**	**4.0**
Female	**24**	**96.0**
Age/ Years		
<25	**1**	**4.0**
25 - <35	**15**	**60.0**
35 - <45	**7**	**28.0**
≥ 45	**2**	**8.0**
Min. – Max.	**23.0 – 49.0**	
Mean ± SD.	**32.08 ± 6.92**	
Median	**30.0**	
Level of education		
Secondary school of nursing diploma	**4**	**16.0**
Technical institute of nursing diploma	**5**	**20.0**
Bachelor degree of nursing	**16**	**64.0**
Years of experience in pediatric intensive care unit		
<5 Years	**14**	**56.0**
5 –	**5**	**20.0**
≥10	**6**	**24.0**
Min. – Max.	**1.0 – 26.0**	
Mean ± SD.	**6.88 ± 7.64**	

Median	**3.0**	
Attendance of training courses about care of central venous line		
Yes	**1**	**4.0**
No	**24**	**96.0**
Attendance of discussions about care of central venous line with infection control team member		
Yes	**25**	**100.0**
No	**0**	**0.0**
Orientation about unit policy of Central venous line care bundle		
Yes	**25**	**100.0**
No	**0**	**0.0**

SD: Standard deviation **n=25 (number of nurses)**

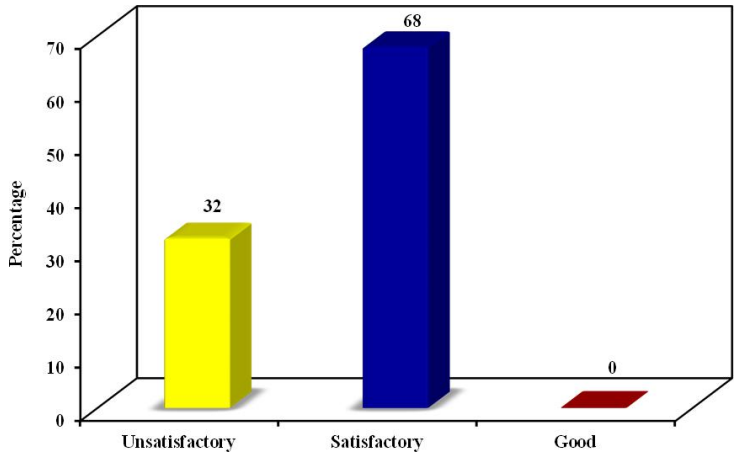

Figure (I): Percent Scores of Adherence of Pediatric Intensive Care Nurses to Central Venous Line Care Bundle

Table (II): Descriptive Analysis of the Studied Pediatric Intensive Care Nurses` According to Percent Score for Adherence of Nurses to Central Venous Line Care Bundle (number of average observations =25)

Adherence of Pediatric Intensive Care Nurses to Central Venous Line Care Bundle	% Score		
	Min. – Max.	Mean ± SD.	Median
Hand Hygiene	**37.04 – 92.59**	**65.55 ± 16.50**	**67.59**
1. Hand Washing	**40.0 – 96.67**	**70.47 ± 18.44**	**70.0**
2. Hand Rub	**31.25 – 93.75**	**59.42 ± 17.72**	**62.50**
Personal Protective Equipment	**55.21 – 97.92**	**78.67 ± 10.07**	**81.25**
1. Wearing Medical Mask	**50.0 – 100.0**	**74.25 ± 12.97**	**77.08**
2. Wearing Sterile Gloves	**54.86 – 97.22**	**80.14 ± 10.60**	**82.64**
Assessment of Central Venous Line	**0.0 – 100.0**	**52.13 ± 34.52**	**60.0**
Dressing of Central Venous Line	**30.26 – 83.77**	**61.60 ± 12.87**	**63.60**
Administration of Fluid/ Medication through Central Venous Line	**45.20 – 71.43**	**58.01 ± 6.55**	**56.06**
Central Venous Line Needleless Connector Change	**42.75 – 78.99**	**56.26 ± 8.76**	**54.35**
Administration Set Change	**45.16 – 66.67**	**55.21 ± 6.26**	**55.38**
Removal of The Central Venous Line	**53.57 – 82.14**	**68.67 ± 8.90**	**69.64**
Total	**44.42 – 79.51**	**63.48 ± 7.27**	**64.38**

SD: Standard deviation

Table (III): Relationship between Total Percent Scores of Pediatric Intensive Care Nurses` Adherence to Central Venous Line Care Bundle and their Socio-Demographic Characteristics

Socio-Demographic Characteristics of The Studied Nurses	Total (n = 25) (Average Observation) Mean ± SD.	Test of Sig.	p
Gender			
Male	**61.08**	**t=**	**0.744**
Female	**63.58 ± 7.41**	**-0.330**	
Age			
<25	**62.32**		
25 - <35	**64.06 ± 5.41**	**F=**	**0.971**
35 - <45	**62.83 ± 6.20**	**0.078**	
≥ 45	**61.97 ± 24.81**		
Level of education			
Secondary school of nursing diploma	**66.14 ± 11.33**	**F=**	**0.412**
Technical institute of nursing diploma	**59.83 ± 9.66**	**0.925**	
Bachelor degree of nursing	**63.95 ± 5.25**		
Years of experience in pediatric intensive care unit			
<5 Years	**64.38 ± 5.22**		
5 –	**65.30 ± 5.48**	**F=**	**0.382**
≥10	**59.86 ± 11.74**	**1.007**	

SD: Standard deviation t: Student t-test F: F for One way ANOVA
P: P Value for comparing between observations
***: Statistically significant at p ≤ 0.**

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