

# Educational Training Using Transmitted Light Device on Nurses' Performance and Pain among Children Undergoing Peripheral Intravenous Cannulation

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## ABSTRACT

**Background:** Peripheral intravenous cannulation is frequently required for hospitalized children. Fluid supplements and administration of medication are mainly dependent on vascular access.

**Aim:** Evaluate educational training using transmitted light device on nurses' performance and pain among children undergoing peripheral intravenous cannulation. Design: A quasi-experimental research design was used to conduct the study. **Setting:** The study was conducted at Pediatric Medical Departments of Benha University Hospital. **Sample:** A convenience sample of all available pediatric nurses (48) and (50) children received an intravenous cannula insertion at the time of the study.

**Tools:** 1. Structured interview questionnaire for nurses to assess socio-demographic characteristics of the studied nurses, pediatric nurses' knowledge and observational checklist for nurse's performance. 2. Structured interview questionnaire for children to assesses socio-demographic characteristics, medical history of studied children and Oucher pain rating scale.

**Results:** A highly statistically significant difference observed between the studied nurses' total knowledge and performance regarding to intravenous cannula insertion at pre- and post-intervention  $P = (<0.001)$  and 68.0% of children in study group had mild pain level, while more than half (56.0%) of control group had severe pain level.

**Conclusions:** The implementation of educational training using transmitted light device had significantly improve nurses' knowledge and performance and reduce pain level among children undergoing peripheral intravenous cannulation.

**Recommendations:** Application of transmitted light device for hospitalized children undergoing peripheral intravenous cannulation. Implementation of educational training would allow pediatric nurses using transmitted light device for hospitalized children undergoing peripheral intravenous cannulation

**Keywords:** Educational Training- Transmitted Light Device- Peripheral Intravenous Cannulation.

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## INTRODUCTION

Peripheral intravenous cannulation is one of the most common invasive and traumatic techniques for the children. (Parker, et al., 2016). It is always done by pediatric nurses to children for many reasons for example, ensuring fluid and electrolyte balance, administration of antibiotics, drugs and transfusing blood or blood products (Sun, et al., 2013). The Peripheral intravenous vein-puncture technique is a very challenging and painful in pediatric patients compared to adult patients because of the smaller vessel widths, decreased visibility of the veins, and exertion in veins' palpation. As the age of the pediatric patient gets lower, peripheral intravenous cannulation may become more difficult (Chapman, et al. 2011).

Intravenous cannulation is the main performance done by the nurse for care of the sick children. The nurses' performance of cannula insertion may be failure for several attempts due to several factors such as more subcutaneous tissues in children, weak venous asset in young child need frequent venous cannulation, dark skin color, malnourished, and obesity (Szmuk, et al. 2013). On occasion, the attempt failure to observe or palpate the vein may be due to inability to figure out which vein and how to enter it. In these circumstances, nurse may perform several attempts to finding the vein (Hess, 2010). Thus, several attempts to access may cause tension, pain, and tissue and vein damage to the child. Likewise, from

the medical caretaker's point of view, failure attempts result in suffering negative feelings such as fear and decrease self-confidence, which harms of trust relationship between the nurse and the child (Perry, et al. 2011). Recognize the variables associated with failure of intravenous cannulation in pediatric patients will provide an evidence to improve accomplishment in less time (Chapman, et al. 2011).

Potential difficulties such as fear, anxiety, and inability to draw blood or stop of blood flow may rise and it is vital to know how to overcome. Complications such as hematoma, phlebitis, injury to the nerve or artery, and needle stick damage may occur, and it is important to the nurse to recognize and prevent them. It is critical for the nurse to detect and prevent complications arising. It is particularly important for pediatric patients who not able to verbalize pain (Health Service Executive, 2016).

Educational training delivers the aptitude to do actions virtually as compared to only knowing theoretically. Many strategies have been planned to assist improving venous access. Specific tools have been established to improve the success rate of intravenous cannulation. Transmitted light device is a tool designed for finding small peripheral veins. It portable, battery operated devices. They have a high intensity light source and movable arms to narrow the area illuminated. Transmitted light device requires a darkened room to eliminate competing sources of visible light. The area of

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illumination depends on the color of skin, with darker skin tones producing greater difficulty. Some devices have protective covers, but they do require adequate cleaning after each use. Successful use of these devices greatly depends upon personal preference (Health Service Executive, 2016). A transmitted light device improved intravenous cannulation in critically ill children (Perry, et al., 2011).

### Aim of the study

The aim of the study was to evaluate educational training using transmitted light device on nurses' performance and pain among children undergoing peripheral intravenous cannulation.

### Research hypotheses:

- 1-Nurses who will receive educational training will have improved their knowledge on using a transmitted light device for children undergoing peripheral intravenous cannulation post intervention than pre intervention.
- 2- Nurses who will receive educational training will have improved their performance on using a transmitted light device for children undergoing peripheral intravenous cannulation post intervention than pre intervention.
- 3- Children who will receive peripheral intravenous cannulation using a transmitted light device (study group) will have lower pain than control group.

## SUBJECTS AND METHODS

### Research Design:

A quasi-experimental research design was used in the current study

### Setting:

The study was conducted at Pediatric Medical Departments affiliated to Benha University Hospital. It is allocated at 4th floor into three units. Each unit consists of 3 rooms, the first unit contains 12 beds, second unit contains 11 beds, and third unit contains 14 beds.

### Sample:

A convenience sample of all available (48) pediatric nurses and (50) children received an intravenous cannula insertion at the time of the study

### Inclusion criteria for children

- Hospitalized children in need for peripheral venous cannula as decided by the treating doctors.

### Inclusion criteria for nurses

- Nurses willing to participate in the study.

### Exclusion criteria for children:

- 1) Children with clear and visible veins
- 2) Children needs another type of access
- 3) Children need resuscitation.

### Tools of data collection:

There were two tools utilized to gather the required data:

### Tool (I): Structure interview Questionnaire for Nurses: -

It was designed by the researchers in the light of relevant studies and research. It was written in an Arabic language and composed of three parts, as the following: -

**Part I:** Socio-demographic characteristics of the studied nurses as: age, sex, educational level, years of experience and qualification.

**Part II:** Pediatric Nurses' knowledge sheet

It was developed by the researchers in an Arabic language after reviewing the related literatures, to assess pediatric nursing knowledge related to intravenous cannulation. It included six (6) multiple-choice questions such as anatomy of veins, differences between arteries and veins, methods of vein selection, indication of IV cannula, complication of IV cannula and number of injections.

### Scoring system

- Correct and complete answer will be scored (2).
- Correct and incomplete answer will be scored (1)
- Don't know will be scored (0).

### Total scoring system for nurses' knowledge will be categorized as the following: -

- High level of knowledge will be considered from 80 % to 100%.
- Moderate level of knowledge will be considered from 60 to less than 80%
- Low level of knowledge will be considered less than 60%

### Part III: observational check list for nurse's performance toward peripheral venous cannulation.

It was designed by the researchers to assess: -

- Nurses' performance about peripheral venous cannulation
- preparation and using transmitted light device
- Number, success rate and time of peripheral venous cannula insertion attempts

Every procedure separated into sub-items. Total procedure's sub-items comprised 36 statements.

### Scoring system

Scoring system of the studied nurses' performance was calculated as correct performance was scored 1 while correct and incomplete and wrong or incorrect was scored 0.

### The total score for performance was classified as the following: -

The nurses' performance level was categorized as either poor level (less than 50%), average level (50% to less than 85%), or good level of performance (85% to 100%).

### Tool (II): Structure interview Questionnaire for children: -

It was composed of three parts, as the following: -

**Part I:** Socio-demographic characteristics of the studied children as regard age, sex, education and residence.

**Part II:** Medical history of children, this tool was designed by the researchers after reviewing the literature and children hospital sheet to collect data about every child related to date of admission, age, causes of admission, child medication. This sheet filled by the researchers by asking the mothers if the child cannot response.

### Tool (III): Oucher Pain Rating Scale

This scale was adopted from Beyer, et al. (2009), which is a numerical scale to assess the severity of pain in children aged 4-12 years old that is alike a horizontal ruler beginning from zero on the left, progress in until 10 to the right; as the numbers increase, the intensity of the pain also increases

### Scoring system

- (0) shows no pain and (10) shows very severe pain.
- The total pain score was 10.

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- Mean score for the different levels of pain was calculated as no pain (0), mild pain (1-3), moderate pain (4-7), severe pain (8-10).

### **METHODS**

#### **Approval**

An official permission to carry out the study was obtained from faculty dean of nursing; Benha University, for administrator of Benha University Hospital explaining the purpose of the study and methods of data collection in order to take their approval for conducting the study. An exploratory phase was conducted before starting the study to decide the feasibility of accomplishing this study.

#### **Study Period**

Data were collected from the 1st October till the end of December 2019.

#### **Ethical considerations and human rights**

The aim of the study explained by the researchers to studied nurses and they were informed that the study is harmless. The researchers secured that entirely collected data are confidential and are used for the research purpose only. The studied nurses were informed that they are optionally allowed either to participate or not in the study and they have the right to withdraw at any time. An oral consent was taken from the nurses.

#### **Tool Development:**

**A. Validity of the tools:** - To measure content validity of the study tools, the researchers assure that items of the tools were submitted to a jury of five experts in the field of pediatric nursing (3 professors and 2 assistance professors) to test face and content validity. Modifications of the tools of the study were done agreeing the panel judgment on clarity of sentences, appropriateness of content and sequence of items.

**B. Reliability of the tool:** - The reliability and internal consistency reliability of wholly items of the tools was assessed by using coefficient alpha. It was 0.94 for a structured interviewing questionnaire to assess pediatric nurses' knowledge regarding Peripheral intravenous cannulation, 0.83 for children pain level pre- and post-questionnaire, 0.75 for instrument to assess nurse's performance about peripheral venous cannulation and preparation during use transmitted light device.

**C. Pilot:** A pilot study was performed on 10% of the total sample size (5 nurses and 5 children) over a period of two weeks to test the validity and applicability of the study tools and to estimate the required time to fill the questionnaire. No essential modifications were carried out on the study tools, so the study subjects were involved in the study sample.

#### **Transmitted Light Device Technique**

This technique will be recognized as cold-light source; the extremity had better be stabilized and inspected for venous access with the fiber optic light source, which positioned against the palmar or plantar surface of the hand or foot. Turned off the lights in the treatment room to assist in venous visualization. Venous visualization may also be possible, even with hematoma or previously punctured veins. Surface veins look darker and more well-defined than the diffuse lines of deep veins. Pediatric patients those venous access was attained after more than two attempts or in a longer time than 10 min were recorded.

#### **Field work:**

Assessment, planning, implementation, and evaluation phases were performed to achieve the study aim. These phases were conveyed from the earliest starting point of

1st October till the end of December 2019 covering 3 months.

**Assessment phase:** Interviews with nurses and children to gather baseline data. At the beginning of interview, the researchers welcomed each studied nurse, explained the purpose, duration, and activities of the study and took written consent from their nurse. After that, assess personal character of nurses and children, medical history and pediatric nursing knowledge about IV cannulation by using tools (I & II)

**Planning phase:** Built on baseline data gained from assessment and relevant review of literatures, the introduction of the instrument's application technique before the procedure was developed by the researchers for both groups,

**Implementation phase:** The researchers were available three days/week (Saturday, Monday and Thursday) from 9am-1pm. Studied nurses included in the study were (48) nurse and total number of studied children were (50) child. The children were divided into two groups: study group (using transmitted light device) and the control group (without using transmitted light device).

Studied nurses divided into 24 as a study group and 24 as control group.

The study group divided into (5 groups), each group contains of (4-5 nurses). The purpose of the study was explained by the researchers to all nurses (study and control groups) included in the study.

#### **Educational Training Sessions:** -

The total numbers of sessions were 4. It divided as follows: one session for knowledge, and 3 sessions for the performance. The time of session ranged between 30 -45 minutes. The nurses divided into groups; each group contains (4-5 nurses).

**First session:** Focus on knowledge acquisition through explanation of definitions indication, and contraindication of peripheral venous cannulation. Orientation about preparation for cannulation; a tourniquet placement directly above the site of puncture, veins thumped or tapped, the arm or leg left droopy downwards, and disinfection with alcohol application.

**Second session:** Focus on performance, session was done by the researcher through demonstration of preparation as well as application of transmitted light device technique during insertion of peripheral venous cannulation.

**Third session and fourth sessions:** The researchers were observing re-demonstration of procedure. The control group were used the traditional method and the study group were used illumination light; the room light was put off during cannula insertion, vein appears darker than the other veins for cannula insertion. The researcher will collect data by using tools (I) in both groups.

The researchers were observing the number, duration, success rate of the attempts, the duration of the process was measured using watch, which was started when the tourniquet attached and finished when venous access was achieved. If the first attempt was unsuccessful, timing and observation continuous until a successful peripheral intravenous cannulation was occurred .

Also, the researchers observed and recorded number and time (in minutes) cannulation' attempts, number of all facilities used to complete the procedure successfully (cannula, swab, and syringes). In addition, the researchers measured the pain level of the pediatric patients during the procedure, using the Oucher pain scale.

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**Evaluation phase:** The researchers evaluated the success of the procedure for both groups which determined by the number, duration and the success rate of the attempts. Successful cannulation was definite by the absence of signs of infiltration after administration of saline solution. Also, the researchers evaluated the level of children pain in both groups.

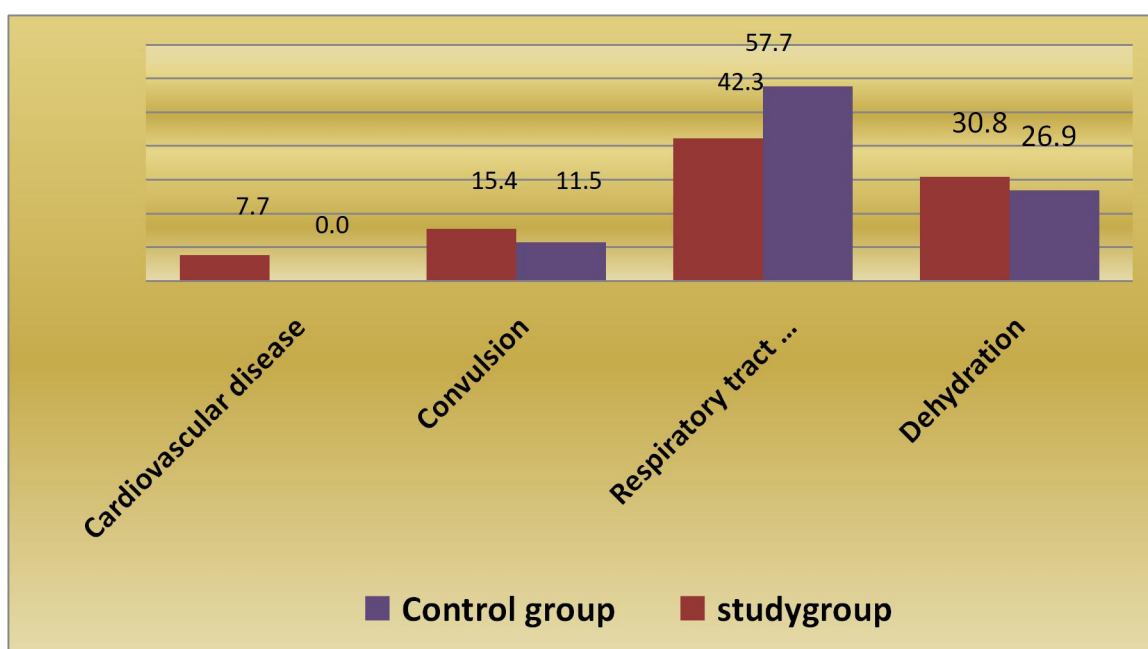
### Statistical analysis

The collected data were organized, tabulated and analyzed using electronic computer and statistical package for social sciences (SPSS) version 20. Descriptive statistics were calculated for the data in the form of: Mean and standard deviation for quantitative data, and frequency and distribution for qualitative data. Also, in analytical statistics, inter-group comparison of categorical data was performed by using chi square test ( $X^2$  -value). Also, Pearson correlation coefficient test was used. P value  $<0.05$  was considered statistically significant (\*) while  $>0.05$  statistically insignificant and P value  $<0.001$  was considered highly significant (\*\*) in all analyses.

### RESULTS

Concerning nurses' age, more than half (54.2%) of the studied nurses had age between 25-30 years old, with mean age  $25.197 \pm 2.747$ . In relation to gender, less than three quarter (60.4%) of them were female, more than half (66.7%) had age of experience from 3 < 6 years old, with mean experience  $4.06 \pm 1.374$ . Meanwhile, less than half (45.8%) of them had diploma of secondary nursing school. In relation to children age, more than half (57.7%) of the studied children had age from 8 < 10 years old, with mean age  $8.200 \pm 1.50$ , while control group (53.8%) of them had age from 6 < 8 years old, with mean age  $7.480 \pm 1.446$ . In relation to gender, more than half (53.8%) of them were female, while control group half (50.0%) of the studied children were male. Also, all (100.0%) of study and control group were primary education.

As regards to children skin color, less than half of them (42.3%) of study children had fair skin while (48.0%) of control group had black skin. In relation to previous hospitalization, more than half (57.7% & 50.0%) of study and control groups had previous hospitalization. **Figure 1:** Distribution of studied children according to diagnosis



**Figure 1:** Reflects that, less than half (42.3% and 57.7%) of study and control groups were diagnosed with respiratory tract disease, while less than one third (30.8% and 26.9%) of study and control groups had dehydration.

**Table 1:** Comparison of studied nurses knowledge score regarding to anatomy of veins, differences between arteries and veins, methods of vein selection, indication and complication of Iv cannula insertion at pre- and post-from implementation of program (n=48).

Items	Nurses knowledge								$X^2$	p
	Pre-Intervention (n=48)				Post Intervention (n=48)					
	Complete		Incomplete		Complete		Incomplete			
No.	%	No.	%	No.	%	No.	%			
Anatomy of veins	22	45.8	26	54.2	42	87.5	6	12.5	18.750	0.001
Differences between arteries and veins	16	33.3	32	66.7	46	95.8	2	4.2	40.987	0.001

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Methods of vein selection	16	33.3	32	66.7	41	85.4	7	14.6	26.991	0.001
Indication of IV cannula	14	<b>29.16</b>	34	70.83	48	100	0	0.0	5.275	.05

Items	Study group (n=25)		Control group (n=25)		X <sup>2</sup>	P				
	No	%	No	%						
<b>Number of IV cannula attempts</b>										
< 5 times	20	<b>76.9</b>	9	34.6	10.172	0.001				
5-10 times	5	19.2	15	57.7						
> 10 times	0	0.0	1	3.8						
<b>Rate of successful attempts</b>										
<b>First attempts</b>										
Succeed	17	<b>65.4</b>	9	34.6	5.128	0.001				
Failed	8	30.8	16	61.5						
<b>Second attempts</b>										
Succeed	6		5	20.0	5.951	0.001				
Failed	2		11	44.0						
<b>Three of attempts</b>										
Succeed	2	8.0	7	28.0	3.029	.387				
Failed	0	0.0	4	16.0						
<b>Duration of attempts</b>										
< 5 minutes	16	61.5	7	26.9	10.885	0.001				
5-10 minutes	8	30.8	8	30.8						
> 10 minutes	1	3.8	10	38.5						
Complication of Iv cannula	25	52.08	23	47.91	48	100	0	0.0	6.400	.011

Table (1): Illustrates that, more than (54.2%, 66.7%, 70.83%) of studied nurses had incomplete answer toward anatomy of veins, differences between arteries and veins and methods of vein selection in pre intervention while (100%, 95.8% and 87.5%) of studied nurses had complete answer in post intervention. There was an improvement in

their knowledge in most items on post intervention compared with pre- intervention, knowledge with high statistically significant difference (p <0.001). Table 2: Distribution of the studied children according to number, rate and duration of IV cannula attempts in study and control groups post intervention

Table (2): Illustrates that, less than three quarter (65.4%) of study group success in 1st attempts, children who successfully have cannula insertion after two attempts were (30.0%), children who successfully have cannula insertion after three attempts were (8.0%). While in the

control group children who successfully have cannula insertion after first attempts were(34.6%), children who successfully have cannula insertion after were(20.0%) children who successfully have cannula insertion after three attempts were (28.0%).

**Table 3:** Total score of the studied children pain level according to number, success in first and time of attempts of study and control groups post intervention



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Items	Study group(n=25)						Control group(n=25)						X <sup>2</sup>	p	
	Mild		Moderate		Sever		Mild		Moderate		Sever				
	No	%	No	%	No	%	No	%	No	%	No	%			
<b>Number of IV cannula attempts</b>															
< 5 times	16	64.0	4	16.0	0	0.0	7	28.0	2	8.0	0	0.0	33.090	0.001	
5-10 times	1	4.0	3	12.0	1	4.0	1	4.0	1	4.0	13	52.0			
> 10 times	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	4.0			
<b>Success in first attempt</b>	15	60.0	2	8.0	0	0.0	7	28.0	2	8.0	0	0.0	29.808	0.001	
<b>Time of attempts</b>															
< 5 minutes	15	60.0	1	4.0	0	0.0	6	24.0	1	4.0	0	0.0	51.217	0.001	
5-10 minutes	2	8.0	6	24.0	0	0.0	2	8.0	2	8.0	4	16.0			
> 10 minutes	0	0.0	0	0.0	1	4.0	0	0.0	0	0.0	10	40.0			

Table (3): Indicate that, less than two third (60.0% & 64.0%) of the study group had mild pain level during first attempt and less five times of IV cannula insertion compared to more than half (52.0% & 28.0%) of control group had severe pain during first attempt and 5-10

times of IV cannula insertion. Also, time of attempts, less than two third (60.0% & 64.0%) of the study group had mild pain level at first five minutes of IV cannula insertion compared to (40.0%) of control group had severe pain during 10 minutes of IV cannula insertion (P=<0.001).

**Table 4:** Association between skin color, diagnosis and number of attempts of cannula insertion in study and control groups post intervention.

Items	Rate successful of cannula insertion attempts												X <sup>2</sup>	p	
	Study group						Control group								
	1 <sup>st</sup> attempts		2 <sup>nd</sup> attempts		3 <sup>rd</sup> attempts		1 <sup>st</sup> attempts		2 <sup>nd</sup> attempts		3 <sup>rd</sup> attempts				
No	%	No	%	No	%	No	%	No	%	No	%	No	%		
<b>Skin color</b>															
White	7	28.0	1	4.0	0	0.0	2	8.0	2	8.0	0	0.0	10.557	.103	
Fairy	8	32.0	3	12.0	0	0.0	3	12.0	3	12.0	6	24.0			
Black	2	8.0	2	8.0	2	8.0	4	16.0	0	0.0	1	4.0			
<b>Diagnosis</b>															
Dehydration	3	12.0	1	4.0	0	0.0	3	12.0	1	4.0	3	12.0	7.480	.587	
Respiratory infection	9	36.0	2	8.0	1	4.0	4	16.0	3	12.0	3	12.0			
Convulsion	4	16.0	2	8.0	1	4.0	2	8.0	1	4.0	1	4.0			
CHD	1	4.0	1	4.0	0	0.0	0	0.0	0	0.0	0	0.0			

**Table (4):** Reveals that, more than one third (32.0%) of study group had fairy skin color in 1<sup>st</sup> attempts compare to less than third (24.0%) had fairy skin color in 3<sup>rd</sup> attempts. In relation to diagnosis, more than one third (36.0% and 16.0%) of study and control groups had respiratory tract

disease in 1<sup>st</sup> attempts. There is not statistically difference between skin color and rate of successful of attempts but there is statistically difference between diagnosis and rate of successful of attempts.

**Table 5:** Relation of total pain score between study and control groups post intervention

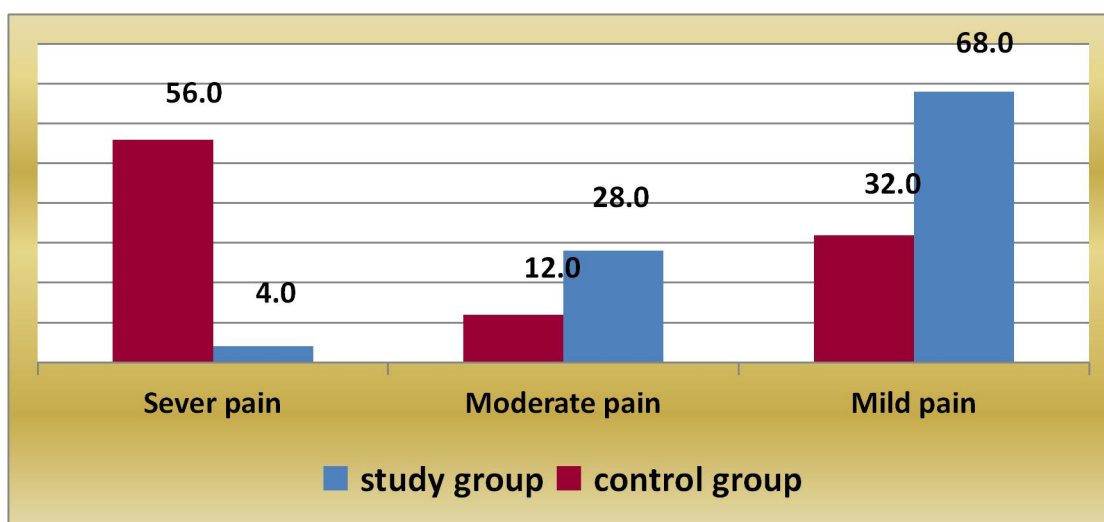
Items	Children pain level		X <sup>2</sup>	P

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	Study group(n=25)		Control group(n=25)			
	No	%	No	%		
Mild pain	17	68.0	8	32.0	<b>16.107</b>	<b>0.001</b>
Moderate pain	7	28.0	3	12.0		
Sever pain	1	4.0	14	56.0		
<b>Total</b>	25	100	25	100		

**Table (5):** Indicate that, There was a highly statistically significant difference of the study group pain level at post application of light source device as compared to control group pain level without application of light source device (P<0.001).

**Fig 2\:** Total children's pain level in study and control groups post intervention.



**Fig 2:** Illustrate that, less than three quarter (68.0%) of the study group had mild pain level, while more than half (56.0%) of control group had severe pain level.

**Table 6:** comparison of the studied nurse's performance regarding cannula insertion and transmitted light device preparation at pre- and post-intervention (n=48)

Items	Nurses performance (n=48)								X <sup>2</sup>	P
	Pre intervention				Post intervention					
	Completely Done		Incompletely and not done		Completely done		Incompletely and not done			
	No	%	No	%	No	%	No	%		
Cannula insertion	20	41.7	28	58.3	45	93.8	3	6.3	16.524	0.001

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transmitted light device procedure	0	0.0	48	100.0	44	91.7	4	8.3	81.231	0.001
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**Table 6:** This table presents that, there was a highly statistically significant differences in all items of nursing **performance** (Cannula insertion and preparation and application of light source device during cannula insertion. at post intervention as compared to pre intervention ( $\chi^2=81.231$ ,  $P<0.001$ ).

**Table 7:** Total knowledge and performance scores of studied nurses regarding IV cannula insertion (No 48).

Items	Nurses (n=48)				X <sup>2</sup>	P
	Pre intervention		Post intervention			
	No.	%	No.	%		
<b>Total knowledge score</b>						
High level	21	44.0	45	93.0	31.395	0.001
Moderate level	19	39.0	2	5.0		
Low Level	8	17.0	1	2.0		
<b>Total performance score</b>						
Good	0	0.0	41	85.0	71.730	0.001
Average	15	32.0	3	7.0		
Poor	33	68.0	4	8.0		
<b>Total</b>	<b>48</b>	<b>100</b>	<b>48</b>	<b>100</b>		

Table (7) shows that there was a highly statistically significant difference observed between the studied nurses' total knowledge and **performance** regarding to IV cannula insertion at pre- and post-intervention  $P= (<0.001)$ .

**DISCUSSION**

Peripheral intravenous cannulation in pediatric patients is challenging procedure. However, successful peripheral intravenous cannulation is completely required for pediatric in hazard condition; this study evaluates the effect of transmitted

light device through number, duration, the success rate of the venipuncture attempts, and the level of pain in pediatric patients during the procedure (Der Woude, et al. 2013).



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In the current study the characteristics of studied nurses revealed that, their mean age was  $25.197 \pm 2.747$ . This finding was agreement with [Essani and Ali, \(2011\)](#), who revealed that the majority of nurse's age between 20- 30 years with the mean 22.9 years.

Concerning to previous experience of studied nurses' findings of the study revealed that more than half of nurses had experience from  $3 < 6$  years. this finding was not agreement with [Perry et al. \(2011\)](#), who showed that, the efficacy of a near-infrared light device in pediatric intravenous cannulation and found that 43% of studied nurses had  $5 < 10$  years of experience.

It was clear from the result that less than half of studied nurses had diploma. These finding in same line with [Arbaee and Ghazali, \(2013\)](#), who found that, more than three quarter of nurses had nursing diploma.

According to children ' age, the result of this study illustrated that, more than half of the children had age from  $8 < 10$  years old, with mean age  $8.200 \pm 1.50$  while control group nearly half of children had age from  $6 < 8$  years old, with mean age  $7.480 \pm 1.446$ . In relation to gender, more than half of the studied children were female, while control group half of the studied children were male. Also, the majority of study and control group were primary education with no significant differences between groups. This finding was in the same context with [Conversano, et al. \(2018\)](#) who illustrated that, children ' age was similar in the two groups, with a median of 9 and 8 in the vein viewer and the control group respectively. Of the total sample of 57 pediatric patients (49.6%) were male and 58 were female (50.4%) with no significant differences between two groups. The findings of the current study demonstrated that three quarter of study group success in 1st attempts. While in the control group about one quarter of children successfully have cannula insertion after first attempts. This finding was in the same context with [Wolters Kluwer Health, \(2018\)](#) who founded in his study about impact of peripheral venous

catheter placement with vein visualization device, found that Placement of PIVC occurred in less time in the study group than in the control group and with fewer attempts. The success rate in the study group in the first attempt was greater (74.1%) than in the control group (40.7%;  $P = 0.028$ ). Also, this finding was in the same context with [Yamazaki, et al. \(2011\)](#), who reported that, the success rate of was 100% when transmitted light was used in venipuncture and 83% when the transmitted light wasn't used. Also, the success rate of intravenous cannulation was 88% when transmitted light was used and 55% when the transmitted light was not used. The utilize of light altogether expanded the victory rate of intravenous cannulation, since it permitted coordinate affirmation of the heading to thrust the intravenous catheter forward. The utilized of transmitted light assents for more fruitful intravenous cannulation in children. Meanwhile, this study accordance with [Demir and Inal, \(2016\)](#), who revealed that, the number of recurrent attempts after the removal of the PIVC, even when a devoted intravenous team with a first-time insertion success rate of 98% perform the initial insertion, the PIVC post insertion failure in an orthopedic ward was 49% attributed to securement device failure.

This study accordance with [Peter, et al. \(2016\)](#), who founded that, the success rate in first attempt was 73%, with 15% need a second attempt and 9% need three or more attempts. (3%) had no recorded number of following attempts. With 15% getting a successful PIVC insertion by the clinician on their second attempt, 6% on their third attempt, 2% on the clinician's fourth attempt and 1% of children were cannulated successfully after five and up to nine attempts.

The current study illustrated that, more than three quarter of study group had IV cannula insertion attempts less than five times, while more than half of control group had IV cannula insertion attempts from five to ten minutes. This study accordance with [Saju, et al. \(2019\)](#), who founded significant reduction in the number and time required for cannulation attempts when using vein-viewing device. The success rate for first attempt was significantly increased with device

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use. The device use has minimal impact on pain and fear during cannulation, provide good clinical care, prevent complications and decrease procedure delays among children. Also, this study agreement with [Peterson, \(2012\)](#), who founded that, the success rate of first attempt increased significantly with the use of vein-viewing device (77.4%), when compared to (67.3%) in control group Success in the second attempt was 25.8% and 20.8% in control and experimental groups respectively. 6.9% and 1.8% needed more than two attempts for successful cannulation in control and the experimental groups respectively. The mean time taken for successful cannulation was 144.3 seconds and 85.1 second in control and experimental groups respectively.

Meanwhile, this study accordance with [Malyon, \(2014\)](#), who founded that, The success rate of venous cannulation was 100% when used transmitted light, and 83% when the transmitted light wasn't used. The use of transmitted light assists in more successful venous cannulation in pediatric patients

Concerning to association between skin color and attempts of cannula insertion, this study showed that, more than one third of study group had fair skin color in 1<sup>st</sup> attempts compare to less than third had fair skin color in 3<sup>rd</sup> attempts. This study accordance with [Yen et al. \(2008\)](#), who founded that, the children with dull skin color, is substantially more troublesome to cannulation, guessed that visualization of veins appears to be valuable when near-infrared light used in pediatrics in whom it is difficult to find the veins with the bare eye and is probable not valuable in children whose veins are obvious.

As regards level of pain, less than two third of the study group had mild pain level during first attempt and less five times of IV cannula insertion compared to more than half of control group had severe pain during first attempt and 5-10 times of IV cannula insertion. This study accordance with [McDermott, et al. \(2019\)](#), who founded that, the pain scores during the venous cannulation were parallel in control and experimental groups. Fear scores inclined to be lower in study group; however, there were no statistically significant. Several failed attempts to accomplish venous access raised pain in children. In the line with this, our study found positively correlation between the pain and fear scores and the number of IV cannulation attempts in the control group. Such correlations were not found in the experimental group.

Meanwhile, this study agreement with [Avelar, et al. \(2013\)](#) and [Ayhan, et al. \(2014\)](#), who founded that the scores of pains were similar in control and study

groups during venous cannulation. The mean fear score value tended to be lesser in experimental group than the control group, but this reduction was not statistically significant. Positive correlation between pain and fear scores and the number of venous cannulations attempts in the control group was found. Positive correlation was also found between the pain score and the time taken for the venous cannulation.

Concerning nurses' total level of knowledge regarding peripheral intravenous cannulation the results of this study showed that, less than half of studied nurses had satisfactory knowledge pre-educational training as compared to post educational training most of them had satisfactory knowledge. This finding was in accordance with that of [Ahlin et al. \(2017\)](#), who founded that the results indicate that the studied sample had adequate knowledge about the preparation and performance of the procedure.

Also, this result was supported by a study done by [Ahmed, \(2016\)](#) who depicted that, more than half of the nurses had a satisfactory knowledge regarding insertion of peripheral intravenous cannulation and its indication.

Moreover, this result concurs with a study done by [George and Muninarayanappa, \(2013\)](#), who showed that most of nurses had average knowledge and good performance regarding ways to prevent of intravenous cannula complications. These results may be due to unsatisfactory level of nurses' knowledge pre intervention. But this figure was changed as the majority of them had the effect of a satisfactory level of knowledge after intervention.

This study accordance with [Ravik, et al. \(2017\)](#), who illustrated that, 75.9 %of nurses have the knowledge about care of intravenous cannulation and 24.1% do not have knowledge. Nurses should have knowledge about this vital procedure in order to prevent risk and complication in the pediatric patient.

This study in accordance with [Abraham, \(2014\)](#) who reported the mean difference in the post-test scores of knowledges between study and control groups was 4.8. This points out an increase scores of knowledges in study group post program. Also founded that 82.47% of the nurses have proper knowledge, 13.21% of the nurses have the wrong knowledge, and 4.32% of nurses have no idea about proper care post intervention. This study accordance with [Heinrichs, et al. \(2013\)](#), the findings showed that, 84.72% of nurses were performance is correct and 82.47% of nurses had proper knowledge.

Moreover, this study consistence with [Avelar, et al. \(2013\)](#), who showed that, nurses had knowledge score in using transparent dressing to recognize infection (100%) and hand hygiene before IV insertion (100%). The research finding contradicted the finding of present study was that nurses also had highest knowledge score in the area of identification of complications of peripheral venous cannula.

Regarding to nurse's total level of performance about peripheral intravenous cannulation the findings of our study revealed that more than half of studied nurses had poor level of performance pre-educational training

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as compared to post educational training, the majority of them had good level of performance this may be due to the effect of intervention on nurses' performance. This finding was to some extent similar to that of [Chang et al. \(2012\)](#) who stated that, measures were generally higher during preparation but low during the actual performance of vein-puncture and intravenous cannulation in the pediatric unit in hospital. But this figure was changed as the majority of them had the good level of performance after intervention.

This study accordance with [Abraham, \(2014\)](#), who founded that 84.72% of the nurses followed the proper performance regarding venous cannulation care, 14.22% nurses did not monitor the proper performance and minority (1.06%) were not confident on their nurses whether they were perform correct or incorrect post intervention. This study accordance with [Ravik, et al. \(2017\)](#), who founded that 83.7 % followed the correct performance of care and maintenance of intravenous cannulation

Also, this study agreement with [Qamar, \(2017\)](#), who illustrated that, the nurses' experience on venous cannulation backed to successful venous cannulation. But less experienced nurses in venous cannulation can also get successful intravenous access without several attempts when using vein-viewing devices.

Meanwhile, this study accordance with [Osti, et al. \(2019\)](#) who reported that, the more the nurses experience, there was 0.18 seconds decreased in the duration for successful venous cannulation (95% CI: -0.67, -0.47, P = .024) in the control group. Whereas the nurses' experience on venous cannulation did not have a main impact duration of insertion ( $\beta$  coefficient 0.04, 95% CI: -0.80, 0.14, P = .59) in experimental group.

### CONCLUSION

The implementation of educational training using a transmitted light device had significantly improve nurses' knowledge and performance and reduce pain level among children undergoing peripheral intravenous cannulation

### RECOMMENDATION

The study recommended that

1. Application of transmitted light device for hospitalized children undergoing peripheral intravenous cannulation.
2. Implementation of educational training would allow pediatric nurses using transmitted light device for hospitalized children undergoing peripheral intravenous cannulation
3. Replication of such study on large and different age group children to be able to generalize the results of the study.
4. Further study can be conducted to find the effectiveness of various strategies on prevention of intravenous cannulation.

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