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Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 202219(2):1084-1097. **OPEN ACCESS**

Effectiveness of simulation based educational intervention on pediatric nurses' practice about tracheal intubation in Covid-19 pediatric Intensive Care Unit

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Nursing interventions have an explicit impact on the clinical pediatric mechanically ventilated children' outcomes. Despite some existing protocols, guidelines and standards, nurses still use it inexpediently in covid-19 pediatric and neonatal patient groups. Therefore, Simulation-based education has been regarded as a tool to cope with the fast changes in care methods and improving nursing professional standards. The present study aimed to investigate the effect of simulation-based education regarding endotracheal intubation on knowledge and practice of pediatric nurses of covid-19 pediatric intensive care unit. A comparative study of intervention and control groups quasi experimental design was used. Pediatric nurses (120) who were working in pediatric intensive care unit of Tanta Main University Hospital, Tanta city, Egypt and pediatric intensive care unit at Damanhour National medical Institute, Buheira, Egypt, who accepted to participate in the study. The simulation education program included online interactive lectures, and skill training, team-based practice. Two tools were utilized for data collection including knowledge test and observational checklist, which were completed before the program, immediate and 3 months after its completion. After simulation program, there was a significant improvement in the nurses' knowledge and clinical proficiency in regard to end tracheal intubation at (P<0.001) in the intervention group, while the control group didn't indicate any statistical differences across the three study periods regarding their total knowledge of intubation scores (p=0.233) Simulation education effectively improved the pediatric nurses' knowledge and clinical competency of the pediatric intubation. Based on this program the participated nurses will educate and transfer information to their colleagues that might advance clinical nursing education.

Keywords: Endotracheal intubation, pediatric nurses, knowledge, clinical practice, , simulation education, Covid-19 PICU.

INTRODUCTION

Pediatric tracheal intubation is often a life-saving procedure for critically ill children. It is an integral part of stabilization and resuscitation. The risks of tracheal intubation are well illustrated in many literatures for children. Skilled multidisciplinary paramedical teams are substantial for safe pediatric intubation management to avoid unwanted tracheal intubation-associated events (TIAEs) such as esophageal intubation, aspiration, or cardiac arrest (Dorman, 2011).

The ultimate goal of nursing is to provide evidence-based care that can improve quality for health care. Many of the established nursing therapies appear to have not been substantiated by solid evidence. One area of concern in nursing is endotracheal intubation, as it is associated by many unwanted events (TIAEs) such as aspiration, hypoxia, arrhythmia, mild and severe bleeding, cardiac arrest, and even death(Hassan, 2018).Nearly fifty percent of children admitted to the intensive care unit need mechanical ventilation and intubation to continue a live (Ebrahimi, Jafarnejad , Sohrabi , Abbasi , Esmaeilian 2020).Which lies more responsibilities on ICU nurses, who in turn are in the forefront battling the Covid-19 virus, particularly during aerosol generating procedures such as intubation (Carter, and Notter, 2020;Goh, et al. 2020).

Psychomotor competences in this skill is considered essential for pediatric nurses training, as defined by the Accredited Commission for Graduate Medical Education (ACGME). The acquisition of this complex skill requires significant continuous training (Kane, Pye, and Jones, 2011). Consequently, it is essential to develop simulation education programs that provide great opportunities for practicing clinical decision-making and high-risk skills without harming any one (Gregory et al. 2020, Myong-Ja et al.2017). Moreover, many reviews showed recently that a simulation education program improved the self-efficacy of nurses; specifically, it improved their confidence towards their ability to acquire theoretical and practical knowledge (Kim, Park, and Shin, 2013; Kim, and Kang, 2016).

In the same line with, Kim and Kang (2015) who demonstrated that a simulation education program for ICU nurses improved their clinical operational performance which could be translated later on clinical settings. However, to the best of the authors' knowledge, studies that assess whether simulated education programs on ETT intubation can increase both the self-efficacy and clinical operational performance of PICU nurses with fewer adverse events have not yet been reported. Therefore, a simulation education program on ETT intubation is expected to enhance ICU outcomes; on the other hand, such programs and literature addressing their effectiveness are scarce. Consequently, the researcher team constructed and applied a simulation educational program that provided pediatric ICU nurses with the opportunity to practice caring for endotracheal intubation safely. It was assessed how the program affected the clinical knowledge and operational performance of the pediatric ICU nurses regarding care of endotracheal intubation.

MATERIALS AND METHODS

The aim of the study is to investigate the effect of simulation-based education regarding care of endotracheal intubation on knowledge and practice of pediatric nurses of pediatric intensive care unit.

The study hypotheses:

Table 1: Hypotheses formulated for the evaluation of the simulation-based education program.

The first hypothesis:	
H_{01}	There is no significant difference between the pre-test and two post- tests scores of the interventional group and the control group in regard to paediatric nurses' knowledge of endotracheal intubation in Covid-19 PICU
H_{A1}	There is a statistical significant difference between the pre-test and two post- tests scores of the interventional group in regard to paediatric nurses' knowledge of endotracheal intubation in Covid-19 PICU
The second hypothesis:	
H_0	There is no significant difference between the pre-test and two post- tests scores of the interventional group and the control group in regard to paediatric nurses' practice of Covid-19 precautionary measures in PICU
H_A	There is significant difference between the pre-test and two post- tests scores of the interventional group in regard to paediatric nurses' practice of Covid-19 precautionary measures in PICU
The third hypothesis:	
H_0	There is no significant difference between the pre-test and two post- tests scores of the interventional group and the control group in regard to paediatric nurses ' practice of care of endotracheal intubation procedure in PICU
H_A	There is significant difference between the pre-test and two post- tests scores of the interventional group in regard to paediatric nurses' practice of endotracheal intubation procedure in PICU

Methods:

Study Design: -

Quasi-experimental design, (interventionand control) comparative study, was adapted throughout the study phases (pre, immediate and three months post-tests) for both interventionand control groups.

Study Setting: -

This study was conducted in pediatric intensive care unit of Tanta Main University Hospital, Tanta city, Egypt and pediatric intensive care unit at Damanhour National medical Institute, Buheira, Egypt**.**

Sample: -

The convenience sample for this study was 120 nurses from total (180) eligible nurses' number who work pediatric intensive care unit of Tanta Main University Hospital, Tanta city, Egypt and pediatric intensive care unit at Damanhour National medical Institute, Buheira, Egypt at the time of the study, randomly assigned60 nurses as study group and the 60 were control group.

Tools for data collection:

Two tools were constructed and utilized by the researchers to collect data relevant to the study. These tools are as follow: I-self-administrated Questionnaire: consists of two parts: - Part-A: Socio-demographic and occupational designed questionnaire was used to collect the demographic and occupational data related to nurses in the study; which involved the following characteristics: nurses' age, qualification, number of years' experience, and previous attendance of training program about tracheal intubation. Part-B: Structured designed knowledge questionnaire was hired to evaluate the nurses' knowledge related to the following: respiratory system' functions; the best rout of intubation, appropriate nursing care for intubated patients, signs of wrong intubation, harbor, high risk group, signs, complications, and prevention of ventilator associated pneumonia. It consists of a reliable and valid questionnaire consists of 6 matching, and 12 multiple choice questions; each question has 3, 4, or more choices, only one is correct. (Theoretical part of the simulation module). II- Structured Observational Checklist was utilized for the practical part of the module which involved precautionary measures for Covid-19 pediatric patients, preparation and steps regarding procedures (practical part of the module) composed of 27 steps of the procedure which adopted. Adopted from **(**Hutching, 2019; Saskatoon Health Region (SHR), 2017) and modified by researchers.

Tools Reliability:

It was established by Cronbach's Alpha to measure internal consistency of the tools, these showed high reliability score for the following:

1-Knowledge questionnaire: 0.80.
2-Observational checklist: 0.92.

Scoring system for the study tools:

A. For observation checklist:

Total score was 27grades; zero degree was given for each wrong or missing step in practice and one degree for each right step in practice; then coding system represented as scoring from (0-20) considered unsatisfactory practice, scoring from (21-27) rated as satisfactory practice (Hassan, 2018; Eskander, Youssef, Morsy, andElfeky, 2013).

B. For knowledge questionnaire sheet:

Total score was 18grades for respiratory system' functions; the best rout of intubation, appropriate nursing care for intubated patients and VAP related questions; zero degree was given for each wrong answer and one degree for each right answer; then coding system represented as scoring from (0-13) for unsatisfactory knowledge level, scoring from (14-18) for nurses have a satisfactory knowledge level **(**Mohammed, Mohamed, Salah, and El-Hosany, 2016; Eskander et al. 2013).

Validity of the tools:

The tools were tested for their content by five pediatric nursing experts to ascertain relevance, completeness, and appropriate time for filling tools.

Pilot Study:

A pilot study was carried out on 12 nurses (6 nurses from each study group) to assess the clarity, feasibility, applicability of the study tools, and the time needed to fill each tool. The needed modifications were done as revealed from the pilot study. The total sample excluded the pilot study sample to ensure the stability of the results.

Field work:

The three collection points, before, immediate and three months after the introduction of the simulation program to allow the researchers to examine the effect of the educational intervention. The intervention and control group were participating in filling the baseline questionnaire and were observed by the structured checklist at day one. then the intervention group only attended the simulation program; followed by two post-tests by questionnaire and checklist done immediately and after 3 months of introduction of the program for both study groups. The study was done by using conveniences sampling technique for selection of the participants depending on the availability of nurses.

Procedure of data collection:

Data were collected throughout a period of the 4-months between Januaryand May-2021. First, classification of nurses into small groups by shift; 5 nurses from each shift, then the nurses were oriented about the objectives of the simulation. For teaching sessions: short online interactive lectures and group discussions supported by audio-visual aids as illustrated simulated videos about pediatric intubation; were conducted for only the intervention group. Each session lasted (60) minutes, were dived as (30) minutes for theoretical part and (30) minutes for presenting the simulated video. Twelve sessions were covered in the first month, were divided into (3) sessions per week, and were implemented on morning shift nurses. Continuous feedback and communication were obtained to clear any misunderstanding, and to reinforce learning for these sessions. Nurses were evaluated by post-tests immediately after the pretest and by 12 weeks from the intervention.

Ethical considerations:

1-An official letters were issued to the directors of the two hospitals and to the heads of each unit, and then approval for carrying out the study were obtained after explaining the aim of the study.

2-All potential nurses who participate in this study was given verbal information individually about the study and informed of their rights. The participants were assured that their work progress would not be affected by their decision to participate, or not participate, in the research study. The researchers were provided ongoing support during the simulation program.

3-Opportunities were assured for the study participants to ask questions at any time, and the researchers were freely available to answer all participants' questions related to scope of the study.

4-All nurses were assured about the confidentiality of their responses. All collected information would be kept in close cabinet, and would be closed to anyone other than the researchers.

Statistical analysis:

The collected data were coded and entered to the statistical package of social sciences (SPSS) version 20. After data entry, The information was verified for detecting any errors or missing, finally, it was analyzed and interpreted by the same program.

The following statistical measures were utilized:

1-Descriptive measures for presenting frequency tables with percentages. Qualitative data was presented as number and percent. Besides, Quantitative data were described as median with minimum and maximum as appropriate

2-The study data were tested for normality by Kolmogorov-Smirnov test. For not normally distributed variables, Friedman test was hired to indicate an actual difference between more than two related groups. Mann-Whitney U test was done to test the difference of the target group knowledge and observed practice categories mean ranks between the intervention and control groups' variables.

The designed-training module:

Contents of the simulation-based education program on pediatric intubation.

The learning objectives	The simulation content
Theoretical part (30) minutes duration	
The pediatric ICU nurses will be able to: Understand the anatomical parts of the respiratory system.	**Online interactive lecture:** Using visual materials, such as photographs and a simple video, on education topics, including the concept, indications of intubation, universal precautions for Covid-19 algorithm, rapid sequence intubation, signs of intubation failure, and the available devices of intubation management, the ventilator associated pneumonia concept, signs , harbours, complications, and prevention of it.
Mention the concept of pediatric intubation.	
Discuss the indications of pediatric intubation.	
Illustrate the best rout of Intubation.	
Discuss the appropriate precautionary measures for Covid-19 intubated patients	
Enumerate the signs of intubation failure.	
List Harbors of ventilator associated pneumonia	
Specify signs, and complications of ventilator associated pneumonia	
Illustratethe preventive measures of ventilator associated pneumonia	
Practical part (30) minutes duration	
The pediatric ICU nurses will be able to: Demonstrate the appropriate steps of wearing the precautionary measures for Covid-19 patients.	Established to resemble a standard intensive care unit setting Practical training: the educator present video on: **A.** The precautionary measures for Covid-19 patients(**Level 3 protection process**). **B.** The standardized sequence of paediatric intubation: How to adapt in intubation situation (monitor vital signs, nursing management steps in case of intubation)

3-The Pearson Chi-Square test was used to check if there a significant difference in the percentages between the study variables and whether the variables are independent of each other or not.

4-All tests were performed at a level of significance (P-value) equal or less than 0.05 It was determined that the difference was statistically significant.

RESULTS

Table (1): indicates that there was homogeneity on all tested characteristics between the two groups of nurses who participated at baseline assessment. As Chi square test shows no significant difference to each other in terms of age, qualification, experience years, and previous training attendance of program about intubation. Mean age and work experience of the participants, respectively, were 34.70 (7.40) and 9.08 (3.21) years. Regarding qualification, slightly less than half of them (46.7%) were technical nursing institute. Concerning previous attendance of training program, majority of the study participants (82.5%) hadn't attended any training courses about tracheal intubation.

Table (2, 3): Friedman results presented very highly statistical improvements in intervention group (P ≤0.001) regarding the different intubation and VAP related items (respiratory system' functions, the best rout, indications and precautionary measures, signs of wrong place of intubation, besides, the most common entry, harbor, high risk group, complication, prevention of VAP and ventilator bundle), , (P=0.964)for precautionary measures, (P=0.486) incomparability with the control group results didn't show any statistically differences at the three study periods at(P= 0.746)for respiratory system' functions, (P=0.834)for best intubation rout,(P=0.764) for intubation indications regarding signs of wrong intubation, (P=0.200)for most common entry of VAP, (P=0.568)for VAP harbor, (P=0.589)for VAP high risk group , (P =0.692)for VAP complications, (P=0.607) for prevention of VAP, (P=0.738) for ventilator bundle.

To ascertains the previous results, the researchers used Chi square to show if there were differences in percentage of PICU nurses' knowledge items in the intervention group to the control group at three study evaluation tests. Because there was no statistical difference between the two groups, this strategy made the two groups equivalent in regard to all the previous mentioned knowledge items at the pretest stage (P=0.503, P =0.850, P=0.056, P=0.57, P=0.264, P=0.852, P=0.361, P=1.00, P=0.715, P=0.194, P=0.409, except for intubation indication (P ≤0.001). Concerning the immediate and 3 months post-tests results, there were highly statistically unexpectedly differences between the two groups, at (P <0.001) about all the previous knowledge items.

Table (4, 5, 6 and7):Friedman results presented unexpectedly highly statistical improvements in intervention group(P ≤0.001)regarding the endotracheal intubation procedure related items (preparatory phase of the procedure, precautionary measures for Covide-19, and all the procedure steps), in contrast the control group

results didn't indicate any statistically differences at the three study phases. To realize the previous results, the researchers used Chi square to show if there were differences in percentage of PICU nurses' practice intubation steps in the intervention group to the control group at three study periods. This method made the two groups comparable as there were no statistical difference between the two groups in regard to all the intubation procedure steps at the pretest stage (P>0.05).

Regarding the immediate test and 3 months follow up results, there were highly statistically differences between both groups, at (P <0.001) about all the procedure steps starting from the preparatory phase, to the precautionary measures of Covid-19, besides the remaining steps of the procedure.

Table (8): shows that there was no significant variation between the intervention and control groups' knowledge and practice scores at baseline level (p=0.746, (p=0.312) respectively when compared by Mann Whitney test. However, very highly significant differences were detected immediately and after three months post simulation training (P<0.001). More ever, Friedman results indicated very highly significant improvements of the intervention group' knowledge and observed practice scores (P < 0.001). In contrast, the control group didn't show any statistically significant differences regarding their knowledge scores (p=0.233) about tracheal intubation**.**

Table 1: Socio-demographic and occupational characteristics of the studied pediatric ICU nurses:

Demographic and occupational characteristics	**Paediatric nurses N =120**						P- value
	Intervention N=(60)		Control N= (60)		Total N= (120)		
	No.	%	No.	%	No.	%	
Age							
20-<30ys	19	31.7	18	30	37	30.8	0.201
30-<40ys	29	48.3	26	43.3	55	45.8	
40-<50ys	12	20	16	26.7	28	23.3	
Mean ±SD	34.31±7.24		35.10±7.61		34.70±7.40		
Qualification							
Diploma of nursing	9	15	15	25	24	20	0.077
Technical Nursing Institute	31	51.7	25	41.7	56	46.7	
Bachelor of nursing	20	33.3	20	33.3	40	33.3	
Experience years							
5-<10ys	50	83.3	40	66.7	90	75	0.221
≥10 ys	10	16.7	20	33.3	30	25	
Mean ±SD	8.50±2.97		9.66±3.8034		9.08±3.21		
Previous attendance of training program about tracheal intubation							
Yes	7	11.7	14	23.3	21	17.5	0.194
No	53	88.3	46	76.7	99	82.5	

Table 2: Percentage comparison between the Intervention and control group according to the response to intubation knowledge items pre, immediate, 3 months post education

Knowledge items	Pediatric Nurses No=120																
	Intervention group (N=60)						Test of significance	Control group (N=60)						Test of significance	(Intervention vs Control group)		
	Pre		Immediate Post		3 months post			Pre		Immediate Post		3 months post					
	Incorrect %	Correct %	Incorrect %	Correct %	Incorrect %	Correct %		Incorrect %	Correct %	Incorrect %	Correct %	Incorrect %	Correct %		Pre	Immediate post	3 months post
Respiratory system' functions	78.3	21.7	11.7	88.3	16.7	83.3	χ^2=52.84, p<0.001	86.7	13.3	88.3	11.7	81.7	18.3	χ^2=0.585 , p=0.746	χ^2=4.33, p=0.503	χ^2=72.4, p<0.001	χ^2=54.50, p<0.001
The best rout of Intubation	63.3	37.7	30	70	30	70	χ^2=23.52, p<0.001	61.7	38.3	61.7	38.3	58.3	41.7	χ^2=0.364, p=0.834	χ^2=0.036, p=0.850	χ^2=12.1, p<0.001	χ^2=9.76, p<0.002
Indications of the e intubation	90	10	63.3	36.7	63.3	36.7	χ^2=19.69, p<0.001	55	45	50	50	53.3	46.7	χ^2=0.538, p=0.764	χ^2=18.43, p=0.001	χ^2=2.17, p=0.141	χ^2=1.23, p=0.267
Precautionary measures for Covid-19 Intubated patients	70	30	20	80	20	80	χ^2=40.90, p<0.001	65	35	66.7	33.3	65	35	χ^2=0.074, p=0.964	χ^2=0.342 , p=0.0559	χ^2=26.6, p<0.001	χ^2=24.85, p<0.001
Signs of wrong intubation place	38.3	61.7	5	95	5	95	χ^2=40.0, p<0.001	43.3	56.7	48.3	51.7	41.7	58.3	χ^2=1.444, p=0.486	χ^2=0.310, p=0.577	χ^2=28.8, p<0.001	χ^2=22.54, p<0.001
The most Common entry for VAP microbes	55	45	5	95	5	95	χ^2=60.0, p<0.001	65	35	70	30	58.3	71.7	χ^2=3.21, p=0.200	χ^2=1.25, p=0.264	χ^2=54.0 , p<0.001	χ^2=39.43, p<0.001
The harbor for VAP bacteria	61.7	38.3	36.7	63.3	36.7	63.3	χ^2=11.53, p<0.003	60	40	65	35	66.7	33.3	χ^2=1.13, p=0.568	χ^2=0.035, p=0.852	χ^2=9.63, p=0.002	χ^2=10.81, p<0.001

Table 3: Percentage comparison between the Intervention and control group according to the response to intubation knowledge items pre, immediate, 3 months post education (continued):

Knowledge items	Pediatric Nurses No=120															
	Intervention group (N=60)						Test of significance	Control group (N=60)						Test of significance	(Intervention vs Control group)		
	Pre		Immediate Post		3 months post			Pre		Immediate Post		3 months post					
	Correct %	Incorrect %	Correct %	Incorrect %	Correct %	Incorrect %		Correct %	Incorrect %	Correct %	Incorrect %	Correct %	Incorrect %		Pre	Immediate post	3 months post
High risk group for VAP	53.3	46.7	13.3	86.7	13.3	86.7	χ^2=36.0, p<0.001	45	55	45	55	50	50	χ^2=1.05, p=0.589	χ^2=0.834, p=0.361	χ^2=14.5, p<0.001	χ^2=18.63, p≤0.001
Signs of VAP on critically ill patients	46.7	53.3	5	95	5	95	χ^2=40.32, p<0.001	46.7	53.3	50	50	41.7	58.3	χ^2=1.31, p=0.519	χ^2=0.00, p=1.00	χ^2=30.4, p<0.001	χ^2=22.54, p<0.001
Complication of VAP	46.7	53.3	3.3	96.7	11.7	88.3	χ^2=33.58, p<0.001	50	50	55	45	51.7	48.3	χ^2=0.737, p=0.692	χ^2=0.133, p=0.715	χ^2=38.7, p<0.001	χ^2=22.18, p<0.001
Prevention of VAP	53.3	46.7	13.3	86.7	13.3	86.7	χ^2=36.0, p<0.001	65	35	61.7	38.3	58.3	41.7	χ^2=1.00, p=0.607	χ^2=1.69, p=0.194	χ^2=29.9, p<0.001	χ^2=26.42, p<0.001
Definition of ventilator bundle	76.7	23.3	5	95	5	95	χ^2=75.46, p<0.001	70	30	65	35	68.3	31.7	χ^2=0.609 , p=0.738	χ^2=0.682, p=0.409	χ^2=47.47, p<0.001	χ^2=51.81, p<0.001
The management of a failed intubation	43.3	56.7	----	100	----	100	χ^2=52.00 , p<0.001	46.7	53.3	43.3	56.7	43.3	56.7	χ^2=0.364, p=0.834	χ^2=0.135, p=0.714	χ^2=33.19, p<0.001	χ^2=33.19, p<0.001

Table 4: Percentage comparison between Intervention and control group according to their observed practice related to precautionary measures of endotracheal tube (ETT) care pre, immediate, 3 months post education (N=120):

Checklist items about endotracheal tube care	Intervention group(N=60)						Test of significance	Control group (N=60)						Test of significance	(Intervention vs Control group)		
	Pre		Immediate Post		3 months Post			Pre		Immediate Post		3 months post			Pre	Immediate post	3 months post
	Not Done	Done	Not Done	Done	Not Done	Done		Not Done	Done	Not Done	Done	Not Done	Done				
	%	%	%	%	%	%		%	%	%	%	%	%				
Endotracheal tube (ETT) preparation																	
Check physician's orders and take consent.	70	30	45	55	45	55	χ^2=19.56, p<0.001	73.3	26.7	73.3	26.7	73.3	26.7	χ^2=00, p=1.00	χ^2=0.164, p=0.685	χ^2=9.96, p=0.002	χ^2=9.96, p=0.002
Prepare a resuscitation bag and equipment.	55	45	----	100	----	100	χ^2=66.00, p<0.001	48.3	51.7	51.7	48.3	53.3	46.7	χ^2=0.560, p=0.756	χ^2=0.534, p=0.465	χ^2=41.79, p<0.001	χ^2=43.63 , p<0.001
Preparatory precautions measures for Covid-19 intubation (Following the recommended Level 3 protection process) in this sequential order																	
Starting with hand disinfection, followed by head cap	86.7	13.3	----	100	----	100	χ^2=104, p<0.001	78.3	21.7	78.3	21.7	86.7	13.3	χ^2=4.54, p=0.103	χ^2=1.44, p=0.230	χ^2=77.26, p<0.001	χ^2=91.76, p<0.001
Wearing protective mask N95 1860 , and surgical one	83.3	16.7	51.7	48.3	60	40	χ^2=23.28, p<0.001	91.7	8.3	93.3	6.7	86.7	13.3	χ^2=2.600, p=0.273	χ^2=1.90, p=0.168	χ^2=26.12, p<0.001	χ^2=10.90, p<0.001
Followed by wearing isolation gown, then disposable latex gloves	60	40	35	65	35	65	χ^2=13.63, p<0.001	70	30	70	30	63.3	36.7	χ^2=1.600, p=0.449	χ^2=1.31, p=0.251	χ^2=14.73, p<0.001	χ^2=9.63, p<0.001
Followed by wearing goggles, then protective clothing	53.3	46.7	53.3	46.7	55	45	χ^2=0.118, p=0.943	55	45	56.7	43.3	56.7	43.3	χ^2=0.11, ,p=0.951	χ^2=0.034, p=0.855	χ^2=0.135, p=0.714	χ^2=0.034 , p=0.854
Followed by wearing the 2nd disposable latex gloves, then shoe covers	38.3	61.7	----	100	----	100	χ^2=46.0, p<0.001	45	55	48.3	51.7	43.3	56.7	χ^2=0.667, p=0.717	χ^2=0549, p=0.459	χ^2=38.24 , p<0.001	χ^2=33.19 , p<0.001
Followed by wearing the 2nd disposable gown , then 3rd disposable latex gloves.	53.3	46.7	----	100	----	100	χ^2=64.0, p<0.001	56.7	43.3	58.3	41.7	58.3	41.7	χ^2=0.1, p=0.951	χ^2=0.135, p=0.714	χ^2=49.41, p<0.001	χ^2=49.41, p<0.001

Table 5: Percentage comparison between Intervention and control group according to their observed practice related to endotracheal tube (ETT) care pre, immediate, 3 months post education (N=120):

Checklist items about endotracheal tube (ETT) care	Intervention group(N=60)						Test of significance	Control group (N=60)						Test of significance	(Interventionvs. Control group)		
	Pre		Immediate Post		3 months Post			Pre		Immediate Post		3 months post			Pre	Immediate post	3 months post
	Not Done	Done	Not Done	Done	Not Done	Done		Not Done	Done	Not Done	Done	Not Done	Done				
	%	%	%	%	%	%		%	%	%	%	%	%				
Endotracheal tube (ETT) care procedure																	
Cut suitable length of ETT	25	75	----	100	----	100	χ^2=30.00 , p≤0.001	30	70	36.7	63.3	30	70	χ^2=1.68, p=0.431	χ^2=0.376, p=0.540.	χ^2=26.93, p<0.001	χ^2=21.17, p<0.001
Raise bed, and Lower side rails on working sideof bed.	51.7	48.3	5	95	5	95	χ^2=46.11, p<0.001	65	35	68.3	31.7	55	45	χ^2=4.52, p=0.104	χ^2=2.19, p=0.139	χ^2=51.81 , p<0.001	χ^2=35.71, p<0.001
Explain Procedure to patient	56.7	43.3	10	90	11.7	88.3	χ^2=50.46.0, p<0.001	55	45	61.7	38.3	60	40	χ^2=0.1.18, p=0.554	χ^2=0.034, p=0.854	χ^2=34.82, p<0.001	χ^2=30.48, p<0.001
Place patient in correct position	53.3	46.7	----	100	----	100	χ^2=64.0, p<0.001	56.7	43.3	58.3	41.7	58.3	41.7	χ^2=0.1, p=0.951	χ^2=0.135, p=0.714	χ^2=49.41, p<0.001	χ^2=49.41 , p<0.001

Table 6: Percentage comparison between Intervention and control group according to their observed practice related to endotracheal tube (ETT) care pre, immediate, 3 months post education (continued….)N=120:

Checklist items About endotracheal tube (ETT) care	Intervention group (N=60)						Test of significance	Control group (N=60)						Test of significance	(Interventionvs Control group)		
	Pre		Immediate Post		3 months Post			Pre		Immediate Post		3 months post			Pre	Immediate post	3 months post
	Not Done	Done	Not Done	Done	Not Done	Done		Not Done	Done	Not Done	Done	Not Done	Done				
	%	%	%	%	%	%		%	%	%	%	%	%				
Endotracheal tube (ETT) care procedure																	
Auscultate lung sounds both right and left side.	41.7	58.3	----	100	----	100	χ^2=50.0 , p<0.001	33.3	66.7	30	70	36.7	63.3	χ^2=1.04, p=0.593	χ^2=0.889, p=0.346	χ^2=21.17, p<0.001	χ^2=2693, p<0.001
Observe ETT fixed number before removing tape.	55	45	----	100	----	100	χ^2=66.0, p<0.001	58.3	41.7	50	50	50	50	χ^2=2.17, p=0.337	χ^2=0136, p=0.713	χ^2=40.0, p<0.001	χ^2=40.00, p<0.001
Remove an oral airway.	30	70	---	100	----	100	χ^2=36.0, p<0.001	30	70	26.7	73.3	25	75	χ^2=0.70, p=0.705	χ^2=0.00, p=1.00	χ^2=18.46, p<0.001	χ^2=17.14, p<0.001
place oral n a bowl of hydrogen peroxide	60	40	71.7	28.3	71.7	28.3	χ^2=6.53, p=0.038	71.7	28.3	65	35	56.7	43.3	χ^2=5.54 , p=0.062	χ^2=1.81, p=0.178	χ^2=.616, p=0.432	χ^2=2.93, p=0.08
perform oral hygiene	78.3	21.7	----	100	1.7	98.3	χ^2=92.04, p<0.001	80	20	76.7	23.3	70	30	χ^2=2.54, p=0.280	χ^2=0.051, p=0.822	χ^2=74.59, p<0.001	χ^2=60.92, p<0.001
Cut the old ETT tie carefully,	36.7	63.3	----	100	----	100	χ^2=44.0, p<0.001	48.3	51.7	48.3	51.7	43.3	56.7	χ^2=0.720, p=0.698	χ^2=1.67, p=0.196	χ^2=38.24, p<0.001	χ^2=33.19, p<0.001
Secure the ETT using new ETT tie	30	70	----	100	----	100	χ^2=36.0, p<0.001	43.3	56.7	38.3	61.7	30	70	χ^2=4.45, p=0.108	χ^2=2.29, p=0.130	χ^2=28.45, p<0.001	χ^2=21.17, p<0.001
Clean the oral airway and rinse it,	53.3	46.7	----	100	1.7	98.3	χ^2=60.18, p≤0.001	61.7	38.3	55	45	53.3	46.7	χ^2=1.82, p=0.401	χ^2=0.853, p=0.356	χ^2=45.51, p<0.001	χ^2=40.16, p<0.001
Reinsert the oral airway gently and correctly.	26.7	73.3	----	100	----	100	χ^2=32.0 p<0.001	41.7	58.3	38.3	61.7	28.3	71.7	χ^2=4.160, p=0.125	χ^2=3.00, p=0.08	χ^2=28.45, p<0.001	χ^2=19.80, p<0.001

Table 7: Percentage comparison between Intervention and control group regarding their observed practice related to endotracheal tube (ETT) care pre, immediate, 3 months post education (continued….)N=120:

Checklist items about endotracheal tube (ETT) care	Intervention group (N=60)						Test of significance	Control group (N=60)						Test of significance	(Intervention vs Control group)		
	Pre		Immediate Post		3 months Post			Pre		Immediate Post		3 months post			Pre	Immediate post	3 months post
	Not Done	Done	Not Done	Done	Not Done	Done		Not Done	Done	Not Done	Done	Not Done	Done				
	%	%	%	%	%	%		%	%	%	%	%	%				
Endotracheal tube (ETT) care procedure																	
Re – auscultate lung sounds, and assess the patient's respiratory and cardiac status.	16.7	83.3	----	100	----	100	χ^2=20.0, p<0.001	21.7	78.3	16.7	83.3	26.7	73.3	χ^2=3.176, p=0.204	χ^2=484, p=0.487	χ^2=10.90, p<0.001	χ^2=18.46, p≤0.001
secure the endotracheal tube in place	---	100	----	100	3.3	96.7	χ^2=4.0, ,p=0.135	----	100	3.3	96.7	1.7	98.3	χ^2=3.00, p=0.223	NA	χ^2=2.03, p=0.154	χ^2=0.342, p=0.559
Reposition the client, Lower bed, and raise side rails.	53.3	46.7	48.3	51.7	70	30	χ^2=9.58, p=0.008	56.7	43.3	53.3	46.7	51.7	48.3	χ^2=0.609, p=0.738	χ^2=0.135, p=0.714	χ^2=3.00, p=0.584	χ^2=4.232, p=0.040
Dispose equipment.	21.7	78.3	----	100	6.7	93.3	χ^2=16.62, ,p<0.001	30	70	25	75	26.7	73.3	χ^2=0.737, p=0.692	χ^2=1.08, p=0.297	χ^2=17.14, p<0.001	χ^2=8.64, p=0.003
Remove third pair of gloves immediately after intubation.	60	40	----	100	6.7	93.3	χ^2=9.52, p=0.009	71.7	28.3	63.3	36.7	58.3	41.7	χ^2=3.92, p=0.141	χ^2=1.81, p=0.178	χ^2=50.41, p<0.001	χ^2=30.12, p<0.001
Hand disinfection	53.3	46.7	10	90	11.7	88.3	χ^2=36.16, p<0.001	45	55	35	65	45	55	χ^2=2.57, p=0.276	χ^2=0.834, p=0.361	χ^2=10.75, p<0.001	χ^2=16.41, p<0.001

Table 8: Comparison between intervention and control group according to the total knowledge and observed practice level toward pediatric intubation pre, immediate, 3 months post education (No=120):

Items	Intervention group (N=60)						Friedman test	Control group (N=60)						Friedman test	(Intervention vs Control group)		
	Pre		Immediate Post		3 months Post			Pre		Immediate Post		3 months post			Pre	Immediate post	3 months post
	No.	%	No.	%	No.	%		No.	%	No.	%	No.	%				
Total knowledge level																	
Unsatisfactory knowledge	59	98.3	3	5	4	6.7	χ^2=91.34, p<0.001	57	95	57	95	58	96.7	χ^2=2.91, p=0.233	U=1739, p=0.746	U=122.5, p<0.001	U=129.5 , p<0.001
Satisfactory knowledge	1	1.7	57	95	56	93.3		3	5	3	5	2	3.3				
Median (Min-Max)	8(5-15)		16(8-17)		15.5(8-17)			8(4-16)		8(5-16)		9(5-15)					
Total observed practice level																	
Unsatisfactory practice	50	83.3	2	3.3	6	10	χ^2=104, p<0.001	55	91.7	58	96.7	52	86.7	χ^2=8.56, p=0.014	U=1609, p=0.312	U=23.5, p<0.001	U=39.5, p<0.001
Satisfactory practice	10	16.7	58	96.7	54	90		5	8.3	2	3.3	8	13.3				
Median (Min-Max)	14(5-24)		22.5(19-27)		22(17-27)			13.5(5-24)		14(4-24)		14(5-25)					

Friedman test (was applied in case the assumption of normality or homogeneity of variances is not met).
χ^2: chi square of Friedman test
U: Mann-Whitney
P: Significance. * Significant (p≤ 0.05).

DISCUSSION

Table (1): indicates that there was homogeneity on all tested characteristics between the two groups of nurses who participated at baseline assessment. As Chi square test shows no significant difference to each other in terms of age, qualification, experience years, and previous training attendance of program about intubation. Mean age and work experience of the participants, respectively, were 34.70 (7.40) and 9.08 (3.21) years. Regarding qualification, slightly less than half of them (46.7%) were technical nursing institute. Concerning previous attendance of training program, majority of the study participants (82.5%) hadn't attended any training courses about tracheal intubation.

Table (2, 3):Friedman results presented very highly statistical improvements in intervention group(P ≤0.001)regarding the different intubation and VAP related items (respiratory system' functions, the best rout, indications and precautionary measures, signs of wrong place of intubation, besides, the most common entry, harbor, high risk group, complication, prevention of VAP and ventilator bundle), incomparability with the control group results didn't show any statistically differences at the three study periods at(P= 0.746)for respiratory system' functions, (P=0.834)for best intubation rout,(P=0.764) for intubation indications, (P=0.964)for precautionary measures, (P=0.486)regarding signs of wrong intubation, (P=0.200)for most common entry of VAP, (P=0.568)for VAP harbor, (P=0.589)for VAP high risk group , (P =0.692)for VAP complications, (P=0.607) for prevention of VAP, (P=0.738) for ventilator bundle.

To ascertains the previous results, the researchers used Chi square to show if there were differences in percentage of PICU nurses' knowledge items in the intervention group to the control group at three study evaluation tests. Because there was no statistical difference between the two groups, this strategy made the two groups equivalent in regard to all the previous mentioned knowledge items at the pretest stage (P=0.503, P =0.850, P=0.056, P=0.57, P=0.264, P=0.852, P=0.361, P=1.00, P=0.715, P=0.194, P=0.409, except for intubation indication (P ≤0.001). Concerning the immediate and 3 months post-tests results, there were highly statistically unexpectedly differences between the two groups, at (P <0.001) about all the previous knowledge items.

Table (4, 5, 6 and7):Friedman results presented unexpectedly highly statistical improvements in intervention group(P ≤0.001)regarding the endotracheal intubation procedure related items (preparatory phase of the procedure, precautionary measures for Covide-19, and all the procedure steps), in contrast the control group results didn't indicate any statistically differences at the three study phases. To realize the previous results, the researchers used Chi square to show if there were differences in percentage of PICU nurses' practice intubation steps in the intervention group to the control group at three study periods. This method made the two groups comparable as there were no statistical difference between the two groups in regard to all the intubation procedure steps at the pretest stage (P>0.05). Regarding the immediate test and 3 months follow up results, there were highly statistically differences between both groups, at (P <0.001) about all the procedure steps starting from the preparatory phase, to the precautionary measures of Covid-19, besides the remaining steps of the procedure.

Table (8): shows that there was no significant variation between the intervention and control groups' knowledge and practice scores at baseline level (p=0.746, (p=0.312) respectively when compared by Mann Whitney test. However, very highly significant differences were detected immediately and after three months post simulation training (P<0.001). More ever, Friedman results indicated very highly significant improvements of the intervention group' knowledge and observed practice scores (P < 0.001). In contrast, the control group didn't show any statistically significant differences regarding their knowledge scores (p=0.233) about tracheal intubation.

CONCLUSION

Pediatric tracheal intubation simulation based educational intervention was associated with an improvement in PICU nurses proficiency and intubation knowledge, first or overall success of the intervention group. Simulation-based education should be calibrated to the desired provider and team competence targets. The concept of maintenance of skills by simulation refresher training should be used when baseline competence level of nurses is sufficient. Future studies with simulation-based educational intervention should vigorously evaluate the effect on operational performance and outcomes in other clinical settings.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEDGEMENT

The research team appreciate all the nurses who participated in the study and thank all for their time and active participation. Also the researcher appreciate the editing work for the paper by Asmaa A.

AUTHOR CONTRIBUTIONS

SMH designed and wrote the manuscript.in addition data collection and analysis. NGA reviewed the manuscript. All authors read and approved the final version.

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