

# EVIDENCE-BASED EDUCATIONAL INTERVENTION FOR NURSES' ABOUT PREVENTION OF CENTRAL LINE ASSOCIATED BLOOD STREAM INFECTION

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## Abstract

Central line associated blood stream infection (CLABSI) is the most common hospital-acquired infection among pediatric patients resulting in excess mortality, increased hospitalization stay and increased health care costs. Prevention and control of CLABSI depends greatly on awareness and implementation of evidence based procedures. The purpose of this study was to evaluate the effect of implementing an evidence-based educational program on nurses' knowledge, practice and attitude about CLABSI prevention in critically ill children. A quasi-experimental research design using one group (pre-test & post-test measures) was used. The study involved a convenient sample of 120 nurses working in the Pediatric Intensive Care Unit (PICU) affiliated to Mansoura University Children's Hospital, Egypt. The results of the current study showed improvement in nurses' knowledge, observed practice and attitude after completion of a short term evidence-based educational program about CLABSI. Our study provides a well-rounded picture of prevention of CLABSI in Egypt and suggested that PICU nurses' knowledge, practice and attitude were improved significantly after the implementation of evidence based educational program. Therefore, the nurses' knowledge and practice should periodically be updated and evaluated regarding guidelines for CLABSI.

**Key words:** central line associated blood stream infection, central venous catheter, evidence-based guidelines.

**Relevance to clinical practice:** These findings provide valuable information about the importance of implementing evidence based guidelines in clinical practice.

### What is already known?

- Bloodstream infections associated with central lines are associated with adverse health outcomes
- Nurses play a critical role in preventing CLABSI
- Although evidence based guidelines are recommended, implementation requires tailored and targeted approaches.

### What does this study add?

- Feasibility and acceptability of the development and delivery of an educational program and demonstration that nurses' knowledge, practice and attitudes toward preventing CLABSI can be improved by the implementation of an evidence-based educational program.

## Introduction

Central venous catheters (CVC) are commonly used in the pediatric intensive care unit for rehydration, blood sample withdrawal, administration of drug, parenteral nutrition, blood and blood product and monitoring of central venous pressure(1). There are many potential hazards associated with the use of CVC including central line associated blood stream infection (CLABSI) (2). CLABSI is defined as a blood stream infection in a patient with a CVC that was inserted before infection onset, not related to another infection site, and developing 48 hours or more after insertion of the central line (3). The CLABSI adversely affects patients' outcomes and results in increased risks for morbidity and mortality, prolonged hospital stay, and increasing associated medical costs (4).

The Centers for Disease Control and Prevention (CDC) and the Asia Pacific Society of Infection Control (APSIC) have recommended evidence-based care components of the central line insertion and maintenance bundles to decrease the incidence of CLABSI). The most important insertion recommendations are; the use of maximal sterile barrier precautions during insertion of CVC, hand hygiene before catheter insertion and maintenance care with proper aseptic technique, optimal selection of CVC insertion site and catheter type must be based upon the intended purpose, duration of use and risk of infection with higher rate in femoral catheter than internal jugular or subclavian catheter. In addition, alcohol-based chlorhexidine has become a standard antiseptic for skin preparation for the insertion of both central and peripheral venous catheters; tincture of iodine may be used if chlorhexidine is not available or contraindicated (5, 6, 7).

Central line maintenance care bundle includes proper dressing change technique and standardized change of the administration set as well as daily evaluation of the line necessity and replacement because the risk of CLABSI is increased with longer duration of CVC. Disinfection of the catheter hubs and catheter lumens change are one of the most important preventive measures for CLABSI as the CVC hub serves as the common source of bacterial colonization and the portal of entry of microorganisms to the internal surface of the catheter (8, 9, and 10).

Many researchers indicated that educational intervention and intensified training are associated with decreasing the risk of infection associated with CVC use (11, 12). Nurses' limited knowledge of evidence-based practice may be a barrier to adherence to the evidence based guidelines for preventing CLABSI as well as translating evidence based findings into consistent care delivered at the bedside (13). Many studies have shown that educational interventions greatly reduced CLABSI rates in pediatric patients with CVC (14, 15). Additionally, the latest CDC guidelines emphasize the importance of staff knowledge in preventing CLABSI and of educating and training healthcare personnel such as nurses who insert

and maintain catheters (5). These findings suggest that higher levels of nurses' knowledge about EB guidelines and practice are strongly related to lower CLABSI rates.

## Significance of the study

Nurses' knowledge of guidelines for the prevention of CLABSI has not been fully assessed, and little is known about the difference between their knowledge and impact on practices. There are only a few studies that have evaluated nurses' knowledge for the prevention of central venous catheter (CVC) related infections in an Egyptian governorate (16, 17). A study conducted by Elbilgahy et al., (18) reported that, there were variations in nursing practice and absence of a uniform protocol for CLABSI prevention among nurses across the studied ICUs. In addition, they reported the need for developing a protocol for CLABSI prevention based upon current evidence based guidelines. Hence this study was to evaluate the effect of implementing an evidence-based educational program on nurse knowledge, practice and attitude about prevention of central line associated blood stream infection in pediatric critically ill populations.

## Subject and methods

### Research design

A quasi-experimental using one group pre / post-test research design was used for this study.

### Aim of the study

The aim of the study was to evaluate the effect of implementing an evidence-based educational program on nurse knowledge, practice and attitude about prevention of central line associated blood stream infection in pediatric critically ill children through achieving the following objectives:-

1. Assessment of the nurses' knowledge, practice and attitude about prevention of central line associated blood stream infection in PICU.
2. Designing and implementing evidence based educational program about prevention of central line associated blood stream infection in PICU.
3. Evaluation of the nurses' knowledge, practice and attitude about prevention of central line associated blood stream infection.

### Research hypothesis

Nurses who attend the evidence based educational program have good knowledge, practice and attitude about prevention of CLABSI in PICU.

### Setting and study participants

This study was carried out in four ICUs (Medical, Surgical, Neonatal and Cardiac Care Unit) affiliated to Mansoura University Children's Hospital (MUCHs), Egypt. A convenient sample included 120 nurses out of 160 with a response rate of 75%, were included in the study.

## Study Measures and Questionnaires

### Nurses Knowledge about Evidence-Based Guidelines for CLABSI Prevention

The questionnaire used was developed by the researchers after reviewing the related literature (19, 20, 21). Questions were in the form of multiple choice questions. The questionnaire was translated to Arabic language and was assessed for its content validity and reliability by nurse experts. The reliability of tool was assessed using Alpha Cronbach's test. The alpha reliability was 0.717. The survey had three parts, as follows:

**Part I:** Characteristics of participants including: age, sex, level of education, years of experience and previous attendance of training program about CLABSI prevention.

**Part II:** Thirteen questions assessing nurses' knowledge related to frequency of CVC change, replacement of CVC over guide wire, use of CVC coated with antiseptic, skin antisepsis, use of antibiotic ointment, type of dressing, frequency of dressing change, disinfection of catheter hub and administration set management. The framework of survey scoring was calculated as follows; the correct answer scoring 1 and the incorrect answer scored zero (0). Accordingly, nurses were considered to have good knowledge if they answered  $\geq 80\%$  questions correctly, average knowledge if  $\geq 75\%$  and  $< 80\%$  were answered correctly and poor knowledge if the score was  $\leq 70\%$ .

**Part III:** The scale for assessing nurses' attitude toward evidence-based guidelines for prevention of CLABSI was developed with the guidance of Bianco et al, (3). The questionnaire consisted of 8 statements and the responses to these statements were; agree, uncertain, or not agree. The alpha reliability of this part was  $\alpha = 0.70$ . The scoring system was developed with the positive attitude scored (2) and (uncertain) scored (1) and negative attitude scored (0). Using this scoring system, nurses were judged to have an extremely positive attitude if score was 80%, positive attitude if score was  $>75\%$  and negative attitude if the score was less than 70%.

### Central line insertion and daily care observational checklist:-

Observational checklist was developed by the researcher based upon review of evidence-based practice (5, 3, 22). The checklist was used to assess and evaluate the pediatric nurses' practice related to prevention of CLABSI for pediatric patients. This checklist was used to observe the actual nurses' practice during insertion of CVC and daily care of the catheter. The observation of nurses' practice was carried out during morning and afternoon shifts. The scoring system for the observation checklist was developed; each correct step of the procedure scored on the bases of "complete correct done" scored (2), & "Not done", scored (0). The level of practice was considered competent practice if the percent score was 80% or higher and incompetent practice if the percent score was less than 70%.

### Evidence-based educational intervention

The researcher designed the evidence-based educational program after thorough reviewing of the related literature (5, 10). The program was combined theoretical content and practical skills aims to increase nurses' information and skills for the prevention of CLABSI in the pediatric patient. The program was introduced for nurses in four sessions; including two theoretical and two practical. Nurses were divided into small groups of 8 participants; each session was lasts for 45-60 minutes and it was conducted inside the unit over a period of 3 months. The theoretical part including knowledge about overview of CVC types, site of insertion, preparation of the pediatric patient, daily maintenance care, CLABSI definition and incidence, mechanism of infection, evidence-based guidelines for prevention of CLABSI. The practical sessions including preparation of patient for CVC insertion, disinfection of insertion site, checking patency, daily care, dressing change, checking patency and correct flushing technique.

The researcher uses different methods of teaching and using different media such as , group discussion, brain storming, demonstration & return demonstration using PowerPoint, video, posters and educational booklet was distributed and available in the department for nurses. The researcher assesses the nurses' knowledge, practice & attitude (post test) after three (3) months of program implementation and observation of nurses' practice.

### Data collection

Data collection of this study was carried out over six months in the period from the beginning of November 2015 to the end of April 2016. Two methods were used for data collection by the researchers, including observation of nurses' practice of daily care of CVC and nurses self-administered questionnaire.

### Pilot study

A pilot study was carried out on twelve (12) nurses to determine the applicability and simplicity of the tool. The pilot study result indicates that the questionnaire is clear and easy to understand.

### Data Analysis

Processing and analysis of data was done by using Statistical Package of Social Sciences (SPSS) version 16.0. Descriptive statistics (number, percentage, mean and SD) were used to describe the main variable. Association between categorical variables was tested using Chi-square test and Mc Nemar test. Paired t-test was used for comparison within groups. The significance level for all tests was at  $p < 0.05$ .

### Ethical Considerations

Ethical agreement was obtained from the "Research Ethics Committee at the Faculty of Nursing - Mansoura University". An executive endorsement was acquired by

an official letter to the director of the hospital to conduct the study after discussing and clarifying the aim of the study. Written consent was obtained from every nurse

after explaining the aim of the study. Concealment of data and secrecy as well as nurses right to retract from the study was clarified.

## Results

Table 1 describes the characteristics of the nurses participating in the study. Approximately half of the nurses (49.2%) were in the age group from 30 to less than 35 years. Among the nurses participating in this study 75.8% had bachelor degree in nursing, with more than one third of nurses (37.5%) having 5 to 10 years of experience. In addition, more than two thirds (67.5%) of the nurses had attended a training program about infection control, approximately three quarters (73.3%) of nurses have revised no training program about CLABSI prevention.

**Table 1: Characteristics of studied nurses**

Characteristics	(n=120)	%
<b>Age in years</b>		
20 < 25	11	9.2
25 < 30	33	27.5
30 < 35	59	49.2
35 ≥ 40	17	14.2
<b>Educational level</b>		
Diploma	15	12.5
Technical institute of nursing	14	11.7
Bachelor degree of nursing	91	75.8
<b>Years of experience</b>		
< 5	28	23.3
5 < 10	45	37.5
10 < 15	36	30
15 < 20	4	3.3
20 & more	7	5.8
<b>Department</b>		
Pediatric intensive care unit (PICU)	41	34.2
Neonatal intensive care unit (NICU)	40	33.3
Surgical intensive care unit (SICU)	19	15.8
Cardiac care unit (CCU)	20	16.7
<b>Attending of training programs on infection control</b>		
Yes	81	67.5
No	39	32.5
<b>Attending of training programs on CLABSI prevention</b>		
Yes	32	26.7
No	88	73.3

There was a highly statistical significant difference pre / post program implementation in relation to the nurses' knowledge about prevention of CLABSI as presented in Table 2. Twenty five percent of studied nurses (25%) gave the correct answer about the use of coated CVC before the program, while, replacement of transparent dressing was answered by 28.3% of nurses before the program compared to the majority of them (95% and 99.2% respectively) P (<0.001).

Concerning replacement of administration set for clear fluid, it was found that, a minority of the nurses (6.7%) reported that IV set must be changed every 96 hours before program and this percentage was improved after program to (98.3%) with the majority of nurses (81.7% & 98.3%) replying that replacement of administration set for lipid solution must be performed every 24 hours. Moreover, disinfection of catheter hub was correctly answered by fewer nurses (8.3%) before the program and the majority of them (91.7%) after program implementation.



Table 2: Nurses knowledge about prevention of CLABSI

Variable	Pre		Post		P - value
	No(120)	%	No (120)	%	
Replacement of central venous catheters (CVCs) routinely					
Every 7 days	26	21.6	46	38.3	X <sup>2</sup> =34.26 p<0.001**
Every 3 weeks	13	10.8	0	0	
Only when indicated	69	57.5	73	60.8	
Do not know	12	10	1	0.8	
Recommendation for CVC replacement in the same insertion site					
Inserting a new catheter at a different site	85	70.8	117	97.5	X <sup>2</sup> =32.71 p<0.001**
Guide-wire insertion has been the accepted technique	19	15.8	3	2.5	
The use of an existing CVC site is associated with an increased risk of CLABSI, as compared with the use of a new CVC site	9	7.5	0	0	
Do not know	7	5.8	0	0	
It is recommended to replace CVCs over a guide wire					
Yes, every 3 days	7	5.8	1	0.8	X <sup>2</sup> =80.52 p<0.001**
Yes, every 7 days	23	19.2	0	0	
No, only when indicated	58	48.3	119	99.2	
Do not know	32	26.7	0	0	
Replacement of pressure transducers and tubing routinely					
Yes, every 4 days	10	8.3	92	76.7	X <sup>2</sup> =128.2 p <0.001**
Yes, every 8 days	0	0	1	0.8	
No, only when indicated	58	48.3	26	21.7	
Do not know	52	43.3	1	0.8	
CVC coated with an antiseptic agent is recommended to prevent CLABSI					
Yes, in patients whose CVC is expected to remain for more than 5 days	30	25	114	95	X <sup>2</sup> =134.1 p<0.001**
No, because the use of such catheters is not cost-effective	5	4.2	6	5	
No, because the use of such catheters does not result in a significant decrease in the rate of CLABSI	22	18.3	0	0	
Do not know	63	52.5	0	0	
Recommendation for transparent dressing change					
Daily	76	63.3	0	0	X <sup>2</sup> =143.1 p<0.001**
Every 3 days	1	0.8	1	0.8	
When indicated (soiled, loosened ) and at least weekly	34	28.3	119	99.2	
Do not know	9	7.5	0	0	
Recommendation for gauze dressing change					
Daily	87	72.5	4	3.3	X <sup>2</sup> =132.2 p<0.001**
When indicated and at least every 2 days	22	18.3	109	90.8	
When indicated (soiled, loosened) and at least weekly	3	2.5	7	5.8	
Do not know	8	6.7	0	0	
Recommended type of CVC dressing					
Polyurethane dressing (transparent, semi-permeable)	14	11.7	2	1.7	X <sup>2</sup> =95.45 p<0.001**
Gauze dressing	53	44.2	0	0	
Both are recommended because the type of dressing does not affect the risk for CLABSI	47	39.2	117	97.5	
Do not know	6	5	1	0.8	

Recommended antiseptic solution to disinfect the catheter insertion site					
2% aqueous chlorhexidine	14	11.7	116	96.7	X <sup>2</sup> =178.2 p<0.001**
0.5% alcoholic chlorhexidine	2	1.7	2	1.7	
10% povidone-iodine	101	84.2	2	1.7	
Do not know	3	2.5	0	0	
It is recommended to apply antibiotic ointment at the insertion site					
Yes, because it decreases the risk of CLABSI	89	74.2	6	5	X <sup>2</sup> =174.1 p<0.001**
No, because it causes antibiotic resistance	12	10	114	95	
No, because it does not decrease the risk of CLABSI	5	4.2	0	0	
Do not know	14	11.7	0	0	
Frequency of change of administration set for lipid emulsions					
Within 24 hours	98	81.7	118	98.3	X <sup>2</sup> =25.85 p<0.001**
Every 72 hours	8	6.7	0	0	
Every 96 hours	0	0	2	1.7	
Do not know	14	11.7	0	0	
Frequency of change of administration set for clear fluid					
Every 24 hours	96	98.3	2	1.7	X <sup>2</sup> =214.2 p<0.001**
Every 48 hours	0	0	0	0	
Every 96 hours	8	6.7	118	98.3	
Do not know	14	11.7	0	0	
It is recommended to use an antiseptic solution to clean the access hub					
Yes, by wiping with 70% alcohol solution or alcohol and chlorhexidine solution for no less than 15 seconds	98	81.7	110	91.7	X <sup>2</sup> =24.22 p<0.001*
Yes, by spraying the access site with 70% alcohol solution or alcohol chlorhexidine solution	10	8.3	10	8.3	
It is not recommended because no evidence has been found	3	2.5	0	0	
Do not know	9	7.5	0	0	

(\*\*) Highly statistically significant at  $p < 0.001$



Table 3: Nurses practice during insertion and daily maintenance care of central venous catheters (CVC)

Variable	Pre						Post						p value
	Done correctly			Not done			Done correctly			Not done			
	No	%		No	%		No	%		No	%		
Care of CVC during insertion													
1. Hand washing	69	57.5	51	42.5	120	100	0	0	0	0	0	0	<0.001**
2. Wearing mask	69	57.5	51	42.5	120	100	0	0	0	0	0	0	<0.001**
3. Wearing sterile gloves	120	100	0	0	120	100	0	0	0	0	0	0	-
4. Wear gown	30	25	90	75	80	66.7	40	33.3	40	33.3	25	20.8	<0.001**
5. Place patient in Trendelenburg position	46	38.3	74	61.7	95	79.2	25	20.8	25	20.8	0	0	<0.001**
6. Disinfect site of insertion with antiseptic and allow to dry	120	100	0	0	120	100	0	0	0	0	0	0	-
7. Open the catheter kit using a sterile technique	120	100	0	0	120	100	0	0	0	0	0	0	-
8. Flush the lumens with normal saline after catheter insertion	120	100	0	0	120	100	0	0	0	0	0	0	-
9. Label the dressing with the time and date	120	100	0	0	120	100	0	0	0	0	0	0	-
CVC maintenance care													
1. Hand washing prior to access the line for medication administration, blood sample withdrawal and change the device	30	25	90	75	80	66.7	40	33.3	40	33.3	0	0	<0.001**
2. Scrub the line and the hub for 10-15 times or from 10-15 seconds and allow to dry	33	27.5	87	72.5	75	62.5	45	37.5	45	37.5	25	20.8	<0.001**
3. Access catheters only with sterile devices	46	38.3	74	61.7	95	79.2	25	20.8	25	20.8	0	0	<0.001**
4. Change wet soiled dressing	120	100	0	0	120	100	0	0	0	0	0	0	-
5. Change dressing using aseptic technique with clean or sterile gloves	120	100	0	0	120	100	0	0	0	0	0	0	-

McNemar Test was used

(\*\*) Highly statistically significant at  $p < 0.001$

Table 3 reports nurses' practice during insertion and maintenance of central venous catheter. It was noted from this table that fifty seven percent of the nurses (57.5%) were correctly performing hand washing and wearing gloves for catheter insertion before program implementation. Immediately after the program, all of nurses (100%) perform these steps correctly. In addition, 25% of the nurses were performing hand washing before accessing CVC and wearing gown before the program and this improved after program to 66.7%. Moreover, there was a statistically significant difference in relation to nurses' practice in the daily care of CVC pre and post program implementation ( $P < 0.001$ ).

Nurses' attitude toward preventive measure for CLABSI as shown in Table 4 was very positive. All nurses agreed that maintaining aseptic technique and hand washing can reduce the risk of CLABSI pre and post program. In addition, the majority of nurses (86.7% & 99.2%) had a positive attitude regarding removing dressing and examining the insertion site when the pediatric patient was feverish pre and post program implementation, respectively.

When the nurses were asked about antibiotic ointment application at the insertion site, sixty eight percent (68.3%) of them reported the benefit of applying antibiotic ointment on the insertion site and this practice is not recommended by guidelines. But the attitude was changed positively after program implementation to 87.5%. Furthermore, the majority of nurses (80%) had a negative attitude regarding routine CVCs replacement without any signs and symptoms of infection pre program and declined to 25.8% after the program.

Table 5 demonstrates the benefit of the program with an increase in the mean score of nurses' knowledge, practice and attitude following the program implementation. Attitude score was improved from  $10.87 \pm 1.88$  to  $14.35 \pm 1.89$  and the difference was highly significant ( $p < 0.001$ ).

Level of nurses' knowledge about prevention of CLABSI is presented in Figure 1 and shows that the majority of nurses (88.3%) had poor knowledge before EB program implementation compared to 97.5% of nurses who had good knowledge after program implementation and the difference was statistically significant.



Table 4: Nurses' attitude about evidence-based guidelines for prevention of CLABSI

Variable	Pre			Post			p-value
	Agree	Uncertain	Not agree	Agree	Uncertain	Not agree	
	No (%)	No (%)	No (%)	No (%)	No (%)	No (%)	
1. Following aseptic technique during insertion and care of CVC reduces the risk of CLABSI.	120 (100)	0	0	120 (100)	0	0	-
2. Performing hand hygiene before and after inserting, replacing, accessing, or dressing CVC reduces CLABSI risk	118 (98.3)	2 (1.7)	0	120 (100)	0	0	0.50
3. CVC dressing should be removed and insertion site should be examined when pediatric patient has fever without obvious source.	104 (86.7)	16 (13.3)	0	119 (99.2)	1 (0.8)	0	<0.001**
4. Inspect catheter insertion site visually or by palpation through an intact dressing on a regular basis reduces the risk of CLABSI.	108 (90)	10 (8.3)	2 (1.7)	118 (98.3)	0	2 (1.7)	0.005*
5. Application of topical antibiotic ointment or creams on CVC insertion sites reduces the risk of CLABS.	82 (68.3)	28 (23.3)	10 (8.3)	8 (6.7)	7 (5.8)	105 (87.5)	<0.001**
6. Antiseptic should be allowed to dry before catheter insertion	98 (81.7)	17 (14.2)	5 (4.2)	116 (96.7)	1 (0.8)	3 (2.5)	<0.001**
7. Routine CVCs replacement is effective to prevent CLABSI	96 (80)	13 (10.8)	11 (9.2)	31 (25.8)	5 (4.2)	84 (70)	<0.001**
8. Using a CVC with the minimum number of lumens is an effective practice to reduce CLABSI risk	83 (69.2)	25 (20.8)	12 (10)	79 (65.8)	0	41 (34.2)	<0.001**

Mc Nemar and chi square tests were used

(\*) statistically significant at  $p < 0.05$

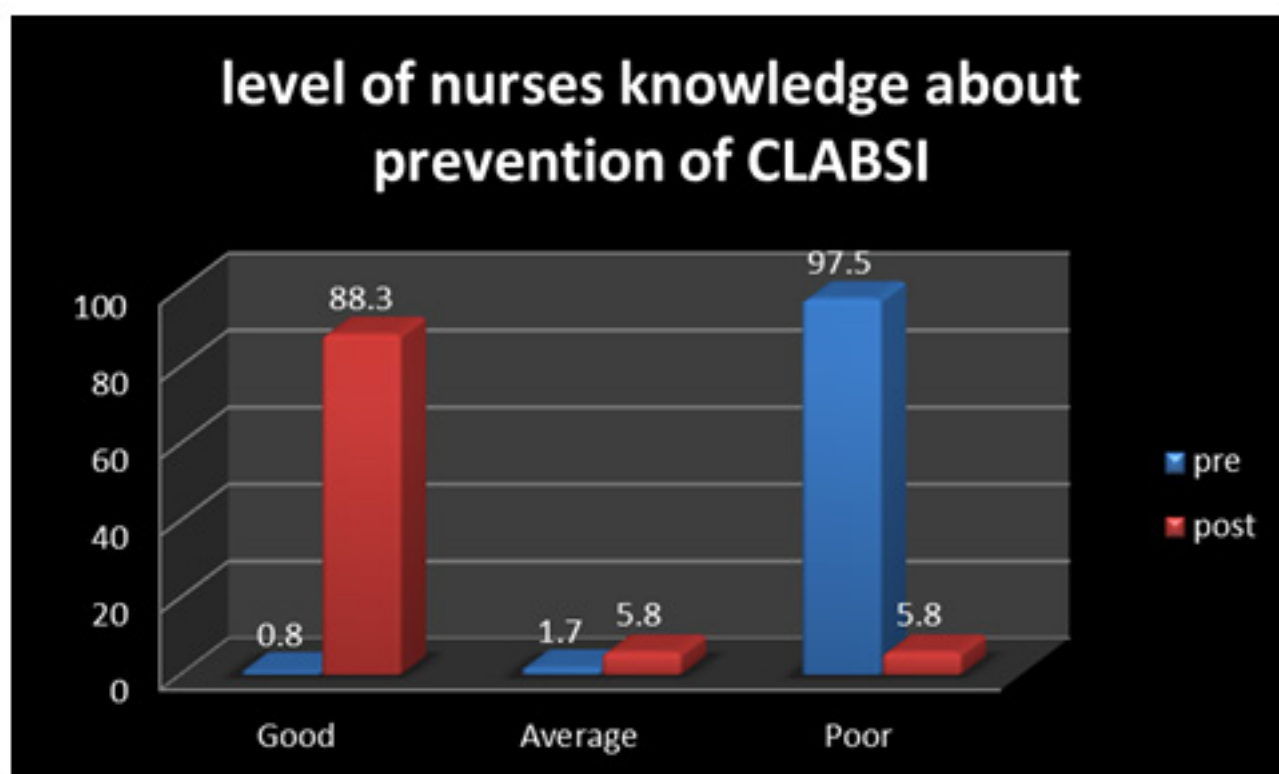
(\*\*) highly statistically significant at  $p < 0.001$

**Table 5: Mean scores of nurses' knowledge, practice and attitude about prevention of CLABSI before and**

	Pre	Post	Paired t-test
	Mean $\pm$ SD	Mean $\pm$ SD	
Knowledge score	4.19 $\pm$ 1.95	10.98 $\pm$ 1.2	t=37.46 p<0.001**
Practice score	23.2 $\pm$ 1.05	38 $\pm$ 0	t=154.4 p<0.001**
Attitude score	10.87 $\pm$ 1.88	14.35 $\pm$ 1.89	t=13.19 p<0.001**

Paired t test used

(\*\*) highly statistically significant at p <0.001

**Figure 1: Level of nurse's knowledge about prevention of CLABSI**

## Discussion

This study verified that nurses have an ample level of knowledge concerning evidence-based recommendations for preventing CLABSIs such as replacement of CVC (57.5%), replacement of administration set for blood and lipid solution (81.7%) and the use of antiseptic solution to disinfect the catheter hub (81.7%). Contrarily, there are wide areas where the knowledge was lower; particularly regarding recommended antiseptic solution to disinfect the catheter insertion site, since 11.7 % only gave the correct answer. To ensure the highest standards of nursing care, nursing practice must be based on a strong body of scientific knowledge. This can be achieved

through adherence to the evidence based guidelines for prevention of CABSI which will contribute to improving patient outcomes. Approximately three quarters (73.3%) of the studied nurses did not receive a training program about CLABSI and its prevention (Table 1). Similarly Chen et al., (1) reported in their study that half of studied nurses had not received training about the guidelines for prevention of CLABSI. However, this result was in contrast with Humphrey, (23) who reported in a similar study that Seventy-eight percent (87%) of studied nurses had been receiving education program regarding maintenance of central line.

In the present study, more than half (57.5% and 60.8%) of nurses gave the correct answer regarding replacement of CVC before and after the educational program respectively. Previous studies also revealed the highest percentage of nurses' knowledge in this point with percentage ranging from 40-76% (16, 24, 25, 26). The reason for the nurses' correct answer can be interpreted as the CVC was changed only when indicated as a part of hospital policy without recognizing the relation between CVC replacement and the risk of CLABSI.

The present study revealed that, 48.3% of the studied nurses only knew that CVC replacement over guide wire should be done only when indicated. This result was in discrepancy with Labeau et al., (21, 26) who reported in a similar study that, approximately 70% of nurses in their study answered this question correctly. Best practice suggests selecting a new site for CVC insertion; this was obvious in this study as approximately three quarters of the nurses gave the correct answer. Furthermore, replacement of CVC over guide wire technique was not implemented in the hospital and the hospital policy recommends insertion of CVC in a new site. Furthermore, few of the nurses were aware that, pressure transducers and tubing should be replaced every 4 days before the program and improved after educational intervention; this result was consistent with Chen et al., and Cicolini et al, (1 & 27).

Regarding the use of coated catheter in the prevention of CLABSI, the present study indicated that, three quarters (75%) of studied nurses did not know the correct answer before program implementation. This result was congruent with Labeau et al., (26) who reported in their study that 36% of European nurses did not know what is recommended regarding the use of such catheter. Lack of knowledge in this point reflects infrequent application of this technique inside the hospital.

According to CDC guidelines for prevention of CLABSI, both sterile gauze and transparent, semi permeable dressing are recommended (5). However, more than one third (39.2%) of the nurses reported the correct answer regarding recommended type of dressing before program implementation. This could be attributed to the fact that the gauze dressing is more accessible and used to cover CVC insertion site compared to transparent, semi permeable dressing which is more expensive.

CVC dressing change is the main responsibility of nurses and our study indicated low level of nurses' knowledge about dressing change. The study showed that, few nurses 28.3% and 18.3 % knew the frequency of change transparent and gauze dressing respectively before conduction of the program. Study result was in concurrence with Alkubati et al., (16); but in contradiction with Guembe et al., (25) who reported higher percentage of nurses' knowledge regarding frequency of dressing change. The result could be interpreted in the light of fact that, gauze dressing is changed on a daily basis in our

hospital in Egypt and this also reflects the gap between the guidelines and clinical practice. In addition, the nurses' reported that, frequent change of dressing decreases the risk of infection, whereas, it may be associated with increased medical cost and patient discomfort. During the study, chlorhexidine solution was not available for disinfection of the insertion site and tincture of iodine and alcohol were used instead. This probably accounts for the low knowledge score, because only 11.7% knew that chlorhexidine is recommended to disinfect the CVC insertion site.

Concerning the use of antibiotic ointment or cream on CVC insertion site, the result of the current study showed that, only 10% of studied nurses knew that application of such practice is not recommended by CDC guidelines because it can lead to antibiotic resistance. Similarly, Alkubati et al; Guembe et al and Labeau et al., (16, 25, 26) showed low level of nurses' knowledge about the use of antibiotic ointment. The lack of nurses' knowledge about this issue also reflected on nurses attitude as more than two thirds (68.3%) of studied nurses had negative attitudes and agree about application of antibiotic cream on CVC insertion site pre program. This result was in agreement with Bianco et al., (3) who reported in their study that approximately one third (31%) of respondents were also in agreement or were uncertain or equivocal about the utilization of topical antibiotic treatment at CVC insertion sites. This could be explained by nurses' belief that, application of topical antibiotic can provide extra protection from infection or may reflect the hospital policy.

Replacement of administration set for blood and lipid solution was correctly answered by the majority of nurses (81.7%) before educational intervention. On the other hand, few of the nurses (6.7%) replied that the administration set used for clear fluid must be changed every 96 hours. Also, Chen et al., (1) reported in their study that, only 3.5% of nurses knew that the administration sets should be replaced after 96 hours in patients not receiving blood, blood products or fat emulsions. In contrast, Cicolini et al., and Labeau et al., (27 & 26) reported that, 26.5% and 45.4% of nurses, respectively, knew this fact. The findings from the current study related to the hospital policy and unit protocol guidelines stated that the administration set for blood and lipid solution was changed immediately at the end of infusion and the administration set for clear fluid must be changed daily.

Knowledge is considered the backbone of the prevention of nosocomial infections especially CLABSI. The goal of continuous education in nursing is to enhance knowledge and to promote the quality of health care delivery to the pediatric patient. The present study findings revealed that, all pediatric nurses with different educational levels and years of experience had unexpectedly poor knowledge scores about CLABSI prevention before program implementation. The overall mean score of nurses' knowledge was 4.19 out of 13, which is congruent with Ullman et al., (24) who reported in their study that, the mean score was 5.5 out of 10 in pediatric ICU nurses. Similarly,



Vandijck et al., (20) also reported limited knowledge in the current guidelines. These results may be due to lack of training courses, or lack of equipment and work overload which in turn affects nurses' knowledge and practice.

Nurses' knowledge of care and maintenance of CVC and prevention of CLABSI were statistically significant ( $p = .0001$ ) and the pre test mean score was improved from  $4.19 \pm 1.95$ , to  $10.98 \pm 1.2$  after the educational intervention as presented in Table 5 and Figure 1. Similarly, Humphrey, (23) reported that, nurses mean score of knowledge revealed a statistically significant mean score from 4.6 to 8.4 after educational intervention. In addition, Comer et al., (14) found that electronic instructional classes and online courses increased physicians' information about prevention of central line associated blood stream infection. Furthermore, Yilmaz et al., (12) reported that a training program for healthcare workers who inserted and maintain CVC was associated with decrease in the incidence of catheter related blood stream infection.

The current study showed that, all nurses (100% & 98.3%) respectively had an extremely positive attitude toward maintaining aseptic technique and hand washing. Similarly, Bianco et al., (3) reported in their study that 96.7% and 95.8% agreed that maintaining aseptic technique and hand washing can reduce the risk of CLABSI. In addition, 86.7% of the nurses believe that dressing must be removed and the insertion site must be examined when the patient is feverish. Furthermore, negative attitude was obvious in routine replacement of CVC as the majority of nurses (80%) did not understand that routine replacement of CVC without signs or symptoms does not prevent CLABSI. In contrast, Bianco et al., (3) reported that, more than half of participant (57.8%) had positive attitude regarding routine CVC replacement.

Our study indicated that, fifty seven percent of studied nurses (57.5%) were washing their hands and wearing mask during insertion of CVC. Moreover, all nurses wore sterile gloves during insertion and only a quarter (25%) of them were wearing gowns, while application of sterile drape to cover patient body during insertion was not applied as the majority of CVC insertion was done inside the unit and the difficult cases were done in the operating room where sterile drape was done. Similarly, Alkubati et al; El-Nemr et al; Ider et al & Rosenthal et al., (16, 17 & 22) reported that less than half of nurses were compliant and adherent with wearing personal protective equipment (PPE) during the insertion of CVCs in developing countries. In addition, sterile towel did not cover the entire body of the patients during CVC insertion. The low percentage of nurses' compliance to maximal sterile barrier could be attributed to lack of supplies such as (gown, mask, cap and sterile drape), work overload, lack of knowledge about the importance of PPE and it may be due to nurses belief that the physicians must only be responsible with using maximal sterile barrier as they insert the catheter and the nurse assists in the procedure.

Flushing CVC with normal saline after insertion and as daily care routine was done by all nurses in the present study and all of them accurately demonstrated the insertion and application of dressing. This result was in contradiction with Mathers, (28) who reported a lower percentage of nurses' practice in this point. Finally, prevention of CLABSI necessitates a collaborative effort, and the nurses had critical responsibility since their frequent interactions with pediatric patients at the bedside. So, it is imperative to increase the nurses' knowledge about prevention of CLABSI through educational programs to enhance the implementation of EBGs of research into practice.

## Conclusion and Recommendation

The study concluded that nurses' knowledge, practice and attitude about prevention of central line associated blood stream infection in pediatric patients were improved significantly after the implementation of the evidence-based educational program. Based on the findings of the current study the following recommendations must be considered: the nurses should provide nursing care to critically ill children based on evidence-based practice other than experience based practice and the hospitals should organize internal training courses for all health care team members as important to broaden the implementation strategy for CLABSI prevention and CVC infection. In addition, the hospital policy maker should offer supplies necessary to provide care for critically ill children with CVC. Establishing a system to ensure that CLABSI prevention protocol should be implemented consistently in all PICUs and the preventive measures for CLABSI applied at time of CVC insertion and at daily CVC care. Furthermore, the nurses must attend external training courses and conferences to upgrade their knowledge and practices in their field and the evidence based guidelines for CLABSI prevention should be incorporated in all nursing curricula.

## Limitation of the study

The main limitation of our study was that, it was conducted in one hospital and on a small sample size; so, the results may not be generalized with those from other institutions with different populations and medical policies. Another important limitation was that, the educational intervention was implemented for nurses only where there are also doctors involved with CVC insertion and assessed by investigator developed instruments. In addition, the impact of educational intervention on clinical outcomes was not evaluated. Moreover, the study provides a lot of information about prevention of CLABSI in PICU in Egypt.

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