

Effect of Nursing Care Bundle on Central Venous Line Associated Blood Stream Infection

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Abstract: Background: Central venous catheters (CVCs) play an integral role in the management of many critically ill children. **Purpose:** The purpose of the study was to assess the effect of nursing care bundle on central venous line associated blood stream infection. **Design:** experimental design was used. **Setting:** It was conducted at the pediatric intensive care unit (PICU) in Menoufia University Hospital. **Sample:** Purposive sample of 33nurses and 34 children with central venous lines. **Instruments:** Three data collection instruments were used: structured interviewing questionnaire of nurses' knowledge about central line and care bundle, Observational checklist for nurses' practice and Laboratory investigation record. **Results:** the result of this study showed that there were very highly statistical significant differences between nurses' knowledge on posttest compared to pretest 25.3333 ± 1.81430 Vs 18.6061 ± 4.14532 respectively as well as nurses' practices on posttest compared to pretest were 25.30 ± 1.99 Vs 22.20 ± 1.81 respectively. Also, children who received bundle of care had decreased the rate of blood stream associated infection than children who got routine hospital care 13.17 ± 0.65 Vs 10.50 ± 0.43 respectively. **Conclusion:** It was concluded that implementation of care bundle of central venous line improved nurses' knowledge and practices regarding prevention of central venous line associated bloodstream infections on post and follow-up tests than pretest. Also, it contributed to lower levels of bloodstream associated infection in children on posttest than pretest. **Recommendation:** ongoing in-service education programs about nursing care bundle for central venous line should be developed and provided for pediatric nurses working in pediatric intensive care units.

Key words: *Nursing Care Bundle, Central Venous Line Associated Blood Stream Infection, Children.*

Introduction

Central venous catheters (CVCs) play an integral role in the management of many critically ill children. Also, it remains a corner stone of resuscitation and critical care in pediatric intensive care unit. Moreover, CVCs serve both as reliable vascular access and the site of venous pressure monitoring. CVCs also play a vital role in infusing medications, withdrawing venous samples and strict monitoring in critically ill children. CVCs provide an efficient delivery of antibiotics, chemotherapy, parenteral nutrition, and other lifesaving medications which require large-caliber vessels. Central venous access also provides an access route for lifesaving interventions such as hemodialysis and plasmapheresis (Chaiyakulsil et al., 2021) & (Foka et al., 2021).

However, central-venous catheters (CVC) use can lead to serious complications in primary care and intensive care units (ICUs), the most serious complication is central line-associated bloodstream infections (CLABSI). CVCs allow children to receive poly therapy, help them to recover immediately and reduce days of admission, morbidity and mortality rates (Wright et al., 2018).

In Egypt, the incidence of CLABSI are 22 CLABSI cases with a CLABSI score 14.1 per 1000 central line days in the PICU (Abdelmoneim et al., 2020). North American PICUs reported that central line associated bloodstream infections (CLABSI) occurred in 1.1/1000- line days (Cho, 2021).

Implementation of care bundles is an important strategy for CLABSI

prevention for the insertion and maintenance of central venous catheters. Care bundles are structured packages of evidence-based practices aimed to improve the care process and patient outcomes when adhered to collectively and reliably. These were proven effective at reducing CLABSIs in pediatric and neonatal intensive care units (Cho, 2021).

Pediatric nurses play a vital role in child safety and reduce the incidence of CLABSI. However, prevention policies are not always adhered to in many hospitals. Nurses' compliance with evidence-based practice is very important for reducing the incidence of CLABSI and improve pediatric patient outcome. Nurses spend more time with the patients than other health care providers and are responsible for care and maintenance of the central lines. Educational interventions addressing adherence to set guidelines may improve compliance and reduce the incidence of CLABSI (Cooper, 2019).

Furthermore, continuous training and education of nurses are one of the most important preventive strategies for CLABSIs required at each stage from insertion to removal of the catheter. PICU nurses have the III most direct and continuous role in performing care maintenance of the CVC insertion and they should be experienced and compliant with supportive care measures in the insertion and maintenance of central lines. Therefore, they are well-positioned to implement the recommendations and have a unique chance to contribute to the primary prevention of these

infections via evidence-based best practices. It is imperative that nurses are essential to improve the proper use of the central venous catheter, profound their knowledge, and attaining this evidence will contribute to more compliance with evidence based practices in order to decrease the incidence of CLABSIs in the PICUs (AbouZed&Mohammed,2020).

Although the educational program emphasize on the importance of proper central line care and maintenance with review of proper technique can improve adherence to policy and decrease CLABSI incidence, few educational intervention studies examined the effects of care bundle on CLABSI. These studies identified that ongoing education pertaining to central line care is important in the reduction of CLABSIs. Consideration should also be given to include educational intervention as a part of new nurses orientation process (Cooper, 2019).

Significance of the study

Central line associated bloodstream infections (CLABSI) are a major source of hospital-acquired infections (HAIs) in pediatric intensive care unit (PICU) and are associated with increased morbidity, mortality, and health care costs (Klevens et al., 2007and Nowak et al., 2010). Blood stream infections (BSIs) from central venous catheters (CVCs) increase morbidity and are estimated to increase mortality risk by 25% and health care costs in the USA (Srinivasan et al., 2011 and O'Grady et al., 2011). In Egypt, the rate of central line-associated bloodstream infection (CLABSI) was 22.5 per 1000 line per

days in the Respiratory Intensive Care Unit (RICU) and 18.8 in the Pediatric Intensive Care Unit (PICUs) (O'Grady et al., 2012). Since the adoption of central line (CL) bundle policies and other practices, CLABSI rates among ICUs collectively have fallen nearly 60% in the past decade (Centers for Disease Control and Prevention, 2011). Above all, there are no adopted central line bundle policies in many hospitals in Egypt. Meanwhile, there are no accurate statistics related to the rate of occurrence of central line associated bloodstream infection in Menoufia for this reason, there are no care bundle policies.

Purpose

The purpose of this study is to assess the effect of nursing care bundle on central venous line associated bloodstream infection.

Research Hypothesis:

- ◆ Nurses who receive health education about care bundle of central venous line will have higher level of knowledge about prevention of central venous line associated bloodstream infections on posttest than on pretest.
- ◆ Nurses who receive health education about care bundle of central venous line will have higher level of practices about prevention of central venous line associated bloodstream infections on posttest than on pretest.
- ◆ Children who receive a bundle of care will have decreased incidence of bloodstream associated infections.

Methods

Research Design:

A quasi- experimental design (pre and posttest) was utilized for this study.

Sampling:

Purposive sample of 33nurses and 34 children with central venous lines.

Instruments:-

Three instruments were utilized for data collection:

Instrument one: A structured interviewing questionnaire:

It was designed by the researcher after reviewing the related literature. This instrument was divided in to two parts (AppendixI):

▪ **Part one:** characteristics of studied nurses. It included questions about nurses' age, gender, level of education, years of experience and previous training related to central venous line care.

▪ **Part two:** Nurses' Knowledge of Evidence-Based Catheter Related Blood Stream Infection (CR-BSI): It was developed by the researcher guided by Labeau et al., (2009) to assess nurses' knowledge about central venous line and nursing care to prevent catheter related blood stream infection. It included two subparts:

◆**Subpart one:** Nurses' Knowledge about central venous catheter (CVC) It contains 7 questions about: definition, indications, types, sites, use of ultrasound for CVC insertion, use of X-ray to ensure correct location of CVC insertion and complications of CVC.

◆**SubPart two:** Nurses' Knowledge about nursing care to prevent Catheter Related-Blood Stream Infection (CR-BSI) it contains 14 questions about hand washing before and after CVC insertion, wearing sterile gloves before and during CVC insertion, wearing mask, gown and head cover during CVC insertion, use of alcohol before and after CVC insertion, follow unit protocol to prevent catheter related bloodstream infection, use antiseptic solution to clean site of CVC, assess CVC insertion site daily, check the location of CVC, type of dressing used, frequency of dressing change, frequency of dressing change for transparent parts, frequency of I.V set change for clear fluid e.g. ringer, sodium chloride. Frequency of I.V set change for total parental nutrition (TPN), frequency of I.V set change for blood & blood product and needleless access device change(three way stop cook)

Total Scoring system (0-5):

Scoring items	Score
Good knowledge (4-5)	> 75%
Fair knowledge (3)	≤75%
Poor knowledge (0-2)	≤ 50%

Reliability of the study instruments were estimated among 10 participants by using test retest method with two weeks apart between them. Cronbach' alpha was calculated between the two scores. It was 0.78 which indicates that the instruments were reliable to meet the objectives of the study.

Instrument 2: Observational checklist for Prevention of CR-BSI:

It was adopted from Elbilgahy (2016) to assess nurses' practices. It included eleven items related to changing CVC such as wash hands, wear sterile gloves, wear personal protective equipment, clean C.V.C site using antiseptic solution, inspect C.V.C site, change C.V.C dressing, change I.V set daily for clear fluid, flush C.V.C by saline, change I.V set for TPN, change I.V set for blood & blood product, change three way stop cook (Appendix II).

Total scoring system for each item (0-2):

Scoring items	Score
competent	75%<
Incompetent	≥75%

Reliability of the study instruments were estimated among 10 participants by using test retest method with two weeks apart between them. Cronbach' alpha was calculated between the two scores. It was 0.752 which indicates that the instruments were reliable to meet the objectives of the study.

Instrument 3: Instrument three:

It was developed by the researcher to assess the rate of Catheter Related-Blood Stream Infection on studied children. It consisted of two parts (Appendix III):

- **Part one:** Characteristics of studied children. It included child age, sex, diagnosis, date of admission and date of discharge.
- **Part two:** Laboratory investigation record. It included Blood Culture and complete blood count.

Validity

For validity assurance, the three instruments were submitted to a jury of five experts in the pediatric field (two professors and two assistant professors in the Pediatric Nursing and one professor in the Pediatric Medicine). All the required modifications were done.

Ethical considerations

- An initial approval was obtained from the Ethical Research Committee in the Faculty of Nursing, Menoufia University
- A written consent was obtained from the nurses related to their acceptance to share in the study. It was obtained after an initial interview was done to inform the nurses about the purpose and methods of data collection to gain their cooperation.
- A written approval from parents of children was obtained to conduct the study.
- Anonymity of the personal data was assured through coding all data and putting data through closed cabinet.

Pilot study

It was carried out on 10% (4) of studied nurses after the instruments were developed and before starting the data collection to test the practicability, applicability and to estimate the needed time to fill the instruments. No necessary modifications were done.

Procedure

Assessment phase:

- 1) Prior to data collection, a written permission to carry out the study was obtained from the director of the unit after submitting an official

letter from the Dean of the Faculty of Nursing at Menoufia University explaining the purpose of the study and methods of data collection.

- 2) Data collection for this study was conducted for a period of eight months extending from the 1st of October 2020 to the end of May 2021.
- 3) The researcher introduced herself to the studied nurses who shared in the study, explained the purpose of the study and methods of data collection.
- 4) The researcher interviewed each nurse and asked her to fill the structured interviewing questionnaire regarding their knowledge about central venous line and care bundle using instrument I it took 20 minutes to fulfill (pretest).
- 5) Instrument II was used by the researcher for data collection about nurses' practices while providing care for central venous line. Nurses were not informed that they were observed. Nurses were observed three days per week during the morning and afternoon shifts (pretest).
- 6) Pre intervention laboratory assessment for complete blood count and blood culture for children with central venous lines was done by the researcher using instrument III (pretest).

Implementation phase:

- Areas of knowledge and practice deficit were identified and health education program related to nursing care bundles of central

venous line was designed accordingly.

- Health teaching sessions were started by the researcher to all nurses working in the PICU. Each session included 2 - 4 nurses, lasted for 60-90 minutes and provided in two days. Oral presentations, group discussions, smart phone, demonstration and re-demonstration and feedbacks were used for health education and explanatory booklets were distributed between nurses. Some sessions were conducted in the nurses' dressing room and others were conducted inside the ward in the previously mentioned setting.
- ◆The first session contained theoretical knowledge related to central venous line and its care e.g. definition, indications, types, places of CVC, use of ultrasound for CVC insertion, use of X-ray to insure the right site for insertion of CVC and complications of CVC (appendix IV).
- ◆The second session contained practical part of central venous line and care bundles through using demonstration and re-demonstration on children in the real situation (appendix IV).
- ◆The researcher provided summary about knowledge provided in the first session. Afterwards, nursing care bundles for central venous line was discussed. As well as nurses' practice were observed until each nurse reach to the competent level of CVC care bundle.
- ◆Also, the session ended by a summary of its contents and feedback from nurses was obtained

to ensure that they had got the maximum benefits.

Evaluation phase:

- 1) Reassessment of nurses' knowledge regarding central venous line and its care for children was done immediately following the health education sessions by the researcher using instrument I (posttest).
- 2) Reassessment of nurses' practice regarding central venous line care and care bundle for children was done immediately following the health education sessions by the researcher using instrument II (posttest).
- 3) Reassessment of nurses' knowledge, practice regarding central venous line as well as complete blood count and blood culture were done for children three months later by the researcher using instrument I,II and III (follow-up).

Statistical analysis:

- Data was statistically analyzed using SPSS (statistical package for social science) program version 13 for windows and for all the analysis a p value < 0.05 was considered statistically significant:
- Data are shown as mean, range or value and 95% confidence interval (95% CI) and frequency and percent.
- Chi square test was done for qualitative variable analysis and p-value < 0.05 was considered significant.
- ANOVA test was done to compare three variables; one qualitative variable and the other two are

quantitative variables of normally distributed variables and p-value < 0.05 was considered significant to detect mean and standard deviation where post hoc tests done to detect the relationship between variables within groups.

- LSD test is a post hoc test it was done to variables of significant difference of more than two groups of normally distributed data after ANOVA test to detect the significant difference between either group.
- Person correlation test was done to study correlation between one qualitative variable and one quantitative variable or two quantitative variables of not normally distributed data and p-value less than 0.05 was considered significant.
- All data are tested with kolmogorov-Smirnov Z test and most of them were found normally distributed and so presented with mean ± SD. And using parametric testes on doing association or correlation

All these tests were used as tests of significance at P<0.05.

> 0.05 non-significant

<0.01 highly significant

Results

Table 1 shows characteristics of studied nurses. It was obvious from this table that about half of studied nurses (48.5%) were between 25 to 30 years old, and most of them were females (97%). Regarding academic qualification, more than half of nurses (57.6 %) were graduated from technical institute of nursing, while 12.1% only graduated from faculty of Nursing and more than half of them (57.6 %) did not attend any training

course in infection control related to central venous line.

Table 2 shows characteristics of studied children. As illustrated in the table, regarding sex, most of studied children were females (70.0%) and half of them were diagnosed as convulsion and status epilepsy (50.0%). Also, the mean age was 4 years old (4.0 ± 1.05) and mean length of stay in PICU on pre, post and follow-up tests were 33.5 ± 13.5 , 34.3 ± 18.3 and 34.5 ± 13.5 respectively.

Table 3 displays nurses' knowledge about children central venous catheter on pre, post and follow-up tests. The findings revealed that nurses had high level of knowledge about central venous catheter on post and follow-up tests than on pretest. Therefore, there were very highly statistical significant differences between nurses' knowledge ($P < 0.0001$).

Table 4 displays nurses' knowledge about nursing care to prevent bloodstream infection on pre, post and follow-up tests. This table revealed that the majority of nurses had higher level of knowledge regarding nursing care to prevent bloodstream infection on post and follow up tests than pretest. Therefore, there were very highly statistical significant differences between nurses' knowledge on post and follow-up tests than pretest ($P < 0.0001$). However, regarding frequency of intravenous set change for TPN nurses had more incorrect answers on post and follow-up tests than pretest (57.6%, 63.6% Vs 69.7% respectively). Therefore, there was no statistical significant difference between post and follow-up test than pretest.

Table 5 displays nurses' practice to prevent central line associated blood stream infection on pre, post and follow-up tests. The findings revealed that the majority of nurses wear personal protective equipment, clean CVC site using antiseptic solution, inspect CVC site, change CVC dressing, flush C.V.C by saline on post and follow up tests than on pretest. Therefore, there were highly statistical significant differences between nurses' practice on pre, post and follow-up tests ($P < 0.001$). However, there were no statistical significant differences regarding washing hands, wear sterile gloves, changing I.V set daily for clear fluid, changing I.V set for TPN, changing I.V set for blood & blood product and changing three way stop cock on pre, post and follow-up tests.

Table 6 displays mean and standard deviation of studied children's laboratory tests on pre, post and follow up tests. The findings revealed that there were very highly statistical significant differences regarding hemoglobin, red blood cells, c-reactive protein ($P < 0.0001$). However, there was no statistically significant difference regarding white blood cells.

Table 7 displays distribution of blood culture findings for studied children on pre, post and follow-up tests. As indicated in this table, blood culture findings were positive (Streptococci) on pre and posttest. Meanwhile, it was negative on follow-up test. So, there was very highly statistical significant difference between blood culture findings on pre and posttest than on follow-up test ($P < 0.0001$).

Table (1): A- Characteristics of studied nurses (N=33)

Characteristics of studied nurses	No (N=33)	%
Age		
• < 20 years	1	3.0
• 20 -24 years	5	15.2
• 25 -30 years	16	48.5
• > 30 years	11	33.3
Total	33	100
Sex		
• Male	1	3.0
• Female	32	97.0
Total	33	100
The academic qualification obtained in Nursing		
• High school Nursing diploma	10	30.3
• Technical institute of Nursing	19	57.6
• Bachelor degree in Nursing	4	12.1
Total	33	100
Years of experience in Pediatric Nursing		
• < 1 year	6	18.2
• 1 - 5 years	11	33.3
• 6 - 10 years	7	21.2
• >10 years	9	27.3
Total	33	100
Attending training course in infection control related to central venous line		
• No	19	57.6
• Yes	14	42.4
Total	33	100

Table (2): B-Characteristics of studied children (N=34)

Characteristic	(N=34)						P-value
	Pretest		Posttest		Follow-up test		
	No.	%	No.	%	No.	%	
Sex							
• Male	5	41.7	3	30.0	6	50.0	0.637
• Female	7	58.3	7	70.0	6	50.0	
Total	12	100	10	100	12	100	
Diagnosis							
• Convulsion	4	33.3	5	50.0	4	33.3	0.360
• Status epilepsy	4	33.3	5	50.0	4	33.3	
• Hyponatremia	4	33.3	0	0.0	4	33.3	
Total	12	100	10	100	12	100	
Age (Mean± SD)	3.92±0.67		4.0±1.05		3.42±1.24		0.342
Length of stay in PICU/days (Mean± SD)	33.5 ±13.5		34.3 ±18.3		34.5 ±13.5		t=0.08, p=0.93 NS

Table (3): Nurses' knowledge about children central venous catheter (C.V.C) on pre, post and follow-up tests.

Nurses' knowledge about C.V.C	Pretest		Post test		Follow-up test		X ²	P- value
	No	%	No	%	No	%		
Definition of C.V.C								
Incorrect answer	21	63.6	5	15.2	12	36.4	60.82	0.001**
Correct answer	12	36.4	28	84.8	21	63.6		
Indications for C.V.C								
Incorrect answer	21	63.6	0	0.0	7	21.2	34.16	0.001**
Correct answer	12	36.4	33	100.0	26	78.8		
Types of C.V.C								
Incorrect answer	26	78.8	6	18.2	15	45.5	24.39	0.001**
Correct answer	7	21.2	27	81.8	18	54.5		
Sites of C.V.C								
Incorrect answer	28	84.8	0	0.0	5	15.2	60.82	0.001**
Correct answer	5	15.2	33	100	28	84.8		
Use of ultrasound for C.V.C insertion								
Incorrect answer	25	75.8	0	0.0	6	18.2	47.99	0.001**
Correct answer	8	24.2	33	100.0	27	81.8		
Use of X-rays to ensure correct location of C.V.C insertion								
Incorrect answer	23	69.7	2	6.1	7	21.2	33.34	0.001**
Correct answer	10	30.3	31	93.9	26	78.8		
Complications of C.V.C								
Incorrect answer	24	72.7	4	12.1	7	21.2	30.85	0.001**
Correct answer	9	27.3	29	87.9	26	78.8		

Table (4): Nurses' knowledge about nursing care to prevent bloodstream infection on pre, post and follow-up tests.

Nurses' Knowledge about nursing care to prevent bloodstream infection	Pretest		Posttest		Follow-up test		X ²	P- value
	No	%	No	%	No	%		
Wash hands								
Incorrect answer	18	54.5	1	3.0	2	6.1	33	0.001**
correct answer	15	45.5	32	97.0	31	93.9		
Wear gloves before CVC insertion								
Incorrect answer	20	60.6	1	3.0	6	18.2	29.64	0.001**
correct answer	13	39.4	32	97.0	27	81.8		
Wear personal protections equipment during CVC insertion.								
Incorrect answer	22	66.7	4	12.1	5	15.2	28.84	0.001**
correct answer	11	33.3	29	87.9	28	84.8		
Wipe C.V.C site with alcohol 70 % before and after use.								
Incorrect answer	23	69.7	2	6.1	6	18.2	35.035	0.001**
correct answer	10	30.3	31	93.9	27	81.8		
Follow unit protocol.								
Incorrect answer	30	90.9	22	66.7	23	69.7	6.27	0.034*
correct answer	3	9.1	11	33.3	10	30.3		
Use antiseptic solution to clean site of CVC insertion before and after use.								
Incorrect answer	30	90.9	19	57.6	26	78.8	10.23	0.006*
correct answer	3	9.1	14	42.4	7	21.2		
Assess CVC insertion site daily								
Incorrect answer	28	84.8	5	15.2	9	27.3	37.47	0.001**
correct answer	5	15.2	28	84.8	24	72.7		
Check the location of C.V.C.								
Incorrect answer	28	84.8	12	36.4	17	51.5	16.62	0.001**
correct answer	5	15.2	21	63.6	16	48.5		

Continue table (4): Nurses' knowledge about nursing care to prevent bloodstream infection on pre, post and follow up tests.

Nurses' Knowledge about nursing care to prevent bloodstream infection	Pretest		Posttest		Follow-up test		X ²	P-value
	No	%	No	%	No	%		
Type of dressing used for the majority of children								
Incorrect answer	26	78.8	1	3.0	7	21.2	45.78	0.001**
correct answer	7	21.2	32	97.0	26	78.8		
Frequency of dressing change								
Incorrect answer	29	87.9	5	15.2	16	48.5	34.99	0.001**
correct answer	4	12.1	28	84.8	17	51.5		
(Frequency of dressing change (transparent parts								
Incorrect answer	32	97.0	21	63.6	26	78.8	11.4	0.003**
correct answer	1	3.0	12	36.4	7	21.2		
Frequency of intravenous set change for clear fluid								
Incorrect answer	20	60.6	4	12.1	7	21.2	20.38	0.001**
correct answer	13	39.4	29	87.9	26	78.8		
Frequency of intravenous set change for TPN								
Incorrect answer	23	69.7	19	57.6	21	63.6	1.05	0.59 ^{nsq}
correct answer	10	30.3	14	42.4	12	36.4		
Frequency of intravenous set change for blood								
Incorrect answer	19	57.6%	1	3.0%	7	21.2%	25.67	0.001**
correct answer	14	42.4%	32	97.0%	26	78.8%		
Frequency of 3-way stop cook change								
Incorrect answer	28	84.8%	20	60.6%	23	69.7%	4.88	0.087*
correct answer	5	15.2%	13	39.4%	10	30.3%		

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Table (5): Nurses' Practices to prevent central line associated blood stream infection on pre, post and follow-up tests.

Nurses' Practice	(N=33)						X ²	P value
	Pretest		Posttest		Follow-up test			
	No.	%	No.	%	No.	%		
Wash hands								
• Adequately done	12	36.4	15	45.5	13	39.4	0.587	0.746 ^{ns}
• Inadequately done	21	63.6	18	54.5	20	60.6		
Wear sterile gloves								
• Adequately done	12	36.4	18	54.5	14	42.4	0.583	0.747 ^{ns}
• Inadequately done	21	63.6	15	45.5	19	57.6		
Wear personal protective equipment								
• Adequately done	9	27.3	23	69.7	19	57.6	12.618	0.002**
• Inadequately done	24	72.7	10	30.3	14	42.4		
Clean C.V.C site using antiseptic solution								
• Adequately done	12	36.4	30	90.9	25	75.8	23.919	0.001**
• Inadequately done	21	63.6	3	9.1	8	24.2		
Inspect C.V.C site								
• Adequately done	21	63.6	29	87.9	25	75.8	5.280	0.071*
• Inadequately done	12	36.4	4	12.1	8	24.2		
Change C.V.C dressing								
• Adequately done	18	54.5	28	84.8	22	66.7	6.346	0.042*
• Inadequately done	15	45.5	5	15.2	11	33.3		
Change I.V set daily for clear fluid								
• Adequately done	33	100	33	100	33	100	----	---- ^{ns}
• Inadequately done	0	0	0	0	0	0		
Flush C.V.C by saline								
• Adequately done	15	45.5	25	75.8	20	60.6	6.346	0.042*
• Inadequately done	18	54.5	8	24.2	13	39.4		
Change I.V set for TPN								
• Adequately done	33	100	33	100	33	100	----	---- ^{ns}
• Inadequately done	0	0	0	0	0	0		
Change I.V set for blood & blood product								
• Adequately done	33	100	33	100	33	100	----	---- ^{ns}
• Inadequately done	0	0	0	0	0	0		
Change three way stop cook								
• Adequately done	33	100	33	100	33	100	---	----- ^{ns}
• Inadequately done	0	0	0	0	0	0		

Table (6): Mean and standard deviation of studied children’s laboratory tests on pre, post and follow-up tests.

Items	Pretest	Posttest	Follow-up	F-test	P-value	LSD
Hemoglobin	9.63±0.88	10.50±1.05	9.53±0.48	4.419	0.020	P1= 0.020* P2= 0.768 P3= 0.010*
Red Blood Cells	4.63±0.69	3.70±0.21	3.90±0.51	10.009	0.001	P1= 0.001** P2= 0.002** P3= 0.379
White Blood Cells	6.40±0.47	6.65±0.16	6.40±0.47	1.319	0.282	P1= 0.163 P2= 1.000 P3= 0.163
C-Reactive Protein	13.17±0.65	12.60±0.63	10.50±0.43	4.606	0.018	P1= 0.028* P2= 0.008** P3= 0.688

Table (7): Distribution of blood culture findings for studied children on pre, post and follow-up tests.

Blood culture (Streptococci)	Pretest		Posttest		follow-up test		P-value
	No	%	No	%	No	%	
+VE	12	100	10	100	0	0.0	14.84 ** <i>P<0.001</i>
_VE	0	0.0	0	0.0	12	100	

Discussion:

Central venous catheters (CVCs) are essential for providing care to children in pediatric intensive care units (PICUs). The central line associated bloodstream infections (CLABSI) are the most common healthcare-associated infections (HAIs) in childhood.

Most cases are preventable with proper aseptic techniques, surveillance and management strategies (Hamza et al., 2021).

Implementation of catheter care bundle guidelines would significantly reduce central line associated blood stream infections among children admitted to PICU with a specific focus on direct education to nurses (Bell & O'Grady, 2017). Therefore, nurses' adherence

with an evidence-based care bundle during their practice is very important for the reduction of CLRBSI as well as improvement of pediatric patient outcome (Savage et al., 2018).

The current study hypothesized that nurses who received health education about care bundle of central venous line would have higher level of knowledge about prevention of central venous line associated blood stream infections on posttest than on pretest. Also, nurses who received health education about care bundle of central venous line would have higher level of practices about prevention of central venous line associated blood stream infections on posttest than on pretest. Furthermore, children who received a

bundle of care would have decreased incidence of blood stream associated infections than children who got routine hospital care.

In relation to hypothesis one: Nurses who received health education about care bundle of central venous line would have higher level of knowledge about prevention of central venous line associated blood stream infections on posttest than on pretest. The present study illustrated nurses' knowledge about children central venous catheter (C.V.C) and prevention of central venous line associated blood stream infections on pre, post and follow-up tests. The study revealed that the highest level of nurses' knowledge was on posttest. From the researcher's perspective, this could be attributed to the positive effect of CVC care bundle implementation. Also, PICU nurses were enthusiastic to learn more about how to prevent infection related to central line.

This result was consistent with Deshmukh and Shinde, (2014) in their study about " Impact of structured education on knowledge and practice regarding venous access device care among nurses," who stated that the structured education was effective in increasing nurses' knowledge scores regarding venous access device care.

Regarding nurses' knowledge about children central venous catheter (C.V.C) and nursing care to prevent bloodstream infection on pre, post and follow-up tests, this study illustrated that the majority of studied nurses had incomplete knowledge about children central venous catheter and nursing care to prevent bloodstream infection on pretest. This could be related to

nurses' resistance to change, little support from managers, lack of PICU training, lack of ease access to the literature, lack of time to read and understand the literature, lack of access to guidelines and competing workload pressures. Meanwhile, the findings of this study showed improvement in nurses' knowledge on post and follow-up tests.

This result was consistent with AbdulKareem, (2014) in his study about "Effect of implementing standard guidelines on prevention of central venous catheter related infection among critically ill patient", who reported that there was a significant improvement of critical care nurses' knowledge about prevention of CLABSI after implementation of guidelines.

Furthermore, this result came in agreement with El-Sol and Badawy (2017) in their study about " The effect of a designed teaching module regarding prevention of central-line associated blood stream infection on ICU nurses' knowledge and practice." They found that there was considerable difference in nurses' knowledge before and after the designed teaching module.

Also, the findings of the current study clarified that there was a significant improvement in the nurses' knowledge about children central venous catheter (CVC) and nursing care to prevent bloodstream infection on post and follow-up tests than on pretest. From the researcher's perspective, this could be attributed to the clarity and simplicity of the methods of teaching (oral presentations, group discussion, smart phone, communication board,

feedbacks and explanatory booklets) that were used in sessions which in turn helped nurses to acquire and improve their knowledge about children central venous catheter (CVC) and nursing care to prevent bloodstream infection. Besides, the utilized communication techniques (e.g. good listening, feedback and two-way communications) could be effective.

This result was in line with Manzo et al., (2017) in their study about "Knowledge and behavior of professionals about bundled strategies of central venous catheter". They found that a regular scientific-based program of continuing education with a focus on nurses can significantly reduce CVC infection rates.

Moreover, this result came in agreement with Alfar et al., (2020) in their study about "The Effect of Applying Nursing Care Bundle on Controlling Central Venous Line Infection in Neonatal Intensive Care Units ". They concluded that there was an improvement in the NICU nurses' knowledge after implementation of the CVL nursing care bundle either immediately post or post three months of the program implementation than before its implementation.

This finding was also in conformity with Ibrahim et al., (2021) in their study about " Application of Care Bundle Approach for Preventing Device Associated Infections: A Training Program for Pediatric and Neonatal Nurses." They concluded that application of training program reported remarkable improvement in pediatric and neonatal intensive care nurses' knowledge toward the care

bundle approach for preventing device associated infection.

In relation to hypothesis two: nurses who received health education about care bundle of central venous line would have higher level of practices about prevention of central venous line associated blood stream infections on posttest than on pretest. The present study illustrated that concerning nurses' practices regarding prevention of central venous line associated blood stream infections on pre, post and follow-up tests. This study revealed that the lowest level of nurses 'practice was on pretest. This could be attributed to the unsatisfactory knowledge of the studied nurses and their few years of experience which was reflected negatively on their practices.

On the other hands, the findings of the current study showed improvement in nurses' practices immediately post health teaching implementation. This result was consistent with Deshmukh and Shinde, (2014) in their study about "Impact of structured education on knowledge and practice regarding venous access device care among nurses." They concluded that mean score of nurses' practice increased in the posttest after structured education and showed a significant improvement. In addition, this result agreed with Bayoumi and Mahmoud, (2017) in their study about " Effect of education program on nurses' knowledge and practice regarding care of central venous line in pediatric hemodialysis: evidence-based practice guidelines." They reported that there was a highly statistically significant improvement in nurses' practice after implementation of program.

Bedsides, this finding was in line with Venkatesan and Manikandan, (2018) in their study about "Effectiveness of central line bundle care upon the knowledge and compliance staff nurses in the ICU". They reported that the overall pretest practice of nurses regarding the insertion and maintenance of CVC catheter was poor compared to the post-test and showed a significant difference. This can be interpreted that nursing care bundle was effective in improving nurses' practice.

Also, the current study illustrated that the majority of nurses showed improvements in their performance regarding care bundle of central venous line for prevention of central venous line associated blood stream infections on post and follow-up tests than on pre intervention. From the researcher point of view, this could be due to the methods of teaching that were used in sessions which in turn helped nurses to acquire and improve their practices about care bundle of central venous line. In these sessions, demonstration and re-demonstration of care bundle of central venous line procedures were done.

Besides, nurses felt empowered to assist children with central line in preventing central venous line associated blood stream infections through application of the care bundle for central venous line. After the program they appreciated that application of care bundle of central venous line can be used to prevent central venous line associated blood stream infections in children.

This result was consistent with Abbady et al., (2019) in their study about

"Bundle of Care for Improving Nurses' Performance Related to Central Line Associated Blood Stream Infection". They found that there was a statistically significant improvement in nurses' practice after implementation of CLABSI bundle of care at post and follow-up tests compared to pre bundle implementation.

In the same context, the study was consistent with Sakshi et al., (2019) in their study about "Effectiveness of Education Program Regarding Central Venous Catheter (CVC) Care Bundle in Terms of Knowledge and Practice of Nursing Personnel". This study revealed that the education program was effective in improving the practice of nursing personnel regarding CVC care bundle.

Moreover, this result came in agreement with Ibrahim et al., (2021) in their study about "Application of Care Bundle Approach for Preventing Device Associated Infections: A Training Program for Pediatric and Neonatal Nurses." They concluded that application of training program reported remarkable improvement in pediatric and neonatal intensive care nurses' performance toward the care bundle approach for preventing device associated infection.

In relation to hypothesis three: children who received a bundle of care would have decreased incidence of blood stream associated infections than children who got routine hospital care. The findings of the current study showed that there was a significant decrease in the rate of central line associated blood stream infections in children who received a central line care bundle. From the researcher's

point of view, this could be attributed to the positive effect of implementation of CVC care bundle. Also, nurses who received the nursing care bundle recognized the importance of this evidence based practice on the level of standard of care and its effect on critically ill children outcomes. These results came in agreement with Smulders et al., (2013) in their study about "Are central line bundles and ventilator bundles effective in critically ill neonates and children?" They found that PICU patients demonstrated a significant decrease in the CLABSI rate after implementation of the bundle. This can be interpreted that children who received nursing care bundle had a decrease in the rate of central line-associated bloodstream infections on posttest.

In addition, these results were in harmony with Melville & Paulus (2014) in their study about "Impact of a central venous line care bundle on rates of central line associated blood stream infection (CLABSI) in hospitalized children." They found that the introduction of a CVL care bundle produced a significant sustainable reduction in hospital acquired CLABSI rates in a children's hospital setting. This can be interpreted that they used the same care bundle.

Also, this finding was in line with Entesari-Tatafi et al., (2015) in their study about "Effectiveness of a care bundle to reduce central line-associated bloodstream infections." They concluded that this care bundle using a novel maintenance procedure can effectively reduce the CLABSI rate and maintain it at zero out to 2 years.

Devrim et al., (2018) in their study about "Central line bundle for prevention of central line-associated bloodstream infection for totally implantable venous access devices (ports) in pediatric cancer patients." They found that central line bundle programs were found to be effective in decreasing central line-associated bloodstream infection rates. In the same context, Süha and Karagözoğlu (2019) in their study about "The Effect of a Guide Based Application Bundle on the Catheter-Related Infection." It was found that the guideline-based care bundle is an effective and useful way to reduce CLABSI.

Besides, this finding was in line with Sedrak et al., (2019) in their study about "Cost Effectiveness Analysis of Bundle versus No Bundle Strategy during Central Venous Catheter Insertion on Reduction of Central Line Associated Bloodstream Infections in Abu El Reesh Hospital, Egypt." They found that the use of bundle precautions during CVC insertion lowers the incidence of Central line-associated bloodstream infections. Furthermore, this finding was in line with Hart (2019) who conducted a study about "Implementing an Updated Evidenced-Based Maintenance Central Line Bundle (CLB) Policy: Monitoring Adherence and Central Line Associated Blood Stream Infections (CLABSI) in a Medical Intensive Care Unit (MICU)". He found that no CLABSI were reported during the project's time frame.

In the same context, Dikeledi and Mustafa (2021) in their study about "The Implementation of Central Line Associated Blood Stream Infection

Prevention Bundles in Neonatal Intensive Care Unit." They found that implementation of a collaborated multidisciplinary approach prevention bundle on Central Line Associated Blood Stream Infection (CLABSI) may contribute to significant decrease in CLABSI rate.

Also, this result was consistent with Al-Khawaja et al., (2021) in their study "Trends of central line-associated bloodstream infections in the intensive care unit in the Kingdom of Bahrain: Four years' experience. Implementing the prevention bundles reduced CLABSI significantly in our ICU." They found that implementing the CLABSI prevention bundle is important to maintain a substantial reduction in the CLABSI rate in the ICU setting.

Conclusion

Based on the finding of the present study, the following is concluded: Nurses who received health education about care bundle of central venous line had higher level of knowledge about prevention of central venous line associated blood stream infections on posttest than pretest. Also, Nurses who received health education about care bundle of central venous line had higher level of practice about prevention of central venous line associated blood stream infections on posttest than pretest. Furthermore, children who received bundle of care had decreased the rate of blood stream associated infection.

Recommendations

In the light of the findings obtained from the current study and its conclusion, the following recommendations are suggested:

- 1) Ongoing in-service education programs about central venous line care bundles should be designed and implemented in pediatric intensive care units to improve nurses' knowledge and practices on the basis of nurse's actual needs.
- 2) Nursing care bundle for central venous line should be integrated in all pediatric intensive care units to prevent central venous line associated blood stream infection.
- 3) In- service educational training programs about nursing care bundle for central venous line should be developed and provided for pediatric nurses working in pediatric intensive care units.
- 4) Continuous training program should be developed for nurses to upgrade their knowledge and practices regarding CVC care.
- 5) Adequate nursing supervision, guidance and regular feedback should be provided for nurses concerning their knowledge, attitude and performance.
- 6) Advanced booklets and electronic media about nursing care bundle for central venous line should be available at each pediatric intensive care unit.

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