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Impact of Implementing Central Venous Catheter Bundle among Nurses on Patients' Outcomes

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ABSTRACT

Background: Amidst the complex landscape of healthcare, the implementation of Central Venous Catheter (CVC) Bundles is pivotal for patient safety. When disseminating educational programs targeting nurses, exploring their potential impact on quality of adherence to care, thereby improving patient outcomes in clinical settings. **Aim**: to examine the impact of an educational program regarding implementation of central venous catheter bundle among nurses on patients' outcomes. **Design:** Quasi-experimental (one group Pre-test post-test) research design. **Setting:** The study was conducted within ICUof Main Assiut University Hospital. **Sampling:** A convenient sample included 60 patients, assigned into "study and control groups". **Tools:** Patients' Outcomes tool. **Results:** There were significant differences in CVC complications, notably in WBC count at days 3 and 4, and culture & sensitivity (P = 0.017, 0.013, 0.001, respectively). Control group had 53.3% with no microorganism growth; study group had 90%. No significant outcome differences. Less than half of the control group (43.3%) transferred to step down unit compared to 60% in the study group. ICU length of stay did not significantly differ, and mean CVP levels were similar (10.4±5.1 control, 10.5±5.7 study). **Conclusion**: The study findings support the research hypothesis, indicating a positive impact of the educational program on patients' outcomes as evidenced by significantly improved WBC count at day 3 and 4, along with favorable culture & sensitivity results. **Recommendations**: Implementing a robust system for ongoing monitoring, ensuring adherence to evidence-based guidelines. Foster collaboration among nursing staff, infectious disease specialists, and relevant healthcare professionals to collectively address CVC-related complications.

Keywords: Central Venous Catheter Bundle, Nurses &Patients' Outcomes INTRODUCTION

Care bundles, defined as a collection of three to five evidence-based interventions implemented together, serve as a comprehensive approach to enhance care quality. These bundles are extensively employed in tertiary healthcare settings to prevent complications and manage various health conditions **(Lavallee et al., 2017).**

Specifically, the use of central venous access device (CVAD) bundles in the insertion and maintenance of central venous catheters has demonstrated notable reductions in complications and bloodstream infections. This success is attributed to stringent compliance monitoring during implementation **(Blot et al., 2014; Ista et al., 2016; Zingg & Pittet, 2016).**

Hospital-acquired infections (HAIs) pose a significant risk to patients, especially in the intensive care unit (ICU), where intrinsic and extrinsic factors heighten susceptibility. Central Line-Associated Bloodstream Infections (CLABSI) are prevalent in ICUs, contributing to extended hospital stays. Evidence supports the efficacy of care bundles, incorporating evidencebased interventions, in reducing CLABSI rates. The Healthcare Infection Control Practices Advisory Committee (HICPAC) emphasizes education, training, and proper staffing as crucial in preventing intravascular catheter-related infections. Recommendations include educating healthcare personnel, periodic assessments of adherence to guidelines, and designating trained individuals for catheter insertion and maintenance **(Horst et al., 2015; Antonio, 2017).**

The implementation of central intravenous catheter insertion and maintenance bundles has proven successful in numerous hospitals, as reported by studies such as that conducted by **Bertoglio et al., (2017).** These findings underscore the effectiveness of adopting bundled approaches in healthcare practices, emphasizing the positive impact on patient outcomes and the reduction of complications associated with central venous access devices.

Lee et al., (2018) highlighted that many studies provided direct evidence that completing all CL bundle components perfectly is essential for preventing CLABSIs. Customized education should be provided, according to specific weaknesses of bundle performance. **Spencer and Bardin-Spencer, (2020)** underscore the significance of operator experience, noting that the risk of infectious complications is inversely proportional to the operator's skills.

Critical Care Nurses (CCNs) play a pivotal role in ensuring the proper maintenance, monitoring, and management of CVCs, acknowledging both their responsibilities and the challenges they face. Nurses are entrusted with multifaceted responsibilities when it comes to CVC care. These include the insertion and removal of catheters, meticulous monitoring of patients with CVCs, and the prevention and management of associated complications **(Abdo et al., 2020).**

The meticulousness required in handling CVCs demands a high level of expertise from nurses, as they are responsible for maintaining aseptic techniques during procedures to mitigate the risk of infections. Furthermore, nurses are charged with educating patients and their families on the significance of CVC care, as well as the signs and symptoms of potential complications. They are the linchpin in facilitating communication between healthcare providers, ensuring a collaborative approach to CVC care **(Abou Zed & Mohammed, 2020).**

The challenges encountered by nurses in CVC care are manifold. Infection prevention stands out as a paramount concern, as CVCs can serve as a gateway for pathogens. Nurses must navigate the delicate balance of

maintaining a sterile environment during CVC procedures while also preventing complications such as catheter-related bloodstream infections. Time constraints and workload intensify these challenges, as nurses often find themselves juggling numerous responsibilities concurrently. The demand for constant vigilance, coupled with the need for swift responses to changes in patient condition, adds to the complexity of their role **(Cheng et al., 2020).**

The role of nurses in CVC care is inextricably linked to patient safety. By adhering to rigorous protocols and implementing evidence-based practices, nurses contribute significantly to reducing the incidence of catheter-related complications. Their vigilance in monitoring patients with CVCs enables early detection of potential issues, fostering timely intervention and prevention of adverse events. The impact of nurses' role in CVC care on patient safety extends beyond the physical aspects of catheter management. Effective communication and patient education by nurses empower individuals to actively participate in their care, thereby enhancing overall safety and well-being **(William, 2019).**

Significance of the study

The outcomes of the present study will serve as a foundational knowledge resource for ICU nurses, particularly in the realm of central venous catheter management. This knowledge is vital for upholding the highest standards of nursing care, ultimately aimed at enhancing patient outcomes. It is crucial for critical care nurses to be at the forefront of disease control and infection prevention, thereby ensuring the safety of the individuals under their care.

The challenge lies in nursing compliance with established evidence-based practice (EBP) bundles, which is essential for preventing complications related to Central Venous Catheters (CVCs). Lack of knowledge or other factors can impede adherence to EBP, contributing to an increased incidence of Central Line-Associated Bloodstream Infections (CLABSIs) **(Flodgren et al., 2013; Jones et al., 2015).**

Recognizing this challenge, educational programs for nursing staff emerge as pivotal interventions. These programs play a vital role in supporting Critical Care Nurses (CCNs) by fostering the development and enhancement of skills necessary to deliver care at the highest standards **(Nakagami et al., 2018).** By addressing knowledge gaps and promoting adherence to evidence-based practices, such education initiatives contribute significantly to improving patient care and safety in the critical care setting.

Aim of the study

This study aimed to examine the impact of implementing of central venous catheter bundle among nurses on patients' outcomes.

Research hypothesis:

H1: The implementation of central venous catheter bundle among nurses will have a significant positive effect on patients' outcomes.

Technical design

The technical design included research design, setting, subjects and tools of data collection used in this study.

Research design:

Quasi-experimental (study and control groups) research design was used to achieve this study aim.

Setting: This research was conducted within the intensive care units (ICU) of Main Assiut University Hospital, specifically encompassing a total of 18 beds. The choice of Main Assiut University Hospital as the study site provides a significant context, given its role as the setting for the investigation into the impact of educational programs on central venous catheter management among nursing staff.

Subjects: A sample of convenience included 60 critically ill patients, assigned randomly to study group included (30 patients) who received central venous catheter bundle care according to the structured educational program, and the control group which included (30 patients) who received the routine care.

Data collection tools:

Tool I: "Patients' Outcomes ": This tool was developed by the researcher after reviewing related literature to evaluate the patient's outcomes. It included the following parts:

Part A: Patients' demographic and clinical profile such as; "patients' age, gender, date of admission, date of discharge, initial diagnosis, past medical and surgical history".

Part B: Assessment data related to CVC such as; "insertion date, removal date, duration, insertion site, number of dressing times per day, and number of CVCs inserted to the same patients at the staying period.

Part C: Complications related to CVC such as; signs and symptoms of CVC associated blood stream infections.

Part D: Duration of ICU stay. **Operational design:**

It included preparatory phase, tools validity and reliability, pilot study and field work.

Approval from the hospital authority was obtained for the study. Nurses voluntarily participated after explanation of the study's aim. Data collection tools were developed based on literature review and pilot-tested, with the needed modifications made. Content validity was confirmed by experts (indexes: 81.5). Internal consistency reliability and inter-rater reliability were confirmed for the tool (Cronbach's alpha: 0.82).

The implementation phase involved three knowledge assessments, two nursing skills assessments, and two patient outcomes assessments. The educational program covered central venous catheter care, CLABSI, risk factors, prevention, insertion and maintenance bundles, complications, and patient safety. Practical application of the care bundle was emphasized in a learning environment in the ICU conference room, using lecture, group discussion, demonstration, and re-demonstration. Teaching aids included booklets, posters, videos, and PowerPoint presentations.

The evaluation phase included three assessments for each nurse: before, immediately after, and three months post-educational program. Tools (questionnaire sheet, observational checklist) were used to evaluate knowledge and practice regarding CVC Care bundle. Nurses were divided into 10 subgroups with 6 nurses each session for efficient evaluation.

Statistical Analysis:

The data underwent coding and transformation into a customized format for computer entry. Statistical analyses were conducted utilizing the SPSS software, version 20. The results were tabulated, presenting frequencies with mean ± SD, as well as numbers and percentages. The chi-square test was employed to assess significance between two qualitative variables, while the t-test was utilized for comparing significance between two means. This comprehensive approach allowed for a robust and nuanced examination of the obtained data.

Results:

Table (1) reveals that there was no statistically significant difference between the control and study groups in terms of demographic characteristics, the high percentage of participants in both groups were between 18 to 30 years old (46.7% in the control group and 36.6% in the study group), identified as female (70% in the control group and 63.3% in the study group), reported neurological diseases (43.3 and 53.3% respectively). Notably, all participants in both groups (100%) reported no history of past or present surgical procedures.

Table (2) portrays that no statistically significant differences were observed between the control and study groups regarding their CVC assessment data, with the exception of the number of dressing changes per day. More than half (56.7%) of the control group had the CVC inserted in the right jugular vein, while half (50%) of the study group had the CVC inserted in the left jugular vein and a (60%) in the right subclavian vein. Regarding the reasons for catheter insertion, the majority of both groups cited other reasons, noting that it's a routine insertion for medication administration to all ICU patients (63.4% and 76.7%, respectively).

Regarding reasons for catheter removal, majority of both groups removed the CVC because of end of treatment (73.3 and 70.0%, respectively). The mean duration of CVC was (6.4±2.3 and 6.3±2.3 days, respectively) and number of dressing per day were (2.9±0.8 and 2.4±0.8, respectively) with P. value 0.034*. Regarding the mean of CVCs inserted was (1.3±0.5 and 1.3±0.4, respectively).

Table (3) shows that there was a statistically significant difference between control and study groups regarding CVC complications especially WBCs count at day 3 and 4 days and culture & sensitivity (0.017, 0.013 and 0.001, respectively). Nearly half (53.3%) of control group had no growth of microorganism while majority (90%) of the study group had no growth of microorganism at inserted CVC.

Table (4) highlights that there were no statistically significant differences between control and study groups regarding outcome as patients' condition on discharge, less than half (43.3%) of control group were transferred to step down unit compared to 60 % in the study group. Regarding ICU length of stay, no significant difference was found between the two groups. Regarding CVP levels mean score of both groups were (10.4± 5.1 and 10.5± 5.7, respectively).

Table (1): Patients' demographic and clinical profile in the two groups (n= 60)

Items	Control group (n=30)		Study Group (n=30)		P value
	No.	%	No.	%	
Age:					0.950
18-30	14	46.7	11	36.6	
30-40	2	6.7	3	10.0	
40-50	4	13.3	8	26.7	
50-65	10	33.3	8	26.7	
Mean ±SD	39.2±15.1		39.4±13.3		
Gender:					0.591
Male	21	70.0	19	63.3	
Female	9	30.0	11	36.7	
Present diagnosis:					0.148
Heat diseases	2	6.7	0	0.0	
Respiratory diseases	5	16.7	4	13.3	
Neurological diseases	13	43.3	16	53.3	
GIT diseases	3	10.0	6	20.0	
Endocrine diseases	1	3.3	1	3.3	
Other diseases	6	16.7	3	10.0	
Past surgical history:					
Yes	0	0.0	0	0.0	
No	30	100	30	100	
Present surgical complaint:					
Yes	0	0.0	0	0.0	
No	30	100	30	100	

Table (2): Comparison between both patients' groups regarding their assessment data (n= 60)

Items	Control group		Study group		P value
	No.	%	No.	%	
Insertion Site:					0.103
- Jugular vein R	23	76.7	15	50.0	
- Jugular vein L	7	23.3	15	50.0	
- Subclavian vein R	15	50.0	18	60.0	0.413
- Subclavian vein L	15	50.0	12	40.0	
Reason for catheter insertion:					0.687
Monitoring of the CVP	10	33.3	6	20.0	
Long term parenteral nutrition	0	0.0	0	0.0	

Frequent blood draws	1	3.3	1	3 .3	
Routine insertion for medication administration	19	63.4	23	76.7	
Reason for catheter removal:					0.988
End of treatment	24	80.0	23	76.7	
Suspected infection	4	13.3	5	16.6	
Catheter dysfunction	0	0.0	0	0.0	
Accidental removal	2	6.7	2	6.7	
Mean ± SD of CVC Duration in days:	**6.4±2.3**		**6.3±2.3**		0.984
Mean ± SD of dressing per day:	**2.9±0.8**		**2.4±0.8**		0.034*
Mean ± SD of CVCs:	**1.3±0.5**		**1.3±0.4**		1.000

Table (3): Comparison between both patients' groups regarding CLABSI in term of WBCs count and culture and sensitivity:

Items	Control group		study Group		P value
	No.	%	No.	%	
CVC Complications:					
Laboratory investigations:					0.092
WBCs count day 1					
Mean ± SD	11.1±6.2		8.7±3.9		
WBCs count day 2					0.120
Mean ± SD	13.4±5.2		11.4±4.5		
WBCs count day 3					0.017*
Mean ± SD	15.1±6.3		11.9±3.5		
WBCs count day 4					0.013*
Mean ± SD	1.7±7.1		11.1±2.6		
Culture and sensitivity:					0.001**
No growth	16	53.3	27	90.0	
Acinetobacter	3	10.0	1	3.3	
Staph Aruerus	6	20.0	2	6.7	
E.coli	2	6.7	0	0.0	
Kelebsiella	3	10.0	0	0.0	
Others	0	0.0	0	0.0	

Table (4): Comparison between both patients' groups regarding their outcomes

Items	Control group		Study Group		P value
	No.	%	No.	%	
Patients' condition on discharge:					
Good recovery	4	13.3	4	13.3	0.283
Comorbidities	2	6.7	3	10.0	
Morality	8	26.7	2	6.7	
Transfer to step down unit	13	43.3	18	60.0	
Discharge to home	2	6.7	4	13.3	
Mean ± SD of ICU length of stay	8.1±4.1		8.9±6.7		0.596
Mean ± SD of CVP levels	10.4±5.1		10.5±5.7		0.906

Discussion

The implementation of a Central Venous Catheter (CVC) bundle among nurses represents a strategic approach to enhance patient care and outcomes. Central Venous Catheters are commonly utilized in critical care settings, but their insertion and maintenance can pose risks, including Central Line-Associated Bloodstream Infections (CLABSI) and other complications. A CVC bundle typically involves a set of evidence-based practices designed to mitigate these risks and optimize patient safety **(Abou Zed & Mohammed, 2020).**

This study explores the impact of implementing a CVC bundle specifically among nurses, acknowledging their pivotal role in catheter care. The bundle may encompass educational programs, practical training, and adherence to standardized protocols. By assessing nurses' knowledge, skills, and practices before, immediately after, and months following the implementation of the bundle, the study aims to gauge the effectiveness of this comprehensive approach on patient outcomes **(Aysha & Ahmed, 2019).**

The present study findings revealed that there was no statistically significant difference between control and study groups regarding demographic and clinical profile. This was important

to ensure that the two groups were matchable before intervention. This was confirmed by **Boonchoo et al., (2019).**

The existing study findings revealed that there was no statistically significant difference between both groups and their CVC assessment data except for dressing number of times per day. This can be interpreted as the number of dressing decreased among patients in the study group because of lowering occurrence of infection among those patients.

Also, the study findings showed that; more than half of control group had CVC inserted in the right jugular vein, while half of the study group had inserted CVC in left jugular vein and more than half in the right subclavian vein.

These findings matched with that of **Ghode et al., (2019)** who found that the main site of CVC was internal jugular vein. **Beccaria et al., (2018)** reported that insertion the internal jugular vein (IJV) is one of the recommended sites for safe insertion of a central venous catheter (CVC). CVC insertion via the IJV has a lower risk of severe complications such as pneumothorax and arterial bleeding than insertion via the subclavian vein. In addition, **Saugel et al., (2017)** concluded that; because the right IJV has a much wider diameter and runs more superficially than the left IJV, a right-sided approach is more acceptable than a left-sided one for CVC insertion via the IJV.

Regarding the reasons for catheter insertion, the majority of both groups reported other reasons as emergency reasons. This was congruent with **Movio & Ahmed, (2020**) who found that the main cause of insertion was the emergency indications. In the same line, **Roldan, & Paniagua, (2015)** revealed that; in the emergent setting, CVCs are used to administer fluid resuscitation, potentially irritant drugs, blood products, and parenteral nutrition.

In other settings, CVCs are used to provide access for hemodialysis, transvenous heart pacing, and monitoring of hemodynamics by measuring central filling pressure and cardiac output. CVC placement requires training and experience and is not without risk for patients, even when performed by skilled professionals **(Ponraj, 2018).**

Regarding reasons for catheter removal, majority of both groups reported end of treatment as a reason of removal. This finding was in the same line with **Raad et al., (2018)** who mentioned that the main reasons of CVC removal were: stability of patient's condition and no potent IV drugs

are required, no indication for CVP measurement, catheter related Infection, catheter exceeded recommend time, persistent catheter occlusion and damaged catheter.

The present study findings revealed that no statistically significant difference were found between control and study groups regarding CVC complications presented as CLABSI as evidenced by; it was noticed that WBCs count at day 3 and 4 days among control group was more than the study group, and culture and sensitivity revealed frequency of no growth of microorganism was significantly higher among study group than that in the control group.

In the same alignment with this perspective, **Saliba et al., (2018)** who observed that; catheter-related bloodstream infections occur in 3 to 8% of inserted catheters, constituting the primary cause of nosocomial bloodstream infections in intensive care units (ICUs). They emphasize the critical need for educating and training healthcare providers responsible for inserting and maintaining Central Venous Catheters (CVCs), emphasizing that such measures are vital for preventing catheter-related infections, ultimately leading to improved patient outcomes and reduced healthcare costs **(Ferrara & Albano, 2018).**

Spencer and Bardin-Spencer, (2020) underscored the significance of operator experience, noting that the risk of infectious complications is inversely proportional to the operator's skills. They advocate for educational initiatives in catheter insertion, highlighting that a well-structured study in this area significantly enhances patient outcomes. They specifically point out the value of simulationbased training programs in residency education.

Similarly, **Wanat et al., (2020)** concluded that training programs for nurses in long-term catheter care correlate with a reduction in catheter-related infections. However, they caution that without the implementation of care protocols and ongoing nursing staff education, reductions in nursing staff below a critical level may contribute to an increase in catheter-related infections due to challenges in providing adequate catheter care.

Collectively, these studies emphasize the pivotal role of well-trained nurses, in sufficient numbers, to ensure optimal patient care in the ICU **(Aloush & Alsaraireh, 2018).**

Conclusion

The research hypothesis positing a significant positive effect of the educational program on patients' outcomes was supported by the study findings. Specifically, the study revealed

significant differences between the groups concerning CVC complications, particularly in WBC count at day 3 and 4, as well as culture & sensitivity. The study group demonstrated a higher proportion of cases with no growth of microorganisms at the inserted CVC site compared to the control group. Additionally, there were slight differences in overall mean score of patients' outcomes.

Recommendations

1- Including the central venous catheter bundle of care in the routine care of critically ill patients with a defined checklist.

2- Continuous attention to CVC-related complications and the potential benefits of targeted educational interventions in improving certain aspects of patient outcomes.

3- Enhancing nurses' skills related to CVC assessment and infection prevention strategies.

4- Implementing a robust system for continuous monitoring of CVC-related practices and ensure strict compliance with evidence-based guidelines.

5- Fostering collaboration between nursing staff, infectious disease specialists, and other relevant healthcare professionals to collectively address CVCrelated complications.

6- Establishing a culture of continuous professional development for nursing staff, ensuring that they stay abreast of the latest evidence-based practices and guidelines.

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