

# Effect of education program on nurses' knowledge and practice regarding care of central venous line in pediatric hemodialysis: evidence-based practice guidelines

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Received 27 March 2017

Accepted 6 June 2017

Egyptian Nursing Journal

2017, 14:87-99

## Introduction

Catheter-related blood stream infections (CRBSIs) are the main cause of hemodialysis (HD) failure in infants and children. Active prevention of CRBSIs required multiple interventions and adherence to evidence-based practice guidelines.

## Aim

The aim of this study was to investigate the effect of education program on nurses' knowledge and practice in pediatric HD unit evidence-based practice (EBP) guidelines.

## Participants and methods

A quasiexperimental design was utilized. The study was conducted in the Pediatric Hemodialysis Unit at Benha University Hospital and the Hemodialysis Unit at Benha Fever Hospital. A convenient sample of 40 nurses from the previously mentioned setting was included in the study. Two tools were used: a questionnaire sheet for assessing nurses' personal data and knowledge about CRBSIs and EBP guidelines, and an observational checklist to assess nurses' practice toward care of pediatric HD catheter.

## Results

The study results showed that there was a highly statistically significant improvement in total knowledge level of nurses immediately after implementation and 6 months after implementation of education program guidelines. Moreover, there was a highly statistically significant relation in nurses' practice and their educational level, occupation, years of experience, and attendance of training course, before implementation/immediately after implementation and 6 months after implementation.

## Conclusion

The current study concluded that the nurses who received evidence-based guidelines educational program as regards central vascular catheter maintenance and care showed high score level in nurses' knowledge and practice after implementation of the program than that before recommendation. The study recommended that training and continuing education of the EBP guidelines for staff nurses are important to improve care provided in the pediatric hemodialysis units.

## Keywords:

catheter-related blood stream infections, evidence-based practice, hemodialysis, nurses' role

Egypt Nurs J 14:87-99

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2090-6021

## Introduction

Hemodialysis (HD) is a widely used mode of renal replacement therapy in infants and children with end-stage renal disease (ESRD). It can be defined as a treatment that cleans the blood of excess waste products and removes excess fluid. Excess water and waste are removed through a semipermeable membrane by means of diffusion and osmosis. The child must have blood vessel access through which the blood can be removed and returned. Long-term HD in the pediatric age group is performed mainly through tunneled cuffed central venous catheters (CVCs) inserted angiographically or surgically, most often into the superior vena cava. Arteriovenous fistulas or

arteriovenous grafts, which are used commonly in adults, are used less often in children because of technical difficulties in creating them in small children and because the waiting time for transplantation (during which the arteriovenous fistulas/or arteriovenous grafts is used) is much shorter in children than in adults (American Nephrology Nurses' Association, 2013). Central vascular catheters remain the most common form of

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vascular access in children and their use has been increasing. CVCs have become necessary components of HD patient care and might result in catheter-related blood stream infections (CRBSIs) (Jeong *et al.*, 2013; United States Renal Data System, 2013).

National Kidney Foundation (2011) reported that vascular access-related infections are a significant cause of hospitalization and are associated with significant morbidity and mortality. The ideal vascular access, besides providing adequate blood flow, should have satisfactory survival and a low rate of complications.

Napalkov *et al.* (2013) conducted a study to provide a new body of data on the risk for catheter-related complications derived from a large patient population. The risk for catheter-related complications is highest during the first 90 days of catheter placement in patients with CVC and HD catheters and in younger patients ( $\leq 16$  years of age) with HD catheters. In younger patients less than 2 years of age and 2–16 years of age with CVCs, the risk for complications is higher than that in patients over 16 years of age.

Gahlot *et al.* (2014) defined CRBSI as the presence of bacteremia originating from an intravenous catheter. It is one of the most frequent, lethal, and costly complication of central venous catheterization and also the most common cause of nosocomial bacteremia in hospitalized patients. CVCs pose a greater risk for device-related infections compared with any other type of medical device and are major causes of morbidity and mortality.

The risk factors that contributed to the occurrence of CRBSI included the type of device, the insertion site, the adherence to preventive measures, and patient hygiene. Risk factors also include previous CRBSI, recent hospitalization, and the duration of catheter use. Further risk factors include hypoalbuminemia, iron overload, *Staphylococcus aureus* nasal carriage, and the immunocompromised host (Bisiwe *et al.*, 2015).

The majority of CRBSIs are associated with CVCs, as the relative risk for CRBSI is up to 64 times greater with CVCs than with peripheral venous catheters. CRBSIs can be diagnosed by at least one positive blood culture obtained from a peripheral vein, clinical manifestations of infections (i.e. fever, chills, and/or hypotension), and no apparent source of infection other than the catheter site (Burrell *et al.*, 2011).

CRBSI is a critical problem in the HD setting. Patient risks include increased length of stay, risk for long-term complications, and even death. For these reasons, preventing CRBSI is essential. The Centers for Disease Control and Prevention (CDC) published guidelines for the prevention of CRBSI, which is the benchmark for all CVC care recommendations. One of the major areas of emphasis in the CDC 2011 guideline is educating and training healthcare personnel who insert and maintain catheter care (Centers for Disease Control and Prevention (CDC), 2011).

Guidelines were used to reduce the discrepancies in the delivery of care and to ensure it was high-quality care and evidence-based care. Further, they provided a means by which nurses in dialysis units could be held accountable for clinical activities (Vanholder *et al.*, 2010).

Evidence-based practice (EBP) guidelines are a set of systematically developed statements, usually based on scientific evidence, to assist practitioners and patients in decision making about appropriate healthcare measures for specific clinical circumstances (Kadium, 2015). The guidelines referred to a set of five steps to prevent CRBSIs using proper hygiene and sterile personnel protection equipment, chlorhexidine for patient's skin preparation, finding the best vein possible for the IV, checking every day for signs of infection, and removing or changing the line only when needed (Kim *et al.*, 2011; Institute for Healthcare Improvement, 2014).

Institute for Healthcare Improvement (2014) emphasized that a structured five elements based on CDC evidence-based guidelines (2011) for CRBSI prevention include hand hygiene, use of maximum sterile barriers with catheter maintenance, use of chlorhexidine for skin preparation, avoiding the use of the femoral and jugular sites for catheter insertion, and prompt removal of unnecessary catheters, a way of improving the processes of CVC care and patient outcomes. Moreover, these guidelines also emphasize on performance improvement by implementing all components as benchmarks for quality assurance and performance improvement.

Nurses play a significant role in HD; they contributed to the preventive, promotive, and curative aspects of the dialysis unit by maintaining an aseptic environment during insertion and preparation of CVC insertion kits and all necessary equipment in aseptic technique. They were responsible for applying their knowledge to

reduce infection episodes. Nonadherence to recommended EBP guidelines for preventing CRBSIs could be due to nurses' lack of knowledge of the guidelines with other health team members where they are providing the best practices in their care during either insertion or care for CVCs (Aiken *et al.*, 2011; Wiegand, 2011).

Thus, the current study focuses on evaluating the effect of educational program adapted from EBP guidelines (Centers for Disease Control and Prevention (CDC), 2011), for care and maintenance of CVC on nurses' knowledge and practice in the pediatric hemodialysis unit.

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### Significance of the study

El-Taib *et al.* (2011) mentioned that the reported annual incidence of patients with ESRD was 52 per million populations (pmp) and 200 pmp in Turkey and Egypt, respectively. Safouh *et al.* (2015) in a retrospective study reviewed the records of 1018 Egyptian children (ages from 1 to 19 years, male 56.7%) suffering from chronic kidney diseases of all stages and followed-up at the pediatric nephrology units (outpatient clinics and dialysis units) of 11 universities providing tertiary medical care to children from all Egyptian governorates during the year 2012–2013. Of the 587 patients who had reached ESRD, 549 (93.5%) were treated with HD in different university hospitals and only 38 (6.5%) were treated with peritoneal dialysis.

Nevertheless, although HD-CVCs are very efficient in delivering adequate dialysis in children, accumulating data have shown a high rate of CRBSIs and short survival times for these catheters. These studies have shown CVC-related infection rates that have varied between 1.5 and 4.8/1000 catheter days in children. However, CRBSIs increased the likelihood of mortality, cost, and length of stay. Therefore, providing nurses with clinical guideline as regards care of HD catheter will result in improving their performance (Burden *et al.*, 2012; Cooper *et al.*, 2014).

Nurses' adherence to EBP is very important for reducing the incidence of CRBSI and improving pediatric patient outcome (O'Grady *et al.*, 2011). Several studies indicated that lack of knowledge and skills is one of the main barriers for implementing evidence-based nursing practice (Grimshaw *et al.*, 2004; Kennedy *et al.*, 2004).

Kadium (2015) reported that studies provided evidence of effects of improving nurses' knowledge on reducing CRBSI. Some studies provided training modules to develop the required skills for health workers. A lack was in the literature relevant to hemodialysis unit. The majority of reviewed literature provided promising evidence as regards the effect of educational and/or intervention programs directed at ICU doctors and nurses on the theoretical knowledge of prevention of CRBSIs. The greater part of the studies proposed that the educational intervention could improve or enhance nurses' knowledge in reducing CRBSI rates.

Therefore, the current study will provide evidence for conducting studies to improve nurses' knowledge and practice as regards CVC maintenance and care. The content of the educational program in this study could be reflected in pediatric nursing education and practice, and improve patient outcomes.

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### Aim

The aim of the current study was to investigate the effect of education program on nurses' knowledge and practice as regards care of central venous line in pediatric HD EBP guidelines.

### Research hypothesis

The research hypothesis was as follows: nurses in the pediatric hemodialysis unit exposed to education program on care of CVC-based EBP guidelines will show higher score of knowledge and practice after intervention than that before.

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## Participants and methods

### Research design

A quasiexperimental research design was utilized to conduct this study. The current study used a single group pretest and post-test educational intervention design. This design helped to investigate the effectiveness of a nursing intervention in achieving the desired outcome in a natural setting (Grove *et al.*, 2013).

### Setting

This study was conducted in the Pediatric Hemodialysis Unit at Benha University Hospital and the Hemodialysis Unit at Benha Fever Hospital. In the Pediatric Hemodialysis Unit at Benha University Hospital there are 27 HD machines, and, there were 21 HD machines in Benha Fever Hospital; the two units provide free HD sessions for children from different governorate.

### **Sample**

The researchers used a convenience sampling to select all nurse participants; 40 nurses were included in the study: 21 nurses from the Pediatric Hemodialysis Unit at Benha University Hospital and 19 nurses from the Hemodialysis Unit at Benha Fever Hospital. The nurses had to fulfill the criteria of having different educational level and different years of experiences.

### **Ethical consideration**

All nurses were informed about the aim of study and its benefits in order to obtain their cooperation and acceptance to participate. The researchers informed them that the participation in the study is voluntary and that they have the right to withdraw from the study at any time, without giving any reason and that their responses would be held confidentially.

### **Data collection tool**

The following instruments were utilized to collect the required data:

#### *Tool I*

Questionnaire sheet was divided into two major parts:

Part I: it was developed by the researchers after extensive reviewing of related literature to assess nurses' personal data, which was composed of six closed-ended questions, including age, level of education, occupation, years of experience in pediatric dialysis unit, attending training courses on infection control, and duration of training courses.

Part II: this part to evaluate nurses' knowledge about EBP related to CRBSIs; it was adapted from the electronic version of the 2011 CDC guideline, which is available online without discharge (<http://www.cdc.gov/hicpac/pdf/guidelines/bsi-guidelines-2011>). One of the major areas of emphasis in this guideline was educating and training healthcare personnel who insert and maintain catheter; it included 25 questions. The questions included the following: incidence rate and mortality rate due to CRBSIs, complications resulted from CRBSIs, risk factors for CRBSIs, time for dressing CVC site, maximal sterile barriers during insertion and care of CVC, use of chlorhexidine as a skin preparation, nursing care that decreases the risk for CRBSIs, dressing change, and CDC evidence-based guideline.

### **Scoring system**

Each correct answer was assigned score 1 and wrong answer was assigned score 0. The total score was 25. The level of knowledge score was converted into a percentage, and the overall adequacy of knowledge was

graded according to the following criteria: if the score was more than or equal to 60% it was considered satisfactory knowledge, and it was considered unsatisfactory if the score was less than 60%.

#### *Tool II*

An observational checklist was adopted from Bindler and Ball (2012) for a CVC site performance checklist to assess nurses' practice as regards maintenance and care for CVC provided for children in pediatric HD, including hand washing, wearing mask and goggles, wearing sterile gown, wearing sterile gloves, use of disinfection, and dressing for CVC including 15 steps of all steps (three steps for preparation, seven steps for insertion, and five for care and maintenance).

#### *Scoring system*

The score of each item was rated as follows: score 1 was assigned if the procedure was performed correctly and score 0 if the nurse performed it incorrectly or did not perform it at all. Total score checklist was 15 grades. Rating scale of checklist was collected and distributed as follows:

- (1) Satisfactory up to 75% of the maximum score (11.25–15 marks).
- (2) Unsatisfactory less than 75% (<11.25 marks).

Education program included illustrated Arabic booklet about EBP guidelines for nurses as regards CVC maintenance and care. The program was adapted by the researchers after reviewing the literature and related research studies and based on the EBPs guidelines of Centers for Disease Control and Prevention (CDC) (2011), which was the benchmark for all CVC care recommendations and provided guidelines for best practices as regards the prevention and monitoring of CRBSI in hemodialysis units before, during, and after CVC care. It includes the following: introduction about pediatric HD, sites for CVC insertion, complications associated with CVC, definition of CRBSI, factors that increase the risk for CRBSIs, causes of CRBSI, overview of EBPs guidelines (Centers for Disease Control and Prevention (CDC), 2011) as regards the prevention and monitoring of CRBSI, maximal sterile barriers, use of antimicrobial ointment, change CVC dressing, CVC maintenance care, and role of the nurse in decreasing the risk for CRBSIs.

### **Validity and reliability**

The content validity of the data collection tools were examined by five experts who were affiliated to the Faculty of Nursing, Benha University and Cairo



University at the Pediatric Nursing Department. The tools were examined for content coverage, clarity, relevance, applicability, wording, length, format, and overall appearance. On the basis of experts' comments and recommendations, minor modifications had been made, such as rephrasing and rearrangements of some sentences. The reliability of the developed tools was estimated using Chronbach's  $\alpha$  test to measure the internal consistency of the tools. It was found that the reliability questionnaire using Chronbach's  $\alpha$  equation was 0.887.

#### Procedure of the study

Data collection was conducted over a 7 months' period extending from April, 2016 to October 2016. Approval from the Faculty of Nursing and directors of previously mentioned hospital was obtained before collection of data. Thereafter, researchers contacted the nurse manager of the pediatric HD unit to explain the aim and nature of the study. The manager introduced researchers to the nurses, and they verbally announced in the HD unit inviting all nurses for voluntary participation in the current study. The study was conducted in three phases.

In phase I, assessment session was for ~30 min in duration and held in the conference room. The researchers explained the study purpose, method, required time commitment, potential risk/benefits, and contact information about the researchers and knowledge that participation was voluntary. Each participant was given a questionnaire sheet part one about nurses' personal data, including age, sex, the level of education, years of experience, and infection control training. The questionnaire time was organized by the manager of the HD unit in collaboration with the researchers. As regards nurses' practice, the researchers observed the nurses during care and assessment of CVC site using observational checklist.

In phase II, the implementation phase, the researchers distributed education program booklet for nurses, which contained theoretical and practice content, and the participants were divided into five groups and each group consisted of 6–8 nurses according to their work schedule. Duration of this stage was 1 month. The total number of sessions was eight sessions for each group, one session per day through 2 days per week during the morning shift. Two weeks for theoretical part were needed to provide nurses with knowledge about CRBSIs through four sessions; the duration of each session was 1 h lecture to provide participants with sufficient information about CRBSIs, through lectures and group discussion using power

point presentation. The content outlines include an explanation of the following subheadings: the session's learning objectives, introduction, incidence of infections with CVC, impact of vascular CRBSI, definition of a central line, causes and sources of CRBSIs, pathogenesis, clinical features of catheter sepsis, prevention of CRBSI, daily review of line, risk factors for CRBSI, CRBSI criteria nursing care, role of the nurse in decreasing the risk for CRBSI. The other 2 weeks were for providing them with practical part of caring for CVC in four sessions; the duration of each session was 60 min, including demonstration and redemonstration of procedure to assess nurses' practice as regards maintenance and care for CVC provided for children in pediatric HD unit, including hand washing, wearing mask and goggles, wearing sterile gown, wearing sterile gloves, use of disinfection, and change CVC dressing using of chlorhexidine.

Phase III included evaluation of the nurses' knowledge and practice as regards children's catheter maintenance care in pediatric HD unit after explanation of CDC EBP guidelines for nurses. The questionnaire sheet and observational checklist were used as immediately after ending of the program and then after 6 months' follow-up.

#### Pilot study

The pilot study was conducted on 10% of nurses (four nurses) in terms of clarity and applicability of the study. No items were modified according to nurses' responses in the pilot study. The sample involved in the pilot study was included in the whole study sample.

#### Statistical analysis

The collected data were categorized, tabulated, and analyzed using the SPSS computer program Version 20 (SPSS Inc., Chicago, Illinois, USA). Numerical data were expressed as mean and SD. Qualitative data were expressed as frequency and percentage.  $\chi^2$ -Test was used to detect the difference between nurse's knowledge and performance before and after education program. Comparison of mean was performed using the paired-sample *t*-test and *F*-test. Correlation among variables was tested using Pearson's correlation coefficient. Level of significance at *P* less than 0.05 was used as the cutoff value for statistical significance.

#### Results

Table 1 and Figs 1 and 2 illustrate that less than one-third (32.5%) of studied nurses were in the age group of 30 to less than 35 years, with a mean age of  $30.87 \pm 5.59$

years. Moreover, three-quarters of the studied nurses (75.0%) did not attend the training program about infection control. However, less than two-thirds of the studied nurses graduated from secondary school of nursing, more than a quarter had bachelor degree, and the minority of nurses had graduated from technical Institute of nursing (62.5, 27.5, and 10.0%, respectively). In relation to the years of experience (Fig. 2), more than half of the studied nurses (55%) had 10 and more years of experience in dialysis unit.

It is evident from Table 2 that less than half of the nurses had satisfactory knowledge as regards CVC and CRBSIs in the preintervention phase. The minority of them (12.5 and 2.5%, respectively) had satisfactory knowledge about site of insertion and

evidence-based guidelines of CVC maintenance care. However, the vast majority of them had improvement in their knowledge score immediately and 6 months after guideline implementation (82.5, 90, 92.5, 95, 97.5, and 100, respectively) with highly statistically significant difference ( $P \leq 0.00$ ).

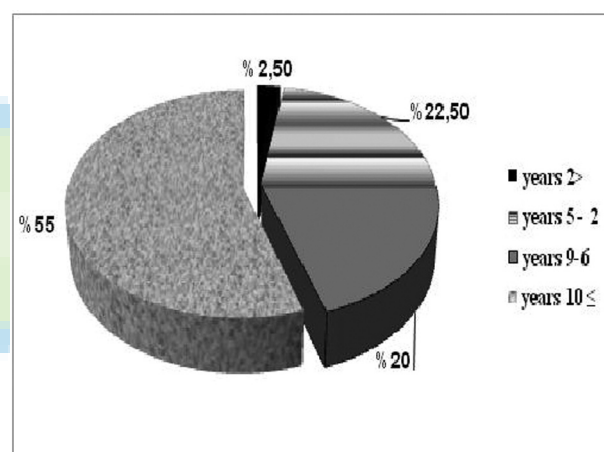
As illustrated in Fig. 3, there was a significant improvement in total knowledge of nurses as regards CRBSIs in pediatric HD unit, when compared with that before intervention and immediately after intervention, as well as that before intervention and after 6 months of implementation of teaching guidelines ( $P \leq 0.01$ ).

As regards nursing practice through program intervention phases (Table 3), there was a highly statistically significant improvement in nurses' practice

**Table 1** Distribution of nurses as regards their personal data (n=40)

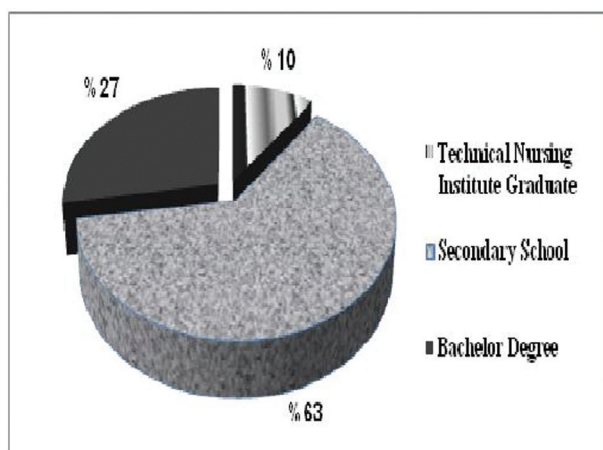
Personal data	n (%)
<b>Age (years)</b>	
20-24	4 (10.0)
25-29	12 (30.0)
30-34	13 (32.5)
≥35	11 (27.5)
Mean±SD	30.87±5.59
<b>Job title</b>	
Head nurse	11 (27.5)
Technical nurse	4 (10.0)
Staff nurse	25 (62.5)
<b>Attending training courses about infection control</b>	
Yes	10 (25.0)
No	30 (75.0)
<b>Duration of training course (N=10)</b>	
1 day	6 (60.0)
2 days	1 (10.0)
3 days	3 (30.0)

**Figure 2**



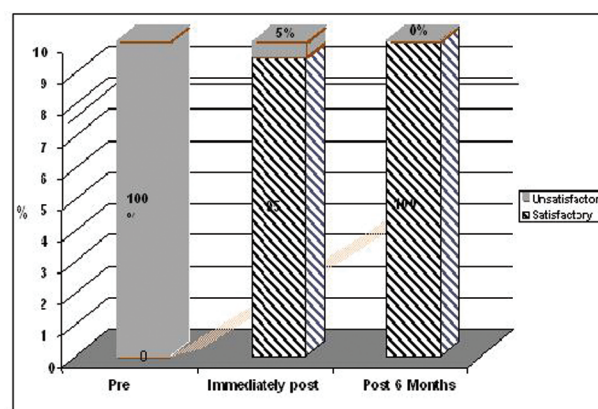
Distribution of nurses according to their experience (n=40)

**Figure 1**



Frequency distribution of nurses according to their educational level (n=40)

**Figure 3**



Nurses' total knowledge score as regards catheter-related blood stream infections, central venous catheter maintenance, and evidence-based practice guidelines through intervention phases (n=40)

**Table 2 Nurses' knowledge as regards catheter-related blood stream infections and central venous catheter maintenance and care intervention phases of educational program guidelines (n=40)**

Satisfactory nurses' knowledge level as regards CRBSI and CVC maintenance and care	Preimplementation [n (%)]	Immediate after implementation [n (%)]	6 months after implementation [n (%)]	P values		
				P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>
1. Rate of CRBSIs	16 (40)	36 (90)	40 (100)	0.000**	0.000**	0.046*
2. Mortality rate of CRBSIs	18 (45)	40 (100)	40 (100)	0.000**	0.000**	1.000
3. Site for CVC insertion	5 (12.5)	33 (82.5)	37 (92.5)	0.000**	0.000**	0.046*
4. Complications associated with CVC	15 (37.5)	40 (100)	37 (92.5)	0.003**	0.083	0.83
5. Factors increase the risk for CRBSIs	19 (47.5)	37 (92.5)	40 (100)	0.000**	0.000**	0.083
6. Use of antimicrobial ointment	17 (42.5)	38 (95)	38 (95)	0.000**	0.000**	1.000
7. Change CVC dressing	12 (30)	39 (97.5)	40 (100)	0.000**	0.000**	0.317
8. Role of the nurse in decreasing the risk for CRBSIs	19 (47.5)	40 (100)	40 (100)	0.000**	0.000**	1.000
9. CVC maintenance care	13 (32.5)	35 (87.5)	38 (95)	0.000**	0.000**	0.083
10. Evidence-based clinical guidelines of CVC maintenance care	1 (2.5)	37 (92.5)	36 (90)	0.000**	0.000**	0.317

CRBSI, catheter-related blood stream infection; CVC, central venous catheter; P<sub>1</sub>, between preintervention and immediately after intervention; P<sub>2</sub>, between preintervention and 6 months postintervention; P<sub>3</sub>, between immediately after intervention 6 months after intervention. \*P<0.05, significant. \*\*P<0.01, highly significant.

**Table 3 Nurses' practice as regards central venous catheter maintenance and care guidelines in pediatric hemodialysis through intervention phases (n=40)**

Nurses' practice regarding CVC maintenance care guidelines	Nurses' practices [n (%)]			P values		
	Before implementation	Immediately after implementation	6 months after implementation	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>
Hand washing						
Adequate	0 (0.0)	36 (90)	21 (52.5)	0.000**	0.000**	0.000**
Inadequate	40 (100)	4 (10)	19 (47.5)			
Wear mask and goggles						
Adequate	0 (0.0)	40 (100)	10 (25)	0.000**	0.002*	0.000**
Inadequate	40 (100)	0 (0.0)	30 (75)			
Wear sterile gown						
Adequate	0 (0.0)	13 (32.5)	12 (30)	0.000**	0.001**	0.835
Inadequate	40 (100)	27 (67.5)	28 (70)			
Wear sterile gloves						
Adequate	0 (0.0)	31 (77.5)	28 (70)	0.000**	0.001**	0.083
Inadequate	40 (100)	9 (22.5)	12 (30)			
Use of disinfection						
Adequate	0 (0.0)	34 (85.5)	30 (75)	0.000**	0.000**	0.046
Inadequate	40 (100)	6 (15.5)	10 (25)			
Dressing for CVC						
Adequate	12 (30)	39 (97.5)	35 (87.5)	0.000**	0.000**	0.317
Inadequate	28 (70)	1 (2.5)	5 (12.5)			

CVC, central venous catheter; P<sub>1</sub>, between personal data and preimplementation; P<sub>2</sub>, between personal data and immediately after implementation; P<sub>3</sub>, between personal data and 6 months after implementation. \*P<0.05, significant. \*\*P<0.01, highly significant.

such as hand washing, wearing mask, goggles, sterile gown, and gloves, use of disinfection, and dressing, when compared with that before and immediately after implementation and also before and 6 months after implementation of teaching guidelines and between immediately after implementation and 6 months after implementation (P<0.01), except in relation to wearing sterile gown and gloves, use of disinfection, and dressing for CVC; there was a highly statistically significant difference between practice before intervention and

immediately after only and there was no statistically significant difference between practice before intervention and 6 months after implementation.

Figure 4 shows that there was improvement in total level of nurses' practices as regards standard precaution, when comparing with before and immediately after implementation, as well as before and after 6 months of implementation of teaching guidelines (P<0.01).

It is evident from Table 4 that there were highly statistically significant improvements in nurses' practice in relation to improvement in nurses' knowledge before or immediately after and 6 months after guideline implementation phases ( $P \leq 0.01$ ).

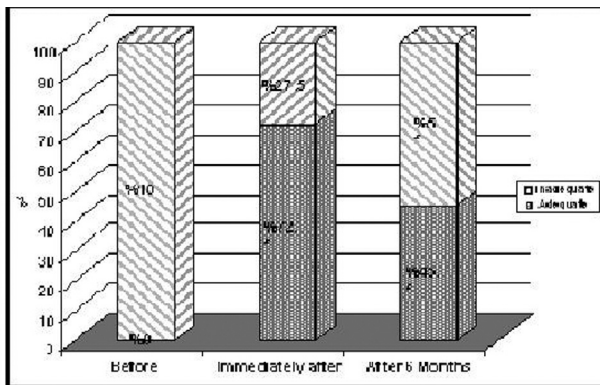
As clarified in Table 5, there was a highly positive correlation between improvement in nurses' knowledge and practice before or immediately after and 6 months after teaching guideline implementation phases ( $P < 0.001$ ).

As shown in Table 6, there was no statistically significant correlation between nurses' knowledge and their personal data immediately after and 6 months after implementation of teaching guideline

as regards standard precautions in pediatric HD unit.

As revealed from Table 7, there was a positive correlation between total nurses' practice and their personal data immediately after guideline implementation in relation to their educational level, occupation, years of experience, and attendance of training course ( $P \leq 0.05$  and  $0.01$ , respectively). However, there was no significant correlation between total nurses' practice and their ages in all implementation phases ( $P = 0.213$  and  $0.086$ , respectively).

Figure 4



Total level of nurses' practices as regards standard precaution in pediatric hemodialysis unit before or immediately after and 6 months after guidelines implementation ( $n=40$ )

### Discussion

A reduction in the incidence of CVC-related infections can have a dramatic impact on the management of children on chronic HD as it leads to a reduction in the use of antibiotics and hospitalization, reduces the need for CVC replacement, and may even reduce mortality. As optimal CVC management is the cornerstone of infection control, identifying the most effective strategy is of utmost importance (Paglialonga *et al.*, 2016). As regards nurses' training program, the current study findings revealed that the majority of nurses did not attend training program about infection control. This is in agreement with Abdelsatir (2013), who conducted a study to evaluate nurses' awareness and practice of HD access care in Khartoum State, Sudan, focusing on the application of proper hand hygiene and HD access care; he stated that most HD centers rely on senior nurses to instruct and educate new staff members on techniques and protocols. The author

Table 4 Relation between total nurses knowledge and practice regarding standard precaution before or immediate and 6 months post-guidelines implementation ( $n=40$ )

Level of nurses' practices	Level of nurses' knowledge [ $n$ (%)]					
	Before implementation		Immediately after implementation		6 months after implementation	
	Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory
Adequate	0 (0)	0 (0)	29 (72.5)	0 (0)	18 (45)	0 (0)
Inadequate	0 (0)	40 (100)	7 (17.5)	4 (10)	17 (42.5)	5 (12.5)
Total	0 (0)	40 (100)	36 (90)	4 (10)	35 (87.5)	5 (12.5)
P value	-		0.001**		0.031*	

\* $P \leq 0.05$ , significant. \*\* $P \leq 0.01$ , highly significant.

Table 5 Correlation between total nurses' knowledge and practice before or immediately after and 6 months after implementation of teaching guidelines

Item	Total scores of nurse's practices		
	Before implementation	Immediately after implementation	6 months after implementation
Total scores of Nurse's knowledge			
$r$	0.526	0.870	0.735
$P$	<0.001	<0.001	<0.001

\* $P \leq 0.05$ , significant. \*\* $P \leq 0.01$ , highly significant.



**Table 6** Relation between total nurses' knowledge and their personal data about standard precautions in pediatric hemodialysis unit before or immediately after and 6 months after guidelines implementation (n=40)

Nurses' personal data	Levels of nurse's knowledge [n (%)]			P value		
	Before implementation	Immediately after implementation	6 months after implementation	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>
Age (years)						
20–24	4 (10)	4 (10)	4 (10)	0.235	0.268	0.45
25–29	12 (30)	12 (30)	12 (30)			
30–34	10 (25)	10 (25)	10 (25)			
≥35	10 (25)	10 (25)	9 (22.5)			
Total	36 (90)	36 (90)	35 (87.5)			
Education level						
Bachelor	11 (27.5)	11 (27.5)	11 (27.5)	0.311	0.298	0.235
Technical Institute	3 (7.5)	3 (7.5)	(7.5)			
Nursing school	22 (55)	22 (55)	21 (52.5)			
Total	36 (90)	36 (90)	35 (87.5)			
Experience years						
<2	1 (2.5)	1 (2.5)	1 (2.5)	0.37	0.557	0.685
2<6	9 (22.5)	9 (22.5)	9 (22.5)			
6<10	7 (17.5)	7 (17.5)	7 (17.5)			
≥10	19 (47.5)	19 (47.5)	18 (45)			
Total	36 (90)	36 (90)	35 (87.5)			
Occupation						
Head nurse	11 (27.5)	11 (27.5)	11 (27.5)	0.311	0.298	0.186
Technical nurse	3 (7.5)	3 (7.5)	(7.5)			
Staff nurse	22 (55)	22 (55)	21 (52.5)			
Total	36 (90)	36 (90)	35 (87.5)			
Training course						
Attend	10 (25)	17 (42.5)	16 (40)	0.070	0.227	0.464
Not attend	30 (75)	19 (47.5)	19 (47.5)			
Total	40 (100)	36 (90)	35 (87.5)			

P<sub>1</sub>, between personal data and preimplementation; P<sub>2</sub>, between personal data and immediately after implementation; P<sub>3</sub>, between personal data and 6 months after implementation. \*P<0.05, significant. \*\*P<0.01, highly significant.

emphasized that this method of education is undeniably useful and necessary, but it should not replace structured training programs for new staff members.

Our results indicated that more than half of the nurses had inaccurate knowledge about CRBSIs rate, factors associated, complications, and CVC maintenance care in preintervention phase. The majority of them had incomplete knowledge about site of insertion and evidence-based guidelines of CVC maintenance and care, whereas the vast majority of them improved their knowledge level immediately after and 6 months after implementation of teaching guidelines, with a highly statistically significant difference. The findings of the present study are similar to those reported by Rosenthal *et al.* (2010), who studied nurses during care of CVC in ICUs in 15 developing countries and found that less than half of them used maximal sterile barrier precautions during the insertion of CVCs. The low percentages of nurses' adherence to maximal sterile barrier precautions in the present study could be attributed to several reasons, including inadequate

knowledge about the importance of maximal sterile barrier precautions for nurses during CVC insertion and prevention of CRBSIS, where the healthcare workers' knowledge about CRBSIs prevention guidelines was generally low. In the same concern, Debbieg and Rickard (2014) in a survey of pediatric ICUs nurses' knowledge and practice as regards prevention of CVC infections found that there was variation in the infection prevention approach and nurses' knowledge about CRBSIs prevention.

As regards nurses' knowledge about clinical guidelines of CVC maintenance and care, the results were somewhat unexpected that most of the nurses in the pediatric HD unit did not have any knowledge about EBP guidelines. There was a highly statistically significant improvement in total knowledge level of nurses immediately after and after 6 months of implementation of teaching guidelines. This finding is consistent with other two studies carried out recently in Egypt: the first one by El-Nemr *et al.* (2013), who conducted an interventional study to decrease CVC-related blood stream infection in ICUs at Zagazig

**Table 7 Total nurses' practice in relation to their personal data before or immediately after and 6 months after guidelines implementation (n=40)**

Nurses' personal data	Level of nurse's practices [n (%)]			P value		
	Before implementation	Immediately after implementation	6 months after implementation	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>
Age (years)						
20–24	3 (7.5)	3 (7.5)	3 (7.5)	0.768	0.213	0.086
25–29	11 (27.5)	11 (27.5)	8 (20)			
30–34	7 (17.5)	7 (17.5)	3 (7.5)			
≥35	8 (20)	8 (20)	4 (10)			
Total	29 (72.5)	29 (72.5)	18 (45)			
Education level						
Bachelor	11 (27.5)	11 (27.5)	10 (25)	0.559	0.048*	0.002**
Technical Institute	2 (5)	2 (5)	1 (2.5)			
Nursing school	16 (40)	16 (40)	7 (17.5)			
Total	29 (72.5)	29 (72.5)	18 (45)			
Experience years						
<2	1 (2.5)	1 (2.5)	1 (2.5)	0.717	0.478	0.011**
2<6	8 (20)	8 (20)	8 (20)			
6<10	6 (15)	6 (15)	3 (7.5)			
≥10	14 (35)	14 (35)	6 (15)			
Total	29 (72.5)	29 (72.5)	18 (45)			
Occupation						
Head nurse	11 (27.5)	11 (27.5)	10 (25)	0.559	0.048*	0.002**
Technical nurse	4 (10)	2 (5)	1 (2.5)			
Staff nurse	20 (62.5)	16 (40)	7 (17.5)			
Total	35 (72.5)	29 (72.5)	18 (45)			
Training course						
Attend	10 (25)	17 (42.5)	12 (30)	0.45	0.001**	0.005**
Not attend	30 (75)	12 (30)	6 (15)			
Total	40 (100)	29 (72.5)	18 (45.5)			

P<sub>1</sub>, between personal data and level of nurse's practices before implementation; P<sub>2</sub>, between personal data and immediately after implementation; P<sub>3</sub>, between personal data and 6 months after implementation. \*P<0.05, significant. \*\*P<0.01, highly significant.

University Hospital. The patients with CVC and healthcare providers working in ICU were enrolled in the study, and the study was conducted at three periods and reported that healthcare workers' level of knowledge on the prevention of CVC infection in surgical and emergency ICUs was approximately one-third or less. The results showed that there was a statistically significant improvement in physician practice after intervention, and that the implementation of simple education program promoted the level of knowledge and developed practice of healthcare providers as well as reduced CRBSI by 50% in ICUs. The second study was conducted in Egypt by Al kubati *et al.* (2015); they studied healthcare workers' knowledge and practices as regards the prevention of CRBSI in ICUs of the Critical Care Medicine Department of Alexandria Main University Hospital and found that most healthcare workers had low-level of knowledge as regards guidelines for preventing CRBSIS as indicated by the low percentages of correct answers and did not follow-up on the EBP during the insertion and care of CVCs, which had a negative effect on

patient outcomes. The two previous studies recommended the need for involving the current EBP guidelines in educational curricula and providing continuous educational programs for healthcare workers to help them in improving their knowledge.

Surprisingly, the findings revealed that the majority of nurses' practice was inadequate as regards the maximal sterile barrier precautions, such as hand washing, wearing mask, goggles, sterile gown, and gloves, use of disinfection, and dressing in preintervention phase. There was a highly statistically significant improvement when compared with immediately after intervention and 6 months after implementation, except in relation to wearing sterile gown and gloves, use of disinfection, and dressing for CVC. There was a highly statistically significant difference before intervention and immediately after intervention only, and there was no statistically significant difference before implementation and 6 months after implementation. The current study results are in accordance with the findings of study held by

Abdelsatir (2013), who found that guideline recommendations for routine preventive care are not always followed. Although most nurses were aware of the importance of hand hygiene and the use of gloves in preventing HD access infection, only half of them were fully aware of the role of proper HD access care in preservation of access function. Moreover, not all aspects of HD access care acknowledged by nurses were implemented in practice. Only two-thirds of nurses actually performed hand hygiene before access manipulation and only half of the nurses properly assessed the access for signs of infection before connection.

In addition, Al kubati *et al.* (2015) revealed that the overall level of nurses' compliance with the recommended EBP during CVC insertion in their study was less than a half, which is considered low. Less than a half of nurses observed followed the maximal sterile barrier precautions during CVC insertion. Nonadherence to recommended evidence-based guidelines for preventing CRBSI could be due to nurses' lack of knowledge of the guidelines as reported by Kadium (2015), who carried out a study about improving nurses' knowledge to reduce CRBSI in HD unit and found that not every nurse was skillful in database searching to find the best evidence on the clinical issue. Professional literature was not available to the nurses in the workplace. They added that the lack of time was regarded as a barrier to applying research to practice. Therefore, nurses' knowledge deficiency showed as an obstacle to adherence to EBP.

From the research investigators' point of view, findings of the present study may be attributed to several factors, including the lack of adequate hand washing facilities, supplement of masks, gloves, caps, and gowns during CVC insertions, and maintenance care. Moreover, it may also be attributed to nursing staff shortage, nursing work overload in HD unit, the time constrains of having to connect or disconnect a large number of patients within a limited time, and lack of knowledge and awareness about risk and complications of CVCRI as a result of a lack of training programs, as our findings illustrated.

The findings of the current study showed that there was a highly significant improvement in total knowledge of nurses as regards CRBSIs, CVC maintenance, and care in pediatric HD when compared with that before and immediately after, and after 6 months of implementation of teaching

guidelines. These findings are in agreement with many authors such as Shrestha (2013) and Deshmukh and Shinde (2014), who conducted a pre-experimental study design (preintervention, intervention, and postintervention) to determine the effectiveness of educational intervention in improving nurses' knowledge as regards care of patients with CVC among nurses in ICUs. There was a significant difference between the preintervention and post-intervention knowledge score. Their study findings showed that educational intervention program significantly improved the nurses' level of knowledge about care of the patient with CVC. Overall, the mean knowledge score between preintervention and postintervention was found to be significant. The results of El-Nemr *et al.* (2013) showed that there was a statistically significant improvement in healthcare providers' practice after intervention, and detected that implementation of a simple education program promoted the level of knowledge and developed practice of healthcare providers as well as reduced CRBSI by 50% in ICUs during the period of the study.

Concerning relationship between improvement of nurses' level of knowledge and their personal data through intervention phases, there was no statistically significant correlation, whereas there was a highly statistically significant correlation in nurses' practice in relation to their educational level, occupation, years of experience, and attendance of training course, at preimplementation phase or immediately after implementation, and 6 months after implementation. The previous findings of the current study are in agreement with Abdelsatir (2013), who found that nurses with a bachelor degree tended to be more adherent to hand hygiene (72.5 vs. 42.9%,  $P=0.1$ ) and the use of gloves (100 vs. 85.7%,  $P=0.1$ ) compared with nurses with a diploma degree, but the difference was not statistically significant. The outcomes were clearly defined, and the study suggested that HD units required organizing adequate training on HD access care for their nursing staff. The studies by Aiken *et al.* (2011) and Al Salmi and Kadium (2013) supported that particular nurse characteristics as they relate to health outcomes, the particular features included nurse education and years of experience. An increase in the percentage of nurses with higher educational degrees decreased the risk for mortality and failure to rescue and they found that each increase in the proportion of nurses with higher degrees decreased the risk for mortality. In the same line, Bianco *et al.* (2013) conducted a study to acquire information about the knowledge, attitudes, and

EBPs associated with the insertion and maintenance of CVC for the prevention of CLABSI among nurses in ICUs, and reported that written policies, formal training, and years of experience contributed to an increase in knowledge, practice, and positive attitudes toward CLABSI prevention. In addition, the authors stated that many non-EBPs are still continuing despite new evidence. Finally, the findings of the present study supported the research hypothesis that nurses in pediatric HD unit who are exposed to education program about EBP guidelines will show high score of knowledge and practice after test than that before.

## Conclusion

The current study concluded that nurses who received evidence-based guidelines educational program as regards central vascular catheter maintenance and care showed a statistically significant improvement in nurses' knowledge and practice after immediate and 6 months after implementation of the program than that before. There was a highly statistically significant positive correlation in nurses' practice to their educational level, occupation, and years of experience and attendance of training courses, through intervention phases.

## Recommendation

- (1) Nursing managers and the infection control team should plan for periodic educational and training programs based on EBP.
- (2) Educate nursing staff as regards the indications for intravascular catheter use, proper procedures for the insertion and maintenance of intravascular catheters, and appropriate infection control measures to prevent intravascular catheter-related infections.
- (3) Periodically assess knowledge of and adherence to guidelines for all nurses involved in the insertion and maintenance of intravascular catheters.
- (4) Continuing training courses for nurses to demonstrate competence for the insertion and maintenance of peripheral and central intravascular catheters.
- (5) Apply EBP guidelines for CVC care and maintenance in other pediatric care settings, such as pediatric and neonatal ICUs.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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