



Effect of implementing a bundle of care for peripheral intravenous catheter on Nurses 'Performance at the pediatric Intensive Care Unit

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Abstract

Introduction: A care bundle is a collection of evidence-based interventions that have been proved to improve patient care and clinical outcomes significantly. Aim of the study was to evaluate the effect of implementing a bundle of care for peripheral intravenous catheter on nurses' performance at the pediatric intensive care unit. Quasi experimental research design was used.

Subjects and Method: All nurses (60) who were responsible for providing care for children who received peripheral venous catheter infusion or medication (Pediatric Intensive Care Unit of Tanta Main University Hospital). Also, sixty pediatric patients who had peripheral venous catheters were included 30 children before, immediately after, and 30 children after one month from the care bundle implementation.

Three tools were used to collect data: A structured interview schedule about peripheral Intravenous Catheter care bundle, an observation Checklist for Peripheral Intravenous Catheter Bundle of Care, and a Visual Infusion Phlebitis Grading Scale (V.I.P).

Results: Revealed that the total scores of nurses' knowledge and practice for most of the participated nurses were improved immediately after and after one month. Also, according to visual Infusion phlebitis grading scales (VIP), phlebitis was encountered among more than three-fifths of studied children and there was a significant improvement immediately after and after one month.

Conclusion: Significant enhancement was found in the mean scores of total levels of nurses' knowledge and practice immediately after and one month after implementing the peripheral intravenous care bundle. Total scores of the studied children's Visual Infusion Phlebitis grading scale were reduced post immediate implantation of care bundle and after one month when compared with pre-implementation of care bundle.

Recommendation: Establish a competency checklist for nurses to evaluate their competency in implementing PVCs maintenance care bundle.

Keywords: Pediatric Intensive Care Unit, Peripheral Intravenous Catheter, Bundle of Car.

Introduction

Healthcare-acquired infections (HAIs) are nosocomial infections that aren't detectable or growing when a patient is admitted to the hospital. These infections are frequently acquired after being admitted to the hospital and then 48 hours later, it appears ^[1].

Invasive medical devices work by bypassing the skin's or mucus membranes' typical defense mechanisms to create foci where microorganisms can thrive while being protected from the patient's immune system. Furthermore, it serves as a point of entrance for microbial colonization or infection. Also, pathogens may be transferred from one portion of a patient's body to another, from a health care worker to a patient, or from a patient to a healthcare worker and subsequently to another patient, thanks to these gadgets ^[2].

Peripheral intravenous catheters are the most prevalent invasive devices in more than 80% of hospitalized pediatric patients ^[3]. Children are at an elevated risk of PVC issues as a consequence of their age. Children's veins are often thin and delicate, and they may refuse to participate during cannulation out of fear, making it more difficult than it is

with adults. Peripheral intravenous catheters could be applied as part of a pre-planned series of events and examinations, or they can be used quickly in an emergency. In many clinical circumstances, it is recommended for short-term use. These mostly comprise delivering the intravenous fluids in addition to blood and its derivatives ^[4]. It's employed for intravenous hydration and/or correction of pre-existing dehydration or electrolyte imbalances, bolus medicine, intravenous drug therapy, opaque medication, and I V treatment of radiologic contrast besides, blood samples. It permits the intravenous access when required to improve patient care and parenteral nutrition when the pathway is unavailable ^[5].

Catheter-related bloodstream infections (CRBSIs) are influenced by several predisposing factors that include nurses' performance, and factors affecting cannula-related infections. These factors are the size of cannula, the insertion site, catheter material type, length of cannula staying time in place, and the number of invasive procedures. Other factors are related to infusion like the duration of infusion, viscosity, tonicity of the solute infused,

and composition of the solute infused. factors in relation to patient's endogenous as past medical history, patient with any blood disorders, length of stay in the hospital, patient's age, sex, medical diagnosis, and hospital environmental factor [6].

Infections that are triggered by intravenous therapy might affect the skin near the catheter insertion location or the bloodstream. One of the most common clinical problems that children who are infused intravenously suffer is post-infusion phlebitis. It is an acute vein inflammation caused by the presence of an intravenous access device, and it can be characterized as chemical phlebitis, mechanical phlebitis, or infectious phlebitis depending on the predisposing circumstances. In USA 338 youngsters were evaluated, of whom (73.0%) did not have local intravenous treatment issues, (16.0%) had infiltration, (8.3%) had additional difficulties, and (2.7%) had phlebitis [7, 8].

According to an investigation in Italy, the local infection rate which is related to peripheral catheters was described to be 2.3% [9]. In Egypt, the prevalence of phlebitis was 64.9% in 2018 [7]. Phlebitis is the most common local consequence, with rates varied depending on the environment (20-80%). Phlebitis has been documented to happen throughout the catheterization or a maximum of 48 hrs after the removal [10]. It is advisable that the catheter be replaced on a regular basis, every 72-96 hours or even earlier if clinically required [11]. If the venous accessing is restricted, the catheter may be left in place if no symptoms of infection are present, and the VIP score is less than two [12]. The Infusion Nursing Society (INS) considers a proportion of 5% phlebitis to be the maximum acceptable for the incidence of this type of complication [13].

To prevent CRBSI, several techniques have been proposed. The peripheral venous catheter care bundle is one of these techniques, and it is defined as "a collection of excellent practices combined together by empirical evidence into a single package, which standardizes administration and observing practices and results in better patient care." Its five rights include using a trained vascular access nursing team for both insertion and management, which is considered the most effective technique for reducing CRBSI [14]. Care Bundles have been effectively used in vascular access to prevent and minimize the occurrence of peripheral vascular cannula-related infection, besides the high rates of morbidity and mortality that are connected with it [15].

Pediatric nurses perform a unique role and obligation in applying intravenous catheter care bundle with its five rights and prevention of PIVCs associated infection. Proper nursing management of PIVCs has an important effect on the reduction of peripheral intravenous catheter failure owing to the complications of occlusion, dislodgment, infiltration, accidental infection and phlebitis. These complications can be prevented by the nurses' education, improved management. Improve insertion techniques and consistent disinfecting practices [1].

Significance of the study

Peripheral Intravenous Catheter insertion is commonly performed procedure in pediatric intensive care unit for many therapeutic applications nursing. Nevertheless, because of the potential for microbial access into the bloodstream, it carries the risk of dislodgment, phlebitis,

extravasation, thrombophlebitis, and infection. The implementing of care bundle solutions for the insertion of PIVC and maintenance has received little attention. The CRBI can increase extent of hospital stay, hospital costs and pediatric patient mortality. So, PIVC care bundle is a package of preventive measures that, if PIVC care bundle teaching program implemented, can improve nurses' nurses' performance for controlling catheter associated infection and pediatric intensive patients' outcomes [1].

Catheter-related blood stream infection (CRBSI) was the most frequent nosocomial infection in pediatric ICUs, and it is considered a serious problem that affects pediatric patient safety. The institute for healthcare improvement introduced care bundles to promote the constancy of evidence-based health-care practice. It has been widely applied to enhance the care quality, practice, and minimize hospital-acquired infection, in addition to morbidity and mortality rates [1, 16]. So the aim of the study was to see how the implementing of a peripheral intravenous catheter care bundle affects nurses' capacity to control catheter-associated infection in a pediatric intensive care unit.

The aim of this study was to evaluate the effect of implementing bundle of care for peripheral intravenous on nurses' performance at the pediatric intensive care unit.

Research hypothesis

Implementing bundle of care for peripheral intravenous catheter on nurses working at pediatric intensive care unit expect to improve their knowledge and practice

Subjects and Method

Research design: Quasi experimental research design was used in this study.

Setting: The study was conducted at Pediatric Intensive Care Unit (PICU) of Tanta Main University Hospital.

Subjects: All nurses (60) nurses who were responsible for provided care for children who received peripheral venous catheter infusion or medication were included from previously mentioned setting (Pediatric Intensive Care Unit of Tanta Main University Hospital) Also, sixty pediatric patients who had peripheral venous catheter were included 30 children before, immediate after and 30 child after one month from care bundle application.

Tools of data collection: Three tools were used for data collection:

Tool I: Structured interview schedule about peripheral Intravenous Catheter care bundle tool. It was developed by the researcher after reviewing the recent related literature and consisted of six parts:

Part I: It covered the socio-demographic characteristics of the studied nurses which include; sex, age, educational level, years of experience and attendance of training courses related to preventing of PVCs associated infection.

Part II: It covered the Biosocial characteristics of studied children which include, Sex, age, length of hospital stays.

Part III: It covered Patient Endogenous Factors related to peripheral venous catheter associated infection which include, such as factors related to catheter, factors related to infusion therapy, factors related to medications ...etc.

Part IV: Assess Nurses' knowledge related to peripheral venous catheter PIVC care and PIVC associated infection. It covered Nurses' knowledge related to peripheral venous catheter. It was designed in multiple choice questions form (MCQ) and it was revised by pediatric nursing experts. knowledgeable items including, definition, indication, contraindications, complications, sites of insertion, factors affecting the choice of vein.

Part V: It covered Nurses' knowledge regarding peripheral venous catheter related infection. It was designed in multiple choice questions form (MCQ) and it was revised by pediatric nursing experts. knowledgeable items including, definition of infection, factors related to PVCs, factors related to child, factors related to intravenous therapy, factors related to drug administration, factors related to nurses, rout of infection.

Part VI: It covered Nurse's knowledge regarding peripheral venous catheters maintenance care bundle It was designed in multiple choice questions form (MCQ) and it was revised by pediatric nursing experts. knowledgeable items, pre insertion action and maintenance action as insertion sites, aseptic technique, cannula fixation, type of dressing proper dressing change.

The tool was positively marked with one mark awarded for each correct & complete answer was scored 2, while the correct & incomplete answer was scored 1 and incorrect answer or didn't know was scored 0. The total scores of the nurses' knowledge equal 100%:

The total scores of nurses' knowledge was calculated and classified as follows

- Less than 60% was considered poor knowledge.
- From 60- <75% was considered fair knowledge.
- From 75-100% was considered good knowledge.

The researcher assessed the nurses' knowledge three times

- The first time before teaching sessions (pretest)
- Immediately following sessions (immediate follow up)
- One month after (short term follow up).

Tool II: Observation Checklist for Peripheral Intravenous Catheter Bundle of Care: It was adopted from evidence-based guidelines ^[12], and modified by the researcher to assess the practices of nurses who provided care for children with peripheral venous catheter in pediatric intensive care unit. It was included nurses' practice regarding implementation of peripheral Intravenous Catheter care bundle and contained two actions, Insertion action (before, during and after procedure) and ongoing care as the following:

a) Insertion action

Before check indication for cannulation, check child for allergies, environmental preparation, equipment preparation

such as, neutral soap, clean tray that has been disinfected with alcohol. Personal protective equipment, sterile towel, syringe with 3 ml, ampoule of sterile water, rubber tourniquet and sharp container, sterile gauze, 2% chlorhexidine and 70% alcohol, semi-permeable transparent dressing. During catheter insertion consider the location and condition of vein, start with upper limb and avoid ante-cubital fossa, smallest cannula gauge, Childs' skin preparation, consider duration and type of therapy, place the site of insertion on a sterile towel, hand wash, wear PPE, disinfect the insertion site, if re -palpate use sterile gloves, apply rubber tourniquet, insert needle cannula using non touch technique, advance cannula slowly, and remove needle, after two attempt seek help, release tourniquet, and infuse 2-3 ml of saline, use sterile semipermeable transparent dressing, leave site clean and dry, secure using arm board. After catheter insertion consists of hand hygiene, documentation, date and time, insertion site, and signature.

b) Maintenance care action

Consisted of prompt removal, document removal reason, remove under aseptic technique, inspect hourly during infusion, sign of infection, Ensure vein patency, flushed with normal saline, check cannula secure, site clean and dry, dressing change, circuit system maintained closed, change IV administration set clean hand, scrub hub documentation. Ongoing care action item were (10 point). Scoring system for nursing practice by using observational checklist which consisted of (49) items, each item was scored from 0-1. Done correctly and complete was scored (1), while didn't do correctly was scored (0).

Total scores of nurses' practices are categorized as follows

- Satisfactory from 70% to more
- Unsatisfactory less than 70%

Tool III: Visual Infusion Phlebitis Grading Scale (V.I.P):

This tool was developed by Great Ormond Street Hospital for Children (GOSH) (2021) ^[8] to assess the signs and symptoms of phlebitis as pain, redness, erythema, swelling, indurations, a palpable venous cord above IV site, pyrexia, purulent discharge and fever. It consisted of 5 grades as following:

"Grade 0": Intravenous site appear healthy and considered as no signs of phlebitis. "Grade 1": One of the following signs or symptoms is evident, as slight pain near Intravenous site or slight redness and considered as possible signs of phlebitis. "Grade 2" which included two of the following signs or symptoms is evident, as pain at Intravenous site with erythema, swelling which considered as an early stage of phlebitis. "Grade 3": which included all of the following signs or symptoms are evident as pain along the path of the catheter, erythema, indurations or a palpable venous cord less than 5cm above the Intravenous site and considered as a medium stage of phlebitis. "Grade 4": which included all of the following signs are evident and extensive as pain along the path of the catheter, erythema, indurations or a palpable venous cord more than 5cm above the Intravenous site and considered as an advanced stage of phlebitis. Whereas "Grade 5" included the following signs are evident and extensive pain along the path of the catheter,

erythema, indurations or a palpable venous cord more than 5cm above the Intravenous site and pyrexia and purulent discharge considered as an advanced stage of thrombophlebitis.

Scoring system will be done as follow

- No signs of phlebitis were scored (0)
- Possible signs of phlebitis were scored (1)
- Early stage of phlebitis was scored (2)
- Medium stage of phlebitis was scored (3)
- Advanced stage of phlebitis was scored (4)
- Advanced stage of thrombophlebitis was scored (5)

Method

1. An official permission to conduct the study was obtained from the responsible authorities, Dean of Faculty of Nursing, Tanta University and paediatric Intensive Care Unit at Tanta University Hospital to obtain their approval and cooperation for carrying out this study after clarifying the purpose of the study and setting the time for beginning
2. Ethical approval was obtained from the research ethics committee of the Faculty of Nursing, Tanta University in (1-3-2020). Informed consent was taken from staff nurses to participate in this study explaining the aim and benefits of it by the researcher reassured them that the information obtained was used only for the purpose of the study and the nature of the study didn't cause any harm or pain to the entire sample.
3. Three tools were used for data collection.
4. Reliability of developed tool was tested through internal consistency. The value of Cronbach's alpha coefficient was = 0.967.
5. Content validity: The tools of the study were presented to a jury of five experts in the field of Pediatric Nursing to check content validity and clarity of the questionnaire. Modifications were carried out accordingly. The face validity of the questionnaire was calculated based on experts' opinions after calculating content validity index of its items and it was 89.5%.
6. Pilot study was carried out on 10% of sample size (6) of the sample to test the tool for its clarity, applicability, feasibility of the tools and identify problems and measures may hinder data collection to overcome it. Necessary modifications were done accordingly. Some questions were added, and others were omitted. The pilot sample was excluded from the study sample.

Phases of the study

The study was conducted throughout four phases

1) Assessment Phase

It was carried out by the researcher for all study subjects to collect baseline data, and to assess nurses' knowledge regarding infants and children with PVC at pediatric intensive care unit. It used by the researcher to assess nurses' knowledge before, immediately and after one month of care bundle implementation.

Explanation of the questionnaire sheet was done. The average time required to complete each questionnaire sheet was 20- 30 minutes. where 2-3 nurses were interviewed each time depending on their physical and mental readiness in addition to the work environment related factors (Tool I).

The researcher was assessing the actual nurses' practice three times before, immediately after and after one month from application of care bundle. All the studied nurses were observed during implementation of nursing care to children with peripheral venous catheter in all periods of morning and afternoon shift (Tool II).

Nurses was assessing the signs and symptoms of phlebitis by observe every infant or child who had PIVC and who received the care for four consecutive days from cannula insertion and two days after removal by using (Tool III)

2) Planning Phase

- Setting educational objectives.
- Preparation of the content which was covered the reasons behind the implementation of the session, media preparation and determining the total number of sessions and duration of each session.

3) Implementation Phase

- Peripheral insertion care bundle was carried out for nurses through conduction of successive sessions according to the actual needs assessment of the nurses.
- Care bundle was conducted in fifth sessions, two/ week. The time of each session was about 45-60 minutes including periods of discussion according to the nurses' progress and feedback.
- Different methods of teaching were used including lectures, group discussion and demonstration to facilitate nurses understanding.
- The studied nurses were divided into small groups and each group was consisted of five nurses.
- Care bundle was carried out for each group separately through conduction of successive sessions according to the actual needs assessment of the studied nurses.
- Each session was started by a summary about what had been discussed in the previous session.
- The sessions covered the following topics:-

The first session

It was related to introduction to peripheral venous catheters, definition, different types, indications, contraindications, complications, sites of insertion of peripheral intravenous catheter, factors affecting the selection of vein, criteria of suitable vein, and.

The second session

It was focused on precautions during insertion, and general principles for maintaining PVCs definition of nosocomial infections of peripheral intravenous catheter associated infection, types of infection, signs and symptoms of infection, and

The third session

It was focused on factors that affecting the catheter related infection, definition of infection control, aseptic techniques, factors associated with PVC and environmental preparation

The fourth session

It was concentrated on PIVC bundle of care procedure such as insertion action and ongoing action.

The fifth session

It was focused on measures of universal precautions as hand washing, wearing protective personnel equipment and using aseptic techniques. Each session ended by a summary of its content and feedback from the nurses was obtained to ensure that nurses got the maximum benefit.

The sixth Session

Check vein patency by flushing of PIVC, steps of changing dressing and arm board, steps of changing IV set of PIVC, disinfecting hub of PIVC and steps of PIVC removal.

4) Evaluation Phase

- Evaluation of the effects of care bundle implementation on nurses' knowledge and practice was carried out using the same assessment tools (Tool I&II). Each nurse was evaluated immediately after implementation of care bundle (post-test) and one month later, and these were compared to pre-test levels.
- The data was collected over a period of one year from May 2020 to May 2021.

Result

Table (1) reveals socio-demographic data of the participated Nurses, more than half (58.3%) of the participated nurses their age ranged from 20 to less than 30 years, with Mean SD (29.15 ± 8.16) year, all of them were female. In relation to the educational level of the studied nurses, it was found that, more than half (58.3%) had health technical institute. More than two-fifths of them (45%) had 5 to less than 10 years of experience with Mean SD (7.03 ± 4.75) years. Moreover, more of them three-quarters (78.3%) of them not attended programs related to prevention of peripheral venous catheters associated infections.

Table (2) illustrates biosocial data of studied children, more than one-third (36.7%) of the studied children aged ranged between 2.5 to 3 years before and immediate with mean age (2.03 ± 0.82) years and 36.7% aged ranged between 1 to less than 1.5 years with mean age (1.92 ± 0.82), majority (80%) of them were female before and immediate, while they were nearly three-quarter (73.3%) after one month. Moreover, half (50%) of them had stayed in hospital period ranged between 14 to less than 21 days with a mean (15.47 ± 6.35) days before and immediate but more than two-fifths (46.7%) of them had stay period ranged between 8 to less than 14 days with mean (16.27 ± 5.53) after one month. In addition, more than one-quarter (26.7%) of studied children suffered from pneumonia followed by CNS and GIT disorder (23.3%) respectively before and immediate, while (30%) of them suffered from pneumonia after one month.

Table (3) reveal total scores of nurses' knowledge regarding peripheral venous catheter infection, and maintenance care bundle, 75% of studied nurses had poor knowledge before care bundle implementation, while (95% & 86.7%) of studied nurses had fair & good knowledge immediate after care bundle implementation and after one month respectively. There was a statistically significant difference between before, immediate after and after one month ($p < 0.001^*$). The mean score of total knowledge of nurses improved from (23.72 ± 11.83) before to (63.05 ± 3.88) immediate program and (59.73 ± 8.49) one-month after care bundle implementation with significant improvement

between before and immediate post, before and after one-month care bundle implementation.

Table (4) shows total scores of nurses' practices regarding peripheral intravenous catheter care bundle. 81.7%, 8.3% & 18.3% of the studied nurses were unsatisfactory practices before, immediately after, and after one month of the care bundle implementation, while 18.3%, 91.7% & 81.7% had satisfactory practices score before, immediately after and after one month of the care bundle implementation.

Table (5) reveals total scores of the studied children's visual infusion phlebitis grading scale (VIP), there was 36.7% of studied children had no signs of phlebitis immediately after care bundle implementation, while 20% had borderline phlebitis, compared by 63.3% before care bundle implementation. Little case 3.3% of them had thrombophlebitis pre-care bundle implementation compared to no complaint after-care bundle implementation and after one month. There was a statistically significant difference between before, and after care bundle implementation and after one month of the care bundle implementation at ($p \leq 0.05$).

Table (6) demonstrates correlation between total scores of nurses' knowledge and practice, there was a statistically significant correlation between total score of nurses' knowledge and practices before, Immediately and one month after care bundle implementation at ($p \leq 0.05$).

Table (7): reflects correlation between children's visual infusion phlebitis grading scale and nurses' knowledge, there was a positive statistically significant difference correlation between total scores of nurses' knowledge and visual infusion phlebitis grading scale immediate after and after one month at ($P < 0.05$).

Table (8) reveals correlation between children's visual infusion phlebitis grading scale and nurses' practices, there was a positive statistically significant difference correlation between total nurses' practices and visual infusion phlebitis grading scale intermediate after and after one month ($P < 0.05$).

Discussion

The utmost common invasive technique performed in the unit of Pediatric Intensive Care is vascular access cannulation utilizing peripheral venous catheters. Phlebitis, an acute blood vessel wall inflammation accompanied by irritation of the venous endothelium in the site cannulated by the catheter, is the maximum common consequence ^[1]. It prolongs hospitalization and treatment, raises financial costs, lowers child satisfaction, and can lead to further issues such pain, discomfort, clotting, thrombophlebitis, sepsis, and catheter-related bloodstream infection ^[8].

Care bundles are presented by the healthcare institute for the support, of developing the nursing procedures and processes, increasing the consistency of evidence-based health care practices, and interrelating interventions to improve child outcomes ^[2]. Nurses must have enough knowledge and practice towards the peripheral intravenous catheters care bundle because its complications can endanger a child's life ^[17]. Therefore, the present report was conducted for evaluating the implementing effect a bundle of care for peripheral intravenous catheters on nurses' performance at the Unit of Pediatric Intensive Care.

Regarding socio-demographic collected data of the evaluated nurses, the current study findings revealed that over half of the nurses' age was between 20 to less than 30 years (Table 1). This result may be attributed to the distribution of older-aged nurses to be ahead nurses and didn't involve in patient care. This result agreed with Ahmed (2014) who found that less than two-thirds of the nurses' age was between 20 to less than 30 years ^[18].

Training programs play an important role in enhancing and updating the nurses' experience and practice, besides enhancing the quality of care which is given to the children. Concerning nurses' attendance training programs, the present study revealed that most studied nurses didn't attend any training program related prevention of peripheral catheter-associated infection (Table 1). This may can be linked to the lack of an in-service training program department in the hospital and increase the workload on nurses in Pediatric Intensive Care Unit. Hasanpour *et al.*, (2017) ^[19] and Mohamed *et al.*, (2019) ^[20] who supported these findings as reported that most nurses did not attend any training courses in the pediatric intensive care unit.

As regards nurses' total scores of knowledge about the peripheral venous catheter, infection, and maintenance care bundle. The present study revealed that three-quarters of nurses had a poor level of knowledge before care bundle implementation (Table 3). This may be attributed to nearly more than three-quarters of nurses did not attend any training program related to the prevention of peripheral intravenous catheters associated infection programs, and workload at the Pediatric Intensive Care Unit prevents them from attending such courses which keep nurses familiar with the recent advances, guidelines around a specialty, and unavailability guideline booklet regarding control of the catheter-related bloodstream infection in hospital. World Health Organization (2006) ^[21] stated that generally, there was inadequate nurses' knowledge and performance and attributed this deficiency to lack of organization programs, unavailability of procedures manual and books in the studied areas, and lack of supervision during the work time.

Also, it may be due to more than two-fifths of participated nurses having experience period lesser than 5 years. Somewhat over half of them were graduated from health technical institutes who had taken insufficient knowledge and practices related to health assessment. Suchitra *et al.* (2007) ^[22], who reported that nurses 'education has a beneficial effect on retaining of information and attains competency in all categories of nurse's staff.

The present research showed that evaluated nurses' knowledge was improved immediately after care bundle implementation and the most of them obtained good scores. This can be attributed to the program's content, which was developed based on nurses' needs, its clarity and simplicity, use of audiovisual aids, availability of the researcher in the field for more clarification, using simple language, and frequent repetition be updated knowledge.

Furthermore, one month after the care bundle implementation, this percentage was slightly reduced. This indicated that the improvement in knowledge was partially lost one month after the care bundle implementation. The current study result might be explained that knowledge retention is usually affected by time. Morehead & Rhodes (2016) ^[23] who were in harmony with current finding

confirmed that information can be easily forgotten if they are not refreshed periodically.

Kleidon (2019) ^[1], who supported this finding, as stated that nurses' performance improved significantly with the implementation of peripheral intravenous catheters maintenance bundle and they become more familiar with the bundle steps for both inserting and maintaining care of the action.

Regarding to the nurses' total score of the practices and regarding the peripheral venous catheter care bundle (Table 4), the current research has reflected that the majority of participated subjects were unsatisfied with total percentage practice scores referring to the peripheral catheter care bundle pre- implementing the care bundle. The researcher believed that it might be attributed to the decline of nurses' knowledge, limited resources, and absence of training linked to the car for peripheral venous catheters, as well as the unavailability of financial support to conduct such training care bundle which may be a role, workload, shortage of staff which more increased due to increase the morbidity rate of nurses by covid-19 and its impacts on the psychological, physical, and social status of nurses and the dilemma between both the work and home responsibilities of the nurse as a caregiver, wife, and mother, hence nurses were unable to deliver a comprehensive and standard care for children to achieve a "good" score of practices. Besides, the nurses' experience based their practices on routine care more than up-to-date knowledge. In additionally the highest percentage of nurses their years of experience was ranged from five to less than 10 years and it has been postulated that the years of experience are directly proportional to the level of performance i.e., the more years of experience, the higher level of practice.

On the contrary, immediately after establishing the care bundle, the present finding showed that most of them had satisfactory score levels of practice and a statistically significant improvement in nurses' practice was found. This could be because of the efficiency of the educational session and the frequent demonstration of related procedures during the period of the study.

In addition, the finding may be explained in the light of the fact that young nurses are more active, have good physical fitness, and are creative in achieving nursing performance than older nurses as shown especially if received concentrated training. Also, could be attributed to the fact that the young age of nurses may reflect short experience, but it also reflects fresh knowledge and enthusiasm. Mahmoud *et al.*, (2018) ^[24], who agreed with this finding as found that the total practices score of more than half of the studied nurses was fair before applying nursing guidelines. While the total practice score of all nurses was good immediately after the guideline. Also Abdelaziz *et al.*, (2016) ^[25] who agreed with the current finding as they mentioned that, after the educational module, there was a significant improvement in the nurses' practice scores.

Alamri *et al.*, (2017) ^[26] who were in the same line with the current finding as they reported that nurses were interested in working and more practice for patients when they were more knowledgeable. In the same context, Higazee *et al.*, (2015) ^[27] who reported that day-to-day activities can enhance the nurses' performance and improves their practices.

Furthermore, after one month of the care bundle implementation, the total scores of nurses' practice were slightly reduced. This indicated that their improved practice after one month of the care bundle implementation decreased slightly than immediately, but still better than their scores before implementation. This may be because of the nurses' need to repeat educational care bundles periodically to maintain their satisfactory level of practice and motivation. Potter *et al.*, (2016) [28] who congruent with the present finding, as they reported that, after three months' post-test the scores of nurses' practice were slightly reduced as the majority of them had satisfactory levels in all items of practice.

Infusion Nurses Society established that, the proportion of 5% of phlebitis is considered as maximum accepted for the occurrence of phlebitis among hospitalized children with an intravenous catheter [29]. Concerning the total score of phlebitis, our present findings have showed that the phlebitis was encountered among more than three-fifths of studied children (Table 5). Also, it was noted that the most common phlebitis type was grade two as the early stage of phlebitis which was encountered among more than one-third of studied children as measured by Visual Infusion Phlebitis Scale before care bundle implementation. These findings may be due to the poor nurses' knowledge and the unsatisfactory score level of practices prior to implementing the care bundle. Oliveira *et al.*, (2012) [11] who was agreed with the current study as reported that the occurrence of phlebitis at the central hospital at Portugal grad two is the most frequent. Nyika *et al.*, (2018) [30] who supported this finding as they found that the occurrence of phlebitis was (3.7% to 67.24%). Also, found that grade two was more than one-half of studied children. On the other hand, Uslusoy, *et al.*, (2008) who found that grade one phlebitis be the most frequent among more than two-fifths of studied children [31].

On the other hand, the current study showed a highly significant difference between the incidences of phlebitis before, immediately after, and after one month. Admonish are put on hospital policies, facilities, and resources. Also, it can be explained as the effort done by the researcher and tool conducted to the Pediatric Intensive Care Unit for continuous observation and documentation, besides external efforts conducted to the Pediatric Intensive Care Unit from external support to provide all supplies needed and continuous training to pass the shortage of supplies. Improvement in the total score of children Visual Infusion Phlebitis Scale didn't decline to the international accepted ratio of five percent because of the presence of more contributing factors rather than nurses' knowledge and practices.

The cannulation performed in children is considered a complex procedure and there are many predisposing factors that should be considered with developing infection and phlebitis such as children's age. The obtained data of the current research showed a statistically significant relation between phlebitis for studied children and children's group age 2 to less than 2.5 years old and 2.5 to 3 years old, before the care bundle implementation, immediate after and after one month (Table 2) respectively. These findings of the current study might be because of the frequent manipulation of the insertion sites, creeping, and mouth secretions due to

suckling their fingers, and these age groups want to master their life and want to explore the environment around them. While the infection control measures did not implement in the true way to maintain a safe environment besides frequent exposure to hospital flora. Milutinović *et al.*, (2015) [29] who supported these findings as reported that the youngest children were more at risk for phlebitis. Nyika, (2018) [30] who disagreed with these findings, as he reported that there isn't any relationship between age and phlebitis.

As regards the length of hospital stay, the current study revealed a statistically significant relation between phlebitis and length of hospital stay where phlebitis encountered more among studied children who spent 14 to less than 21 days. It could be explained in the light of the prolonged hospitalization leads to more opportunity to utilize invasive devices and more time for exposure to exogenous microorganisms in hospitalized children from health care environment and hands of health care workers. Esmail, (2018) [13] who was in the same line with the current finding as she reported that the incidence of phlebitis increased among children who spent longer duration and had prolonged hospitalization stay undergo many complex events and much complex invasive procedures.

As regard to the correlation between the total nurses' scores of knowledge and practicing referring to peripheral catheter care bundle before, immediate, and one month after the care bundle implementation, the current findings revealed a positive correlation between total scores of nurses' experience and practice immediate, and after one month from the care bundle implementation rather than before its implementation (Table 6). This may be due to the theoretical part being effective in modulating nurses' practice as they acquire new knowledge, skills and become able to apply it perfectly during their practice so, their level of knowledge was associated with their competency level of practice.

Saillour and Glenisson (2016) [32] who were in harmony with the present finding, revealed that nurses should maintain a high level of nursing knowledge and practice to be effective in practice and if they work with inadequate knowledge, their practice would be inadequate and incomplete. Also, McEwen and Wills (2017) [33] who mentioned that nursing education and practice have an interdependent relationship; each reflects the progress of the other and that may reflect the significance of integration between theory and practice.

The current research has clarified that there was a positive correlation between children's Visual Infusion Phlebitis Scale and nurses' knowledge immediately after and after one month with a highly significant correlation rather than before (Table 7). It could be elucidated in the light of the improvement in nurses' knowledge that lead to a significant decrease in the incidence of phlebitis besides a positive effect of the care bundle implementation. Draiko *et al.*, (2019) [34] who were in accordance with the current findings, as they reported that nurses' education has a positive impact on the retention of knowledge and achieving competency in all staff categories.

The current study illustrated that a positive correlation was found between the children's Visual Infusion Phlebitis Scale and nurses' practice, immediately and after one month (Table 8). It may be related to the improvement of nurses'

practice due to continuous feedback and frequent re - demonstration of the procedures. As stated by Chaghari *et al.*, (2017) [35] who mentioned that formal training courses and workshops attendance play a vital role in enhancing and updating nurses' knowledge and performance besides improving the quality of care that they provided to the children.

Collectively, based on the obtained results of the present research, it is concluded that there was an improvement in nursing staff knowledge and practice after the peripheral venous catheter care bundle implementation. These results may be because of an educational care bundle that maximized the nurses' knowledge score and improved their practice as this care bundle was planned and implemented according to their pre-assessed needs. Furthermore, simplification of well-presented information and suitable educational aids increased their interest and desire to

acquire a lot of knowledge.

Recommendation: Based on the current findings the following recommendation is offered

- In-service training program should be conducted periodically and regularly for teaching nurses working at Pediatric Intensive Care Unit the basic clinical skill.
- Providing educational programs which emphasize on the evidence-based practices about infection control measures in pediatric intensive care units for the recently graduated nurses
- Establish competency checklist for nurses to evaluate their competency in implementing PVCs maintenance care bundle
- A system for accreditation and certification should be developed to motivate nurses' participation in the educational programs which should be conducted.

Table 1: Percentage Distribution of participated Nurses regarding Sociodemographic data

Sociodemographic data of nurses	The participated nurses (n=60)	
	No.	%
Age / years:		
20 - < 30	35	58.3
30 - < 40	23	38.3
≥ 40	2	3.3
Range	20 – 40	
Mean ± SD	29.15 ± 8.16	
Sex:		
Male	0	0.0
Female	60	100.0
Educational level		
Secondary Nursing school	6	10.0
Health Technical Institute	35	58.3
Bachelor of Nursing Science	19	31.7
Years of experience		
< 5	21	35.0
5- > 10	27	45.0
10- >15	8	13.3
≥15	4	6.7
Range	1.0 – 20.0	
Mean ± SD	7.03 ± 4.75	
Attendance of any training programs related to prevention of peripheral venous catheters associated infection		
Yes	13	21.7
No	47	78.3

Table 2: Percentage Distribution of Studied Children regarding Biosocial Characteristics

Biosocial data of the studied children	Before (n=30)		After(n=30)	
	No	%	No	%
Age (years)				
1 -> 1.5	9	30.0	11	36.7
1.5- >2	2	6.7	5	16.6
2- > 2.5	8	26.7	8	26.7
2.5-3	11	36.7	6	20.0
X ± SD	2.03 ± 0.82		1.92 ± 0.82	
Sex				
Male	6	20.0	8	26.7
Female	24	80.0	22	73.3
Length of hospital stay				
8- > 14	8	26.7	14	46.7
14-> 21	15	50.0	9	30.0
21-28	7	23.3	7	23.3
X ± SD	15.47 ± 6.35		16.27 ± 5.53	
Diagnosis				
Pneumonia	8	26.7	9	30.0
Asthma	6	20.0	7	23.3

Bronchiolitis	1	3.3	2	6.7
• Central nervous system disorder	7	23.3	6	20.0
Gastrointestinal disorder	7	23.3	5	16.7
Renal disorder	1	3.3	1	3.3

Table 3: Percentage Distribution of Total Scores of nurses' knowledge regarding peripheral venous Catheter, Peripheral Venous Catheter Infection, and Maintenance Care Bundle.

Total scores of nurses'-knowledge related to PVC, PVC infection, and maintenance care bundle.	The participated nurses (n=60)						χ^2	P
	Before		Immediate after		After one month			
	No	%	No	%	No	%		
Poor < 60%	45	75.0	0	0.0	4	6.7	100.911*	<0.001*
Fair 60-75%	10	16.7	3	5.0	4	6.7		
Good 75-100%	5	8.3	57	95.0	52	86.7		
Range	11.0 – 48.0		46.0–64.0		34.0–64.0		F value = 554.299*	
Mean ± SD	23.72±11.83		63.05±3.88		59.73±8.49		P = 0.0001*	

*Statistically significant difference at ($P < 0.05$).

Table 4: Percentage Distribution of Total Scores of Nurses' Practices regarding Peripheral Intravenous Catheter Care Bundle.

Total scores of nurses' practices regarding Peripheral intravenous catheter care bundle.	Before		Immediate		After one month		χ^2	p
	No.	%	No.	%	No.	%		
A-Before procedure:								
Unsatisfactory	49	81.7	5	8.3	13	21.7	73.244*	<0.001*
Satisfactory	11	18.3	55	91.7	47	78.3		
B- During performing procedure								
Unsatisfactory	47	78.3	3	5.0	9	15.0	75.911*	<0.001*
Satisfactory	13	21.7	57	95.0	51	85.0		
C-After procedure								
Unsatisfactory	43	71.7	5	8.3	28	46.7	51.116*	<0.001*
Satisfactory	17	28.3	55	91.7	32	53.3		
Total scores								
Unsatisfactory	49	81.7	5	8.3	11	18.3	75.911*	<0.001*
Satisfactory	11	18.3	55	91.7	49	81.7		

*Statistically significant difference at ($P < 0.05$)

Table 5: Percentage Distribution of Total Scores of the Studied Children's Visual Infusion phlebitis grading scale (VIP)

Total scores of studied children's visual infusion phlebitis grading scale	Children Number(n=60)						χ^2	p
	Before (30)		Post immediate (30)		After one month(30)			
	No.	%	No.	%	No.	%		
No phlebitis	8	26.7	11	36.7	7	23.3	15.235*	<0.001*
Borderline Phlebitis	2	6.7	6	20.0	6	20.0		
Phlebitis	19	63.3	13	43.3	17	56.7		
Thrombophlebitis	1	3.3	0	0.0	0	0.0		

Table 6: Correlation between total scores of nurses' knowledge and practice

Variables	Correlation between knowledge and practice					
Practice	Before care bundle implementation		Immediately after care bundle implementation		One month after care bundle implementation	
Knowledge	r	p	r	p	r	p
	0.148	0.258	0.781*	<0.001*	0.876*	<0.001*

r: Pearson coefficient

*: Statistically significant at $p \leq 0.05$

Table 7: Correlation between children's visual infusion phlebitis grading scale and nurses' knowledge

Nurses' Knowledge	Phlebitis grading	
	r_s	p
Before	0.126	0.336
Immediate after	0.268*	0.039*
After one month	0.486*	<0.001*

*Statistically significant difference at ($P < 0.05$)

r_s : Spearman coefficient

Table 8: Correlation between children's visual infusion phlebitis grading scale and nurses' practices

Nurses' practices	Phlebitis grading	
	R	P
Before	0.041	0.756
Immediate after	0.421*	0.001*
After one month	0.502*	<0.001*

*Statistically significant difference at ($P < 0.05$) r_s : Spearman coefficient

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