

Effect of evidence based recommendations about open endotracheal suctioning on nurses' performance at neonatal intensive care units

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Abstract

Background: Endotracheal-suctioning is probably one of the most common invasive procedures performed in neonates with an artificial airway. **Aim:** Evaluate the impact of evidence based recommendations about open endotracheal tube suctioning on nurses' performance in neonatal intensive care units. **Design:** A quasi-experimental design was used. **Setting:** The study was conducted at neonatal intensive care unit of Suez Canal University hospital and neonatal intensive care unit of Ismailia Medical Complex Hospital **Subjects:** A convenience sampling of 60 nurses from the previous mentioned settings. **Tools:** Two tools were used to collect data (pre and post training) **Tool (1):** Structure interviewed schedule to assess nurses' knowledge related to open endotracheal suctioning, **Tool (2):** Observation checklist to assess nurses' practice regarding evidence based recommendations related to open endotracheal suctioning. **Results:** Revealed that, statistically significant improvement in the knowledge and practices of the studied nurses regarding endotracheal suction post implementation of the training than pre-implementation. Also, there was a positive correlation between total nurses' knowledge and practices post implementation of the educational training. **Conclusion:** Studied nurses' total knowledge and practice scores regarding endotracheal suction were improved post-implementation of the training recommendations than pre-training implementation. **Recommendations:** The study, emphasized on the importance of continuous training programs for pediatric nurses regarding endotracheal suction and importance of evidence based guidelines to be announced in neonatal intensive care units.

Keywords: Endotracheal suction, Evidence based recommendations & Nurses' performance

Introduction

Endotracheal-suctioning (ETS) is probably one of the most common invasive procedures performed in neonates with an artificial airway (Hu et al., 2019). Endotracheal suction is essential for neonates with an endotracheal tube (ETT), its primary aim being the removal of secretions and prevention of obstruction of the patient's airway (Tume & Copnell, 2015). Failure to clear secretions can result in an obstructed or occluded ETT, which if untreated, will impair oxygenation and ventilation and gas exchange, potentially resulting in cardiopulmonary arrest (Schults et al., 2019). Although essential, ETS has established adverse effects including bradycardia, atelectasis, hypertension, hypoxemia, and cardiac arrest, and the risk of these complications may be increased in high-risk neonates (Schults et al., 2020). There are two methods of endotracheal suctioning based on the selection of catheter: open and closed suction. The open suctioning technique requires disconnecting the neonate from the ventilator, while the closed suctioning technique involves attachment of a sterile closed, in-line suction catheter to the ventilator circuit, which allows passage of a suction catheter through the artificial airway without disconnecting the neonate from the ventilator (Volsko

et al., 2021). Also; there are also 2 methods of suctioning based on the catheter suction depth selected during the procedure: deep and shallow suction. Deep suctioning is defined as the insertion of a suction catheter until resistance is met, followed by withdrawal of the catheter by 1 cm before application of negative pressure, and shallow suctioning as the insertion of a suction catheter to a predetermined depth, usually the length of the artificial airway plus the adapter (Morrow & Argent, 2008).

Intubated neonates often have an increased production of mucous and weakened ability to clear airway secretion which may pose some risks to the neonate including pneumonia and atelectasis (Day et al., 2015). Therefore, ETS is a life-saving procedure to enhance clearance of respiratory tract secretion, improve oxygenation and prevent atelectasis (Spears et al., 2015). Despite of ETS being a necessary procedure to neonates, if the procedure is not performed with correct techniques, it can lead to serious complications, such as bleeding, infection, hypoxia, bronchoconstriction, atelectasis, increase in intra-cranial pressure, cardiac arrest and sudden death (Haniffa et al., 2017). Since the procedure can cause harm to the neonate if it is done incorrectly, therefore; it is important that neonatal intensive care nurses have

the necessary knowledge and skills based on valid scientific evidence in performing ETS and aspects related to it (Kol et al., 2017).

Unsafe endotracheal suction practices remain the problem worldwide. Although scientific evidence for the safe and efficient accomplishment of endotracheal suction is available, many of these recommendations have not been observed in neonatal nurses' clinical practice, perhaps due to poor knowledge about this procedure (Schults et al., 2019). Different evidence has shown that neonatal nurses often perform procedures traditionally and routinely, regardless of established ETS evidence-based recommendations. That indicates the existence of gaps between scientific knowledge and common practice (Ntoumenopoulos et al., 2018).

The reasons identified for neonatal nurses not to incorporate the recommendations in to clinical practice may include: resistance to change, little support from managers, lack of training, lack of ease access to the literature, and lack of time to read and understand the literature, competing workload pressures, poor change management process and lack of access to guidelines (Heidari & Shahbazi, 2017). As a crucial procedure, if ETS is not performed with correct techniques, it will lead to numerous adverse effects, such as tracheobronchial edema, ulceration, and denudation of the epithelium. These areas of mucosal damage increase the risk of infection and bleeding (Mwakanyanga et al., 2018).

Therefore, it is essential for pediatric nurses to have updated knowledge on the evidence-based practices of ETS so that they can perform the procedures scientifically and thereby reduce neonates' complications and potential risks (Leddy & Wilkinson, 2015). Clinical practice guidelines are "systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances" (Zeb et al., 2017). Guidelines provide clinicians trustworthy recommendations and can be used to reduce inappropriate practice variations and promote the delivery of high-quality care (Negro et al., 2014). Therefore, the current study was carried out to evaluate the effect of evidence based recommendations about open endotracheal tube suctioning on nurses' performance at neonatal intensive care units.

Significance of the study:

Endotracheal suctioning is a complex procedure and numerous attendant risk and complication may be associated with it. Endotracheal tube complications increase morbidity, hospital cost and mortality of trauma. By backing to the hospital records the researchers found that, the prevalence of neonates

who were connected with mechanical ventilator and therefore undergone endotracheal tube suctioning were 280 cases in the last year, this number was large in relation to the total number of cases which was admitted to the neonatal intensive care unit by the same year that was 1250 cases.

Neonates who require intubation during neonatal intensive care unit stay, makes the health care providers do great efforts to decrease the incidence of this complication. They should have the knowledge, good practice and be skillful in dealing with these complications. Therefore, the present study was conducted to improve the nurses' knowledge and practice regarding endotracheal suctioning at neonatal intensive care units in the light of implementing evidence based recommendations for endotracheal suctioning.

Aim of the study was to:

Evaluate the Effect of evidence based recommendations about open endotracheal tube suctioning on nurses' performance at neonatal intensive care units.

Research hypothesis:

Pediatric nurses who participated in the current study are expect to have higher mean score in their knowledge and practices related to open endotracheal suctioning following completion of the study at the post-intervention evaluation than the pre intervention.

Research Design:

A quasi-experimental (one group pre and post) research design was used in the present study.

Subject and Method

Setting: This study was conducted at neonatal intensive care unit of Suez Canal University hospital and neonatal intensive care unit of Ismailia Medical Complex Hospital in Ismailia City.

Subjects: A convenience sampling of 60 nurses (28 nurses working at Suez Canal University Hospitals and 32 nurses working at Ismailia Medical Complex). They were recruited in the study regardless of their gender, educational level and years of experience.

Tools of data collection: Two tools were used to collect the required data as the following:

Tool 1: Structure interviewed questionnaire: The researchers developed this tool based on related evidence-based recommendations to assess nurses' knowledge related to open endotracheal suctioning in simple Arabic language to suit the understanding of the study subjects and to gather the required data. It composed of two parts as the following: **The First part** Nurses' Socio demographic data which developed by the researchers and involved the characteristics of the studied nurses as age, level of nursing education, place of work, years of work in neonatal intensive care unit, and if received previous

specific ETS training. **The second part** nurses' knowledge assessment, adopted from **Ackley, et al. (2019) & Chen, et al. (2021)** and it was concerned with assessing the nurses' knowledge regarding open endotracheal suctioning. It consisted of four sections: **section A:** General information about endotracheal tube suctioning (nine questions) which ask about indication, purpose of ETT and nursing cares after ETT insertion **section B:** Preparation before endotracheal suctioning (nine questions) such as size of suction catheter, position of neonate during suction and recommended suction pressure **section C:** Procedure of endotracheal suctioning (seven questions) as routine use of normal saline instillation prior to endotracheal suction should not be performed, use of shallow suction is suggested instead of deep suction for pediatric patients, the suctioning procedure should last no longer than 15 s. and number of consecutive attempts during suction procedures, and **section D:** evaluation after endotracheal suctioning (five questions) such as assessment of breathe sounds, oxygen saturation, respiratory rate and pattern, hemodynamic parameters, assessment of characteristics of secretions and ventilator parameters should be monitored prior to, during, and after the procedure, Endotracheal suctioning, unless managed appropriately, can lead to various adverse events and increase mortality and morbidity rates. The nurses were asked to read these items well and answer by either yes or no.

Scoring system: The total numbers of questions in the structured interviewed questionnaire were 30 questions. Regarding Knowledge scores, correct answer was giving one score; incorrect answer was giving zero score. The total knowledge scores were 30 scores; the scores of the items were summed up and the total divided by the number of the items, these scores were converted into a percent score.

Tool 2: Observation checklist: It was adopted from **Lema-Zuluaga GL et al., (2018)** to assess nurses' practice regarding evidence-based recommendations about open endotracheal suctioning. Data collected by the observation checklist were based on: "not done", "done incomplete & not accurate" and "done complete & accurate". It consisted of three sections: **section A:** preparation before open endotracheal suctioning (two items), **section B:** procedure of open endotracheal suctioning (eleven items) and **section C:** Post procedure of open endotracheal suctioning (five items).

Scoring system: The total numbers of steps in the observation checklist were 18 steps. Regarding practice scores, done complete & accurate was giving two scores, done incomplete & not accurate was giving one score, and not done was giving zero. The total practice scores were 36 scores; the scores of the

steps were summed up and the total divided by the number of the steps, these scores were converted into a percent score.

Evidence-based recommendations about open endotracheal suctioning in pediatrics, it was adapted from **American Association for Respiratory Care (2016)** by the researchers based on needs' assessment of the studied nurses in the light of different national and international references. Among these recommendations: pediatric intensive care nurses should carefully assess and determine the need for endotracheal suction and take precautions to minimize the risk, preoxygenation for most pediatric intensive care patients, In certain high-risk groups (congenital heart disease with unrestricted pulmonary blood flow), preoxygenation is not recommended and an oxygen mixer must be used to accurately control the amount of oxygen delivered., There is no evidence to support the practice of deep (to carina) suctioning; shallow suction to or just beyond the tip of endotracheal tube is recommended and Instillation of saline cannot be recommended as routine practice.

Method:

Preparatory phase: An official permission to conduct the study was obtained from the director and head nurse of each study setting, after explaining the aim, nature of the study and method of data collection by the researcher.

Pilot study: A pilot study was carried out after the development of the study tools and before starting the data collection. It was conducted on 10 % (6 nurses) of the total sample size of the studied nurses to evaluate the clarity and the applicability of the study tools. After obtaining the result of the pilot study, necessary modifications were done according to the study subject's response and the final form was developed. Those included in the pilot study were excluded later from the sample.

Ethical consideration was followed through: An oral approval was obtained from each nurse before the study beginning, after explanation of the purpose of the study, nature of the study and its expected outcomes. The researchers assured maintaining anonymity and confidentiality of the collected data throughout the study phases. The participants were informed that they have the right to withdraw from the study at any time without any responsibility. The head nurses were informed about the observation checklist while all the nurses in the study were not informed.

Fieldwork: The period of data collection was extended over a period of 5 months, started from September, 2022 to the end of January, 2023. The researchers were available in the study setting during working hours four days/week. To assess studied nurses knowledge and practice regarding open

endotracheal tube suctioning through the following phases:

Assessment phase (pre-implementation of the evidence-based recommendations): It was started by meeting nurses. At the beginning of the interview, the researchers introduced themselves to the studied nurses and presented a brief explanation about the aim and nature of the study plus the content of the evidence-based recommendations, clarifying that, it was designed to improve their knowledge and practice for open endotracheal tube suctioning. Each nurse interviewed individually, her knowledge and practice were assessed using the previously mentioned tools. The average time required for completion of structure interviewed questionnaire was around 20-30 minutes. Meanwhile, observational checklist was assessed by the researchers during their actual practices with neonates. Then studied nurses were divided into ten groups, each group was consisted of 6 nurses.

Implementation phase: At this stage, the researchers educated the participated nurses about the evidence based recommendations about open endotracheal tube suctioning. The educational training was implemented for 4 days per week. It was provided in 4 sessions (2 theoretical and 2 practical). Each session ranged between 45-60 minutes including time for discussion. The theoretical sessions was prepared to cover items related to definition of endotracheal tube suction, purpose, indication of suction, precaution and hazards of suction, management of complication. While practical sessions included nursing care practices prior to, during and after endotracheal tube suction as well as assessment for the need for suction, use of shallow suction & assessing breathe sounds, oxygen saturation, respiratory rate and pattern, hemodynamic

parameters, characteristics of secretions and ventilator parameters. Each group of the studied nurses was given the opportunity to choose their optimal time for receiving the educational training according to their workload and mitigating circumstances of the study setting. At the beginning of the first theoretical session, an introduction about the objectives of the training was given, each session usually started by a summary of what has been taught during the preceding sessions and the objectives of the new one. Different teaching methods were used as: lectures, demonstration and re-demonstration. Suitable teaching media were prepared and used during the implementation phase as data show, real equipment (for demonstration and redemonstration), posters and pictures.

Evaluation phase: Participated nurses were reevaluated post-training implementation after 3 months of the educational recommendations by using the same previously mentioned tools. A comparison between nurses' pre and post 3 months-test findings was done to determine the effect of the study intervention on their level of knowledge and practice.

Statistical design: The study data were analyzed using SPSS version 21. Descriptive statistics including the frequency distribution and percentages were used for the analysis of nominal data as demographic data of the studied nurses. Differences between variables through times of evaluation were analyzed using T -test. The statistical significance and associations were assessed using, the arithmetic means, the standard deviation (SD), (chi square test), Pearson's and Spearman's tests used to explore correlation between the variables. Significant level was identified at $p < 0.05$.

Results:

Table (1): Percentage distribution of the studied nurses according to their sociodemographic characteristic (n=60)

Variable	No	%
Age in years		
< 20	10	16.7
20 < 30	35	58.3
30 \geq 40	15	25.0
Mean & SD	25.7 \pm 4.2	
Level of education		
Diploma of nursing	21	35
Technical institute of nursing	10	16.7
Bachelor of nursing	29	48.3
Place of work		
Suez Canal University Hospital	28	46.7
Ismailia Medical Complex Hospital	32	53.3
Years of experience (per years)		
Less than one year	4	6.7
1<5 years	15	25
5<10	23	38.3
\geq 10 years	18	30
Previous training		
Yes	60	100
No	0	0

Table (2): Mean scores of the studied nurses' knowledge about open endotracheal tube suction pre/post-training implementation (n=60)

Items	Pre Implementation	Post Implementation	Significance	
	Mean ±SD	Mean ±SD	T-test	P value
General information about endotracheal tube suctioning	2.00±0.94	3.26±1.01	6.553	.015*
Preparation before endotracheal tube suctioning	3.69±2.30	6.09±2.06	12.258	.001*
Procedure of endotracheal tube suctioning	6.38±2.49	12.57±4.13	13.487	.000*
Evaluation after endotracheal tube suctioning	2.79±1.14	4.88±1.22	10.678	.005*

*P-value<0.05

statistically significant difference

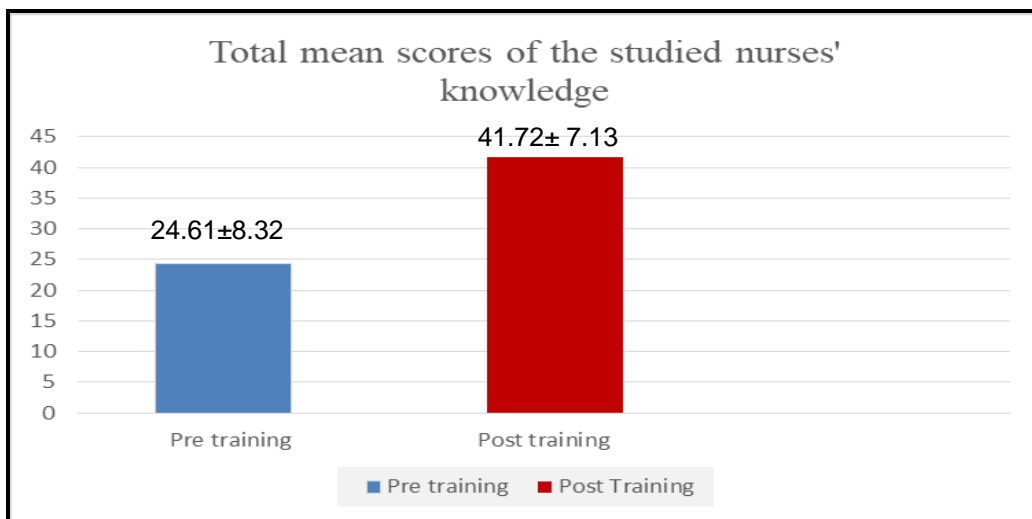


Figure (1): Total mean scores of the studied nurses' knowledge about open endotracheal tube suction pre/post- training implementation (n=60)

Table (3): Mean scores of the studied nurses' practices about open endotracheal tube suction pre/post- training implementation (n=60)

Items	Pre Implementation	Post Implementation	Significance	
	Mean ±SD	Mean ±SD	T-test	P value
Preparation before endotracheal suctioning	2.08±1.35	6.09±1.13	9.201	.002**
Procedure of endotracheal suctioning	6.23±3.16	10.57±3.71	11.243	.001**
Post procedure of endotracheal tube suctioning	3.08±1.56	7.99±1.23	10.201	.003**

*P-value<0.05

statistically significant difference

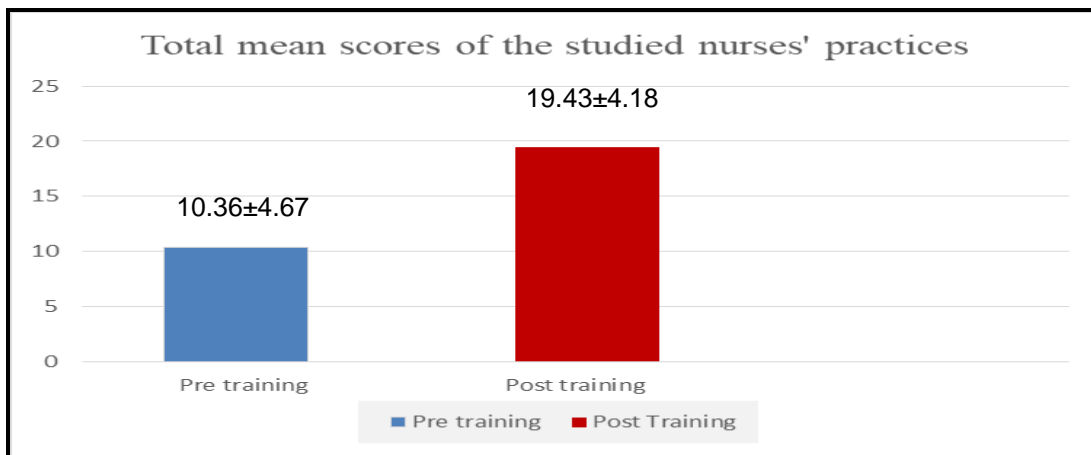


Figure (1): Total mean scores of the studied nurses' practices about open endotracheal tube suction pre/post- training implementation (n=60)

Table (4): Correlation between studied nurses' total mean scores of knowledge and practices regarding open endotracheal tube suction pre/post-training implementation (n=60)

Items	Total mean scores of knowledge			
	Pre		Post	
	r	P value	R	P value
Total mean scores of practice pre training	0.283	0.05*		
Total mean scores of practice post training			0.423	0.001*

*P-value<0.05

statistically significant difference

Table (5): Correlation between studied nurses' knowledge and practices regarding endotracheal tube suction post-training implementation and their personal characteristics (n=60)

Nurses' personal characteristics	Nurses' knowledge		Nurses' practice	
	R	P value	R	P value
Age	0.453	0.002*	0.583	0.014*
Educational level	0.357	0.001*	0.465	0.002*
Years of experience	0.324	0.012*	0.526	0.013*
Previous training	0.436	0.001*	0.445	0.001*

*P-value<0.05

statistically significant difference

Table (1): Illustrates demographic characteristics of the studied nurse in which, 58.3% of the participants are aged between 20 to less than 30 years, (mean age, 25.7 ±4.2), in addition, 48.3% of them had bachelor nursing degree. Concerning place of work 53.3% of the studied nurses worked at Ismailia Medical Complex Hospital. It also, shows that 38.3% of nurses' years of experience were between 5 to less than 10 years. Also; all of the studied nurses had no previous training regarding pediatric endotracheal tube suction.

Table (2): Shows that the studied nurses had the high mean scores of knowledge regarding open endotracheal tube suctioning post training implementation compared to pre training implementation as regards general information about endotracheal tube suction, preparation before ETT suction, Procedure and evaluation after ETT suction. There were statistically significance differences between nurses' knowledge in the pre and post implementation of training recommendations mean scores at P= .015*, P = 0.01*, P = 0.000* and P = 0.005* respectively.

Figure (1): Clarifies that, the studied nurses had the high total mean scores of knowledge regarding endotracheal tube suction post training implementation (41.72 ±7.13) compared to pre training implementation (24.61±8.32).

Table (3): Shows that the studied nurses had the high mean scores of practices regarding open endotracheal tube suctioning post training implementation compared to pre training implementation as regards preparation before endotracheal tube suction, procedure of ETT suction, post procedure of ETT suction. There were statistically significance

differences between nurses' practices in the pre and post implementation of training recommendations mean scores at P= .002*, P = 0.001* and P = 0.003* respectively.

Figure (2): Clarifies that, the studied nurses had the high total mean scores of practices regarding endotracheal tube suction post training implementation (19.43 ±4.18) compared to pre training implementation (10.36±4.67).

Tables (4): Illustrates that there was a positive statistical significant correlation between total scores of nurses' knowledge and their total practices' scores regarding endotracheal tube suction pre/post- training implementation at p< 0.05.

Tables (5): Reveals a statistical significant correlation between total knowledge and practice of the studied nurses and their personal characteristics (age, educational level, years of experience & previous training) pre and post training implementation (P < 0.05).

Discussion:

Tracheal suctioning is an essential aspect of effective airway management. However, ETT suctioning is not a benign procedure. It is a potentially harmful one, and may be associated with risks and life threatening complications if it is not performed correctly. Thus, nurses should remain sensitive to possible hazards and complications, and take all necessary precautions to ensure neonates' safety (Schults et al., 2020). Therefore, evidence based recommendations related to ETS is crucial to reduce the possible hazards and complications on the neonates' health. Accordingly, this study aimed to evaluate the impact of evidence based recommendations about open endotracheal tube

suctioning on nurses' performance in neonatal intensive care units.

Concerning demographic characteristics of the studied nurses (table 1), the current study revealed that, more than half of them were aged between 20 to less than 30 years with a mean age of 25.7 ± 4.2 years, nearly half of them graduated from bachelor of nursing and more than one third of them having years of experience ranged between 5 to less than 10 years. From the researchers' point of view, nurses with the previous characteristics are characterized by being aware of the impact of medical care on the neonates' progress; sensitive to their fears; honestly explain medical procedures and expected outcomes. These findings are goes in line with a study conducted by **Susmita & Rosy (2018)** who conducted a study about Knowledge and Practice Regarding Endotracheal Suctioning among Nurses of Selected Teaching Hospitals, Bharatpur, Chitwan and found that majority of the respondents were above 20 years with the mean age of 21.77 ± 1.91 , more than half had work experience more than 6 years, while more than two third of them had nursing diploma.

On assessing studied nurses knowledge regarding endotracheal suction (table 2 & Figure 1), the study results showed a highly statistical significant improvement in nurses' knowledge regarding general information about endotracheal suction, preparation before ETS, procedure of ETS and evaluation after ETS post training implementation of the evidence based recommendations compared with pre training implementation. Also, there was significant improvement regarding total mean scores of the studied nurses' knowledge regarding endotracheal tube suction throughout the study phases. From the researchers' point of view, these results could be attributed to lack of continuous training and education of the studied nurses, as well as lack of sources of knowledge and guidelines of nursing care. As stated by **Schults et al., (2019)** poor knowledge about scientific evidence for the safe and efficient accomplishment of endotracheal suction is one of the main causes of the morbidity and mortality of neonates who have endotracheal tube. So that, there is a need for evidence based guidelines to be announced in the NICUs. These results were similar to **Schults et al., (2021)** whom conducted a study about appropriate use criteria for endotracheal suction interventions in mechanically ventilated children and they found a significant improvement in all items of knowledge among the studied nurses after implementation of the criteria for endotracheal suction intervention. Furthermore, the current finding supported also by **Heidari & Shahbazi (2017)** who conducted a study about Nurses' awareness about principles of airway suctioning and reported that the level of knowledge

nursing staff in endotracheal suction increased after the training program.

In relation to studied nurses practices regarding endotracheal suction (table 3 & Figure 2), the study results showed a highly statistical significant improvement in nurses' knowledge regarding the preparation, procedure and post procedure of endotracheal suction post training implementation of the evidence based recommendations compared with pre training implementation. Also, there was a highly significant improve in the total mean scores of the studied nurses' practices regarding endotracheal tube suction throughout the study phases. From the researchers' point of view, these findings could result from shortage of training programs which, emphasizes the importance of on job training in improving nurses performance. **Laura et al., (2021)** reported that, regular in-service education program at every hospital is required to keep the nurses updated with evidence-based guidelines to achieve positive patient outcomes. These results was concurrent with those of **Mohamed et al., (2018)** in their study about effect of educational program on nurses practices regarding care of patient with endotracheal tube. They found a statistically significant improvement in the studied nurses' practices after program implementation. Furthermore, a study conducted by **Abo Jeesh et al., (2021)** about Effectiveness of Teaching Program on Critical Care Nurses' Performance during Endotracheal Suctioning in the Intensive Care Units in Syria was in accordance with the current study findings and found that, studied nurses demonstrated very low level of practice regarding endotracheal tube suction before implementation of the educational program.

The present study was illustrated a highly statistically significant positive correlation between studied nurses' total knowledge and practices regarding endotracheal suction pre and post evidence based recommendation training implementation (Table 4). From the researchers' point of view these findings emphasize on the fact that, the level of practice influenced by the level of knowledge and without correct, sufficient knowledge nurses practices will become more hazardous and inefficient. These results were similar to **Kadhim & Mhabes, (2020)** who conducted a study about Effectiveness of an Educational Program on Critical Care Nurses' Practices Regarding Endotracheal Suctioning of Patients Who are Mechanically Ventilated in Hospitals at AL-Najaf, Iraq and was found a highly statistically significant correlation between nurses' knowledge and their practice in pre- and post-program implementation.

The current study results found a highly statistical significant correlation between studied nurses'

knowledge and practices regarding endotracheal suction post- evidence based recommendation training implementation and their personal characteristics (age, educational level, years of experience and previous training) (Table 5). From the researchers' point of view, these results could be attributed to the positive relation between level of education and both nurses' knowledge and nursing practice also years of experience had a great effect on nurses' practice. The greater the years of experience of the nurses, the greater their knowledge and practices. These results were supported by **Abo Jeesh et al., (2021)** whom found a statistical significant positive correlation among nurses' knowledge and practice and their socio-demographic characteristic.

Conclusion:

Based on the findings of the current study, there were statistical significant improvements in nurses' knowledge and practices regarding endotracheal suction post evidence based recommendation training implementation than pre implementation. Also, there were statistical significant correlation between studied nurses' personal characteristics and their total knowledge and practices scores in the post training implementation.

Recommendations:

At the light of study results, the present study recommends:

- Implementing of continuous training programs regarding evidence based recommendations for endotracheal suction for nurses in NICUs.
- Evidence based guidelines for endotracheal tube suction should be announced in the NICUs.
- Further studies should be conducted to improve pediatric nurses' knowledge and practices regarding endotracheal suction as well in different settings and large samples.

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