Effect of Clinical Guidelines About Endotracheal Tube Suctioning on Nurses' Knowledge and Practice at Neonatal Intensive Care Unit

Shaima Shaban Mohamed[1] & Sanaa Mahmoud Ahmed[2]
[1.] Lecturer of Pediatric Nursing, Faculty of Nursing, Minia University, Egypt
[2.] Assistant Professor of Pediatric Nursing, Faculty of Nursing, Minia University, Egypt

Abstract

Endotracheal tube (ETT) suctioning is one of the most common airway procedures applied for mechanically ventilated neonates, However, if the standard guidelines for suctioning were followed the risks of developing complications due to mechanical ventilation decreases. **Aim.** Evaluate the effect of clinical guidelines of endotracheal tube suctioning on nurses' knowledge and practice at neonatal intensive care unit. **Research design:** Quasi-experimental research design was used. **Sample:** A convenient sample of all the available nurses (40)**. Setting:** The study was conducted at Neonatal Intensive Care Unit (NICU) at Minia University Hospital for Obstetric and Pediatrics (MUHOP). **Tools:** Two tools were used. **Tool I:** Included the following parts. **Part I**: Personal and professional characteristics of nurses. **Part II:** knowledge about endotracheal tube suctioning. **Tool II:** Observational checklist for endotracheal suctioning procedure. **Results:** The current study results proved that**;** the total mean score of nurses' knowledge regarding endotracheal tube suctioning was improved from 12.1 in pretest to 19.1 in the immediate posttest and 18.2 in the follow up test after three months respectively. And also, the total mean score of practice show improvement in immediate posttest and the follow-up test after three months compared to the pretest. Also, there was a positive association between nurses' knowledge about endotracheal tube suctioning with their age and years of experience. **Conclusion:** Providing the nurses with endotracheal suction guidelines improved their knowledge and practice mean scores regarding endotracheal suctioning in immediate posttest and follow-up test compared to the pretest. **Recommendations:** Hospital administration should adopt the clinical guidelines of endotracheal tube suctioning in NICU to be practiced by nurses.

Keywords: Clinical Guidelines, Endotracheal suctioning, Knowledge, Nurses &Practice

Introduction

The high-risk neonates defined as the neonates, regardless of gestational age or birth weight, who have a greater than average opportunity of illness or mortality, usually because of conditions associated with birth and adaptation to extra-uterine existence **(Hockenberry & Wilson, 2018).** Most common health conditions associated with physiologic status of high-risk neonates involve the neonate´s maturity, outcomes of immature organs and systems such as jaundice, respiratory distress and chemical disturbances as hypoglycemia and hypocalcemia (**Allawama et al., 2019**).

Preterm has characterized by physiological instability such as difficult airway clearance and maintenance, smaller airway diameter, compliant chest wall, few collateral airways, decreased functional residual capacity and poor airway functioning. A little amount of mucus can create a great increase in airway resistance, which decreases air flow and the secretions are not well excreted without expiratory force (**Rocha et al., 2018**). Endotracheal tube suctioning (ETS) includes using a suction catheter attached to a suction system to aspirate respiratory secretions mechanically from the internal diameter and distal end of endotracheal tube. Endotracheal tube suction should only be done when clinically indicated, with a less harmful effect on lung volume observed when the suction catheter attached with mucous **(Zeb etal., 2017).**

Endotracheal tube (ETT) suctioning is one of the most common airway procedures performed in mechanically ventilated neonates, practice of this procedure is differed despite its ubiquity. Complications derive from ETT suction are common, they occur in nearly one quarter of ETS episodes and there is a wide differentiation in clinical practice. Complications such as, alveolar decruitment, decreased saturation and cardiovascular functioning contribute to patient harm and may increase the days of stay in neonatal intensive care unit. ETS interventions with the most efficient and least complications could provide away to improve health for large numbers of critically ill children, and significantly saving costs (**Schults et al., 2020**).

Endotracheal suctioning is done in two ways, open and close procedures, in the open procedure, the patient is separated from ventilator and suctioning is

carried out, while in closed procedure, the patient is connected to a mechanical ventilator and then suctioning will be performed. The most commonly used procedure for suctioning for patient is an open suction that involves dislodgement of the device from the patient during suction, which cause of airway pressure loss and loss of lung volume. It was observed that while the endotracheal tube suctioning machine is used to remove secretions and when the airway is kept open, numerous side effects are produced **(Javadi et al., 2017)**.

To overcome ETT suctioning complications, nursing staff should be aware and follow endotracheal suction guidelines rendering to American association of respiratory care (AARC) recommendations which produce improvement in patient' outcomes. These guidelines include, providing 100% oxygen before, during and after endotracheal suctioning, normal saline instillation is avoided before endotracheal suctioning, a closed system with high positive end expiratory pressure is used, and increase FIO2, extends the period of suction which ranging from 5 to 10 second **(Alphonse Mary, 2017)**.

The study conducted by **Mwakanyanga et al. (2018)** about knowledge and practice of intensive care nurses on endotracheal suctioning of the intubated patient; showed that accurate performance of endotracheal suctioning by nurses can decrease its undesirable side effects for the patients. The nurses can improve the quality of care by following evidence-based recommendations in their practice, which is important for prevention of deaths as well as medical interventions, and decrease the duration of hospitalization admission and cost.

Health care professionals should update their knowledge on the evidence-based practices and the clinical guidelines of endotracheal tube suction that can be used to decrease unacceptable practice and promote the providing of high-quality care, so that they can practice the procedures scientifically and also, decrease patients' complications and possible risks **(Chen et al., 2021)**

Significance of the study

In the neonatal period at the day of birth about one third is dying, close to three quarters dying within the first week of life and 47% of all under-5 deaths occurred, although the global number of newborns deaths declined from 5 million in 1990 to 2.4 million in 2019. Preterm birth, birth asphyxia or lack of breathing at birth, intra partum- related complications, infections and birth defects cause most neonatal mortality **(WHO, 2020)**.

By referral to the hospital records we found that, the prevalence of neonates who were connected with mechanical ventilator and therefore undergone endotracheal tube suctioning   were 300 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 1300 cases.

Endotracheal suctioning is an important technique for secretion clearance which is necessary to assure endotracheal tube (ETT) patency, preventing mucous staining and airway obstruction **(Diaconu et al., 2018)** .Although the procedure is necessary to both children and adult patients, if the procedure is not done with proper techniques, it can lead to severe complications, such as infection hypoxia, atelectasis, bleeding, bronchoconstriction, increase in intra-cranial pressure, cardiac arrest and sudden death **(Fisk , 2018)**.

The nurses are responsible to gain strong evidence-based knowledge. However, the risks of acquiring complications due to mechanical ventilation decreases if the nurses follow the recommended guidelines while suctioning **(Zeb et al., 2017)**. The study by **Heidari & Shahbazi (2017)** showed that, endotracheal tube suctioning performed by a well-trained health care professionals based on the best evidence can decrease its adverse effects.

There are scarce studies in Egypt regarding the effect of endotracheal suction guidelines on nurses' knowledge and their practice about endotracheal suctioning in neonatal units. So, the current study was conducted to improve the nurses' knowledge and clinical practice of endotracheal tube suctioning using clinical guidelines for high -risk neonates.

Aim of the study
The aim of the current study was to
Evaluate the effect of clinical guidelines about endotracheal tube suctioning on nurses' knowledge and practice at neonatal intensive care unit.

Research Hypotheses:

H_1: Nurses who will receive the clinical guidelines about endotracheal tube suctioning could have a higher mean score of knowledge regarding endotracheal tube suctioning in the immediate and follow up tests than the pretest.

H_2: Nurses who will receive the clinical guidelines about endotracheal tube suctioning could have a higher mean score of practice regarding endotracheal tube suctioning in the immediate and follow up tests than the pretest.

H_3: There will be statistically significant differences between nurses' knowledge, practice and their selected personal and professional characteristics.

Subjects and Methods
Research design
Quasi-experimental research design was used to achieve the aim of the current study. It is one type of

experimental design that is very similar to the true-experimental design except, it involves the manipulation of an independent variable without the random assignment of participants to conditions or orders of conditions. The pre-test aimed at ensuring the comparability of the two groups before the intervention. In contrast, the post-test allows the researchers to determine the immediate effects of the intervention on the outcome variable (s) **(Grove & Gray, 2018).**

Sample

A convenient sample includes all the available nurses (40 nurses) who are working in the neonatal intensive care unit at Minia University Hospital for obstetric and paediatrics (MUHOP).

Theoretical definition:

Endotracheal tube suctioning: The artificial aspiration of respiratory secretions from the distal end of an endotracheal tube to maintain airway patency and facilitate ventilation and oxygenation.

Clinical guidelines of endotracheal suctioning: Included measures such as, endotracheal suctioning should be done as needed, hyperoxygenation was given before suctioning, suction catheter should be not more than half the diameter of the ETT, the depth of suction to the length of the ETT or no more than 0.5 cm beyond (shallow suction) and normal saline instillation during endotracheal suction is not recommended etc…………..

Setting:

The study was conducted at neonatal intensive care unit (NICU) located on the third floor at Minia University Hospital for Obstetric and Paediatrics (MUHOP). It receives neonates from all over Minia governorate who complained of different diseases, such as neonatal jaundice, respiratory distress syndrome, congenital anomalies and infant of diabetic mothers, and the total number of incubators in this unit is 30 incubators and 7 mechanical ventilators which provides levels of care up to the 3rd level.

Tools for data collection

Two tools were used in the current study

Tool I: A structured interview questionnaire sheet which was written and translated into an Arabic language and it consisted of the following parts: -

Part 1: Personal and professional characteristics of nurses such as, age, sex, marital status, years of experience, qualifications, attendance of training courses related to endotracheal suctioning and the number of training courses

Part ΙΙ: Knowledge about endotracheal tube suctioning include:

A. Knowledge about the clinical guidelines included 11 multiple choice questions pertaining to endotracheal tube suctioning which was adopted from **American Association of Respiratory Care (AARC) (2010)** and included, frequency of endotracheal tube suctioning, the recommended duration of suctioning each time for preterm, relation of suction catheter to endotracheal tube , the size of endotracheal tube , the importance of preoxygenation before suctioning, normal saline instillation before endotracheal suction, the effect of instilling saline in endotracheal suction procedure, the recommended suction pressure for preterm, the use of shallow suctioning is recommended than deep suctioning and closed system is recommended than open suction system in neonates.

B. General knowledge about endotracheal suctioning of the preterm and included10 multiple choice questions regarding definition, indications, contraindications, positioning, documentation etc.

Tool II-Observational checklist for endotracheal suctioning procedure: It was adopted from **(Kalia,2015).** Included 14 steps and it was used to assess nurses' practice regarding endotracheal tube suctioning

Scoring system for nurses' knowledge categorized as the following:

Correct answer took one score incorrect or don't know answer took zero, the total nurses' knowledge score was 21, the total score was converted to 100% and then categorized as the following:

• Good knowledge: More than (18.7) >85%

• Average knowledge: (16.5-18.7) 75 – 85%

• Under average knowledge: less than 16.5 < 75% .

(Hendy et al., 2020)

Scoring system of nurses' practice

The done practice step took one and not done took zero, the total score was 14 it is converted to 100% and then categorized as the following:

The nurses' level of practice was categorized as the following: - Competent level (equal or more than11.2) ≥ 80%, incompetent level (less than11.2) < 80% **(Mahmoud etal.,2017).**

Ethical considerations

An approval to conduct the study was taken from Ethical Committee in the Faculty of Nursing of Minia University. A written permission was taken from the director of the previously mentioned hospital and a written consent was taken from all nurses who participated in the study. After that, the researchers explained the purpose and nature of the study. Confidentiality was assured and the nurses had the right to refuse participation and or withdrawal from the study without any rational at any time. Study subject privacy and anonymity were considered during collection of data and all the protective measures were followed by the researcher during data collection procedure.

Pilot study:
A pilot study was conducted with10% of the nurses (4 nurses), it was done to estimate the amount of time it would take to complete the study tools, and to assess the current study tools for its clarity, and time required to be applied. No modifications were done so that participants in the pilot study were included in the study sample.

Tool validity and reliability
Three experts from Minia University, pediatric nursing department evaluated the data collecting tool's content validity. Content coverage, clarity, relevance, application, language, length, structure, and overall look were evaluated. The reliability of knowledge and practice was 0.704 and 0.785 respectively.

Data collection procedure
Planning of a clinical endotracheal guidelines: The guideline's material was divided into four sessions, two theoretical sessions, and a practical session plus a preliminary session.

Assessment phase
The researchers explained the nature and the purpose of the study to the nurses who participated in the current study after that, nurses were exposed to the pre-test through filling the questionnaire sheet which was distributed by the researcher and included the personal and professional characteristics about nurses and the knowledge regarding endo tracheal tube suctioning as guideline knowledge ,general knowledge and total nurses' knowledge (Tool1) after that, the researchers assessed nurses' practice regarding endotracheal tube suctioning using (tools II).

Planning (preparatory phase):
The planning phase included the teaching place, sessions about endotracheal tube suctioning guidelines conducted at neonatal unit of Minia university hospital for obstetric and pediatrics. The planning phase also included the time, the researchers divided the sample into small groups (4 nurses per group), then the researchers provided knowledge using illustrated Arabic brochure, pictures, posters, and educational videos, duration of each one is about 30 minutes. The researchers used different teaching methods included: lectures, group discussion and feedback.

Implementation phase.
The content of the clinical guidelines was provided for nurses in the neonatal intensive care unit. The teaching sessions were provided orally and written for nurses as the following.
Session I: Included orientation for participants about the aim and its expected outcomes, provide an introduction about the guideline (purpose, session's time and session's content), and discussing expectations of the participants. **Session 11:** Included,

definition, indications, contraindications ,duration, complications, documentations of endotracheal tube suctioning procedure. **Session III.** Include knowledge about nursing guidelines for endotracheal suctioning which include, importance of preoxygenation before endotracheal suctioning, when endotracheal suctioning should be applied, selection of catheter size, recommended suction pressure for preterm, instillation of normal saline and its adverse effects and importance of using shallow suctioning instead of deep suction. **Session IV.** Included nursing practices about endotracheal suctioning procedure for nurses after the educational session, each group was 4 nurses the demonstration about was done actually on the preterm infant.

The researchers used handouts, teaching materials, Power-point and videos. The guidelines were written into an Arabic language and discussed in the seminar room with images, diaries, and handouts, as well as videos, to facilitate training.

Evaluation phase:
Assessment of nurses was done three times using the questionnaire sheet and checklist about endotracheal tube suctioning to investigate whether the knowledge and practices was improved or not, the first assessment was done before giving the guideline sessions as a pre-test, the second one was also carried out immediately after giving these guidelines (immediate post-test), and the third one was carried out three months later as a follow-up to evaluate the retention of nurses' knowledge and practice. Data collection was conducted over 6 months extending from the beginning of September 2021 to the end of February 2022.

Statistical Analysis
Data entry was done through using a compatible personal computer. After data collection, it was revised, coded, and fed to statistical software (SPSS) IBM 25. By Monte Carlo test and Friedman test for non -parametric value and percent to describe the scale and categorical data, was used for qualitative data. Spearman's correlation is used to test the nature and strength of the relation between two quantitative/ordinal variables. The sign of the coefficient indicates the nature of relation (positive/negative) while the value indicates the strength of relation.

Results
Table(1): Percentage Distribution of the Studied Nurses Regarding their personal and professional Characteristics(n=40)

Personal and professional characteristics	Nurses (n = 40)	
	No.	%
Age of nurses/ year		
< 25years	27	67.5
25-30 years	11	27.5
More than30 years	2	5
Mean ± SD	25.10 ± 2.416	
Sex		
Male	4	10.0
Female	36	90.0
Qualification		
Baccalaureate degree	4	10.0
Technical institute of nursing	26	65.0
Diploma degree	10	25.0
Years of experience		
<5 years	34	85
5-10 years	4	10
More than10 years	2	5
Mean ± SD	4.63 ± 2 .416	
Training courses		
Yes	10	27.5
No	30	72.5
If yes, No. of training courses(N=10)		
One course	9	90
Two courses	1	10

Table (2): Percentage Distribution of Nurses' General Knowledge About Endotracheal Tube Suction Pretest, Immediate Posttest and Follow-up test after three months regarding to Correct Answer.

General knowledge regarding endotracheal tube suctioning	Time of educational program						Monte Carlo Test	
	Pretest		Immediate posttest		Follow-up after three months		Value	P-value
	No.	%	No.	%	No.	%		
Definition of endotracheal tube suctioning	27	67.5	32	80.0	31	77.5	1.805	0.504
Indications of endotracheal tube suctioning	20	50.0	36	90.0	36	90.0	21.971	0.0001**
Assessment for the need of suctioning determined by	19	47.5	28	70.0	25	62.5	4.295	0.133
During suction procedure, when aspiration of secretions should be applied	12	30.0	36	90.0	36	90.0	44.304	0.0001**
Contraindications of endotracheal suctioning	18	45.0	40	100.0	40	100.0	52.539	0.0001**
The most appropriate position for giving endotracheal suctioning for preterm	12	30.0	32	80.0	32	80.0	27.994	0.0001**
The nursing care as regards to the suction catheter	17	42.5	37	92.5	36	90.0	31.736	0.0001**
Endotracheal tube suctioning is sterile procedure	8	20.0	37	92.5	35	87.5	59.301	0.0001**
Stop suctioning if the following were present	23	57.5	40	100.0	38	95.0	30.526	0.0001**
Complications of endotracheal suctioning	26	65.0	38	95.0	37	92.5	14.861	0.0001**
Documentation in the nursing notes after ETT suctioning	27	67.5	36	97.5	39	92.3	15.303	0.0001**

*Statistically significant differences at < 0.5   * Statistically   significant differences at < 0.01*

Table (3): Percentage Distribution of Nurses' Knowledge Regarding to Correct Answer for Endotracheal Suction Guidelines, Pretest, Immediate Posttest and Follow-up test after three months (n=40)

Knowledge regarding endotracheal tube suctioning guidelines	Time of educational program						Monte Carlo Test	
	Pretest		Immediate posttest		Follow-up after three months		Value	P-value
	No.	%	No.	%	No.	%		
When endotracheal tube suctioning should be done.	26	65.0	37	92.5	35	87.5	10.521	0.006**
The recommended duration of suctioning each time for preterm.	17	42.5	40	100.0	38	95.0	47.769	0.0001**
The relation of suction catheter to endotracheal tube should be	31	77.5	38	95.0	34	85.0	5.153	0.101
The size of endotracheal tube should be	18	45.0	40	100.0	37	95.5	40.790	0.0001**
Normal saline instillation before endotracheal suction.	21	52.5	39	97.5	37	92.5	29.393	0.0001**
The effect of instilling saline in endotracheal suction procedure	10	25.0	27	67.0	25	60.0	26.214	0.0001**
the recommended suction pressure for preterm	16	40.0	37	92.5	35	87.5	37.011	0.0001**
The importance of preoxygenation before suctioning	33	82.5	40	100.0	38	95.0	8.537	0.012*
The use of shallow suctioning is recommended than deep suctioning.	18	45.0	35	87.5	34	85.0	21.389	0.0001**
Closed system is recommended than open suction system in neonates	18	45.0	34	85.0	38	80.0	17.159	0.0001**

Statistically significant differences at < 0.5   ** Statistically significant differences at < 0.01*

Table (4): Comparison Between Nurses' practice in pretest, Immediate posttest and follow-up test after three months regarding done practices of endotracheal tube suctioning (n=40)

Nurses' practice	Time of educational program						Monte Carlo Test	
	Pretest		Immediate posttest		Follow -up after three months		Value	P-value
	No.	%	No.	%	No.	%		
Wash hands thoroughly	33	82.5	36	90.0	37	92.5	1.956	0.452
Put on sterile gloves	36	90.0	39	97.5	39	97.5	2.575	0.363
Test pressure of suction and patency of catheter by applying gloved finger	0	0.0	36	90.0	35	87.5	100.336	0.0001**
Detach the oxygen tubing from ET tube with non-dominant hand	36	90.0	40	100.0	40	100.0	5.912	0.036*
Insert suction catheter into ET tube gently till resistance is felt	33	82.5	36	90.0	37	92.5	1.956	0.452
Hyper inflate with 100% oxygen	35	87.5	38	95.0	38	95.0	2.575	0.363
Suction for 5 seconds and rotate the catheter gently	0	0.0	34	85.0	32	80.0	86.121	0.0001**
Take out catheter while rotating gently	34	85.0	38	95.0	37	92.5	2.356	0.378
Attach oxygen tubing and do chest physiotherapy	5	12.2	35	87.5	33	82.5	61.326	0.0001**
Monitor Spo_2, pulse and respiration	36	90.0	40	100.0	40	100.0	5.912	0.036*
Allow 30-60 seconds interval between each suction	0	0.0	31	77.5	32	80.0	78.468	0.0001**
Wipe off catheter with sterile gauze	23	57.5	39	97.5	36	90.0	22.806	0.0001**
Flush catheter with sterile water	37	92.5	40	100.0	38	95.0	4.168	0.108
Repeat procedure until secretion are minimal	36	90.0	40	100.0	38	95.0	4.012	0.161
Remove gloves	33	82.5	35	87.5	40	100	8.373	0.018*

Statistically significant differences at < 0.5   *Statistically significant differences at < 0.01*
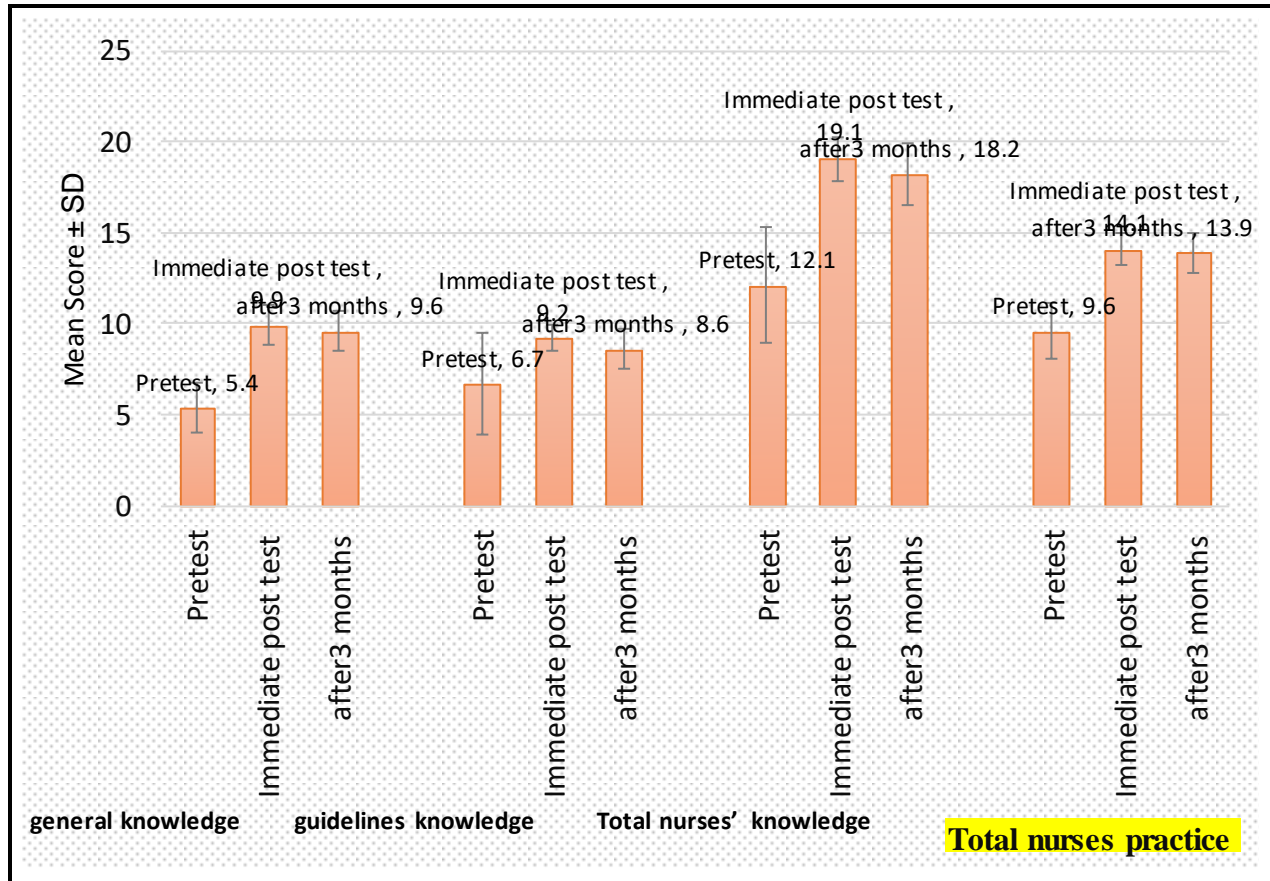
Figure (1): Total mean scores of nurses' knowledge and practices in pretest, immediate posttest and follow-up test after 3 months regarding endotracheal tube suction (n = 40).
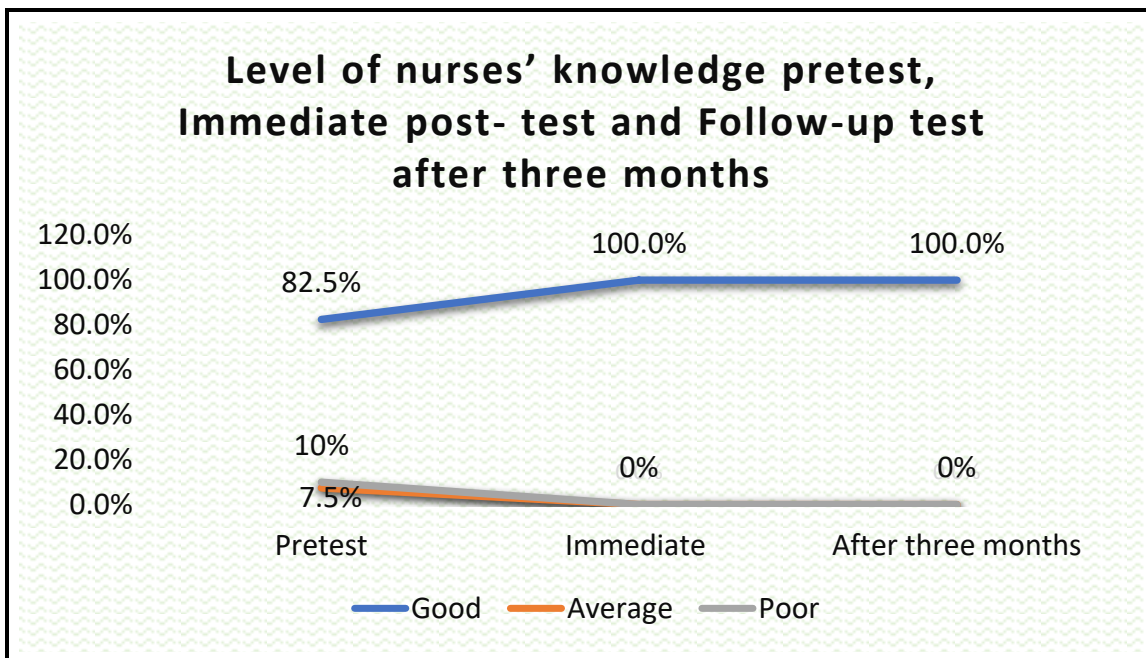

Figure (2): Comparison Between Level of Nurses' Knowledge Pretest, Immediate Post- test and Follow-up test after three months (n=40)

Table (5): Relations Between the Studied Nurses' Total knowledge and Practice Scores with Selected Personal and Professional Characteristics (n=40)

Personal and professional characteristics	Total knowledge level						Total practice levels			
	Poor (n = 4)		Average (n = 3)		Good (n = 33)		Incompetent (n = 38)		Competent (n = 2)	
	No.	%	No.	%	No.	%	No.	%	No.	%
Sex										
Male	4	11.1	3	8.3	29	80.6	4	100.0	0	0.0
Female	0	0.0	0	0.0	4	100.0	34	94.4	2	5.6
Monte Carlo (P-Value)	0.455 (0.624)						0.234 (0.629)			
Qualification										
Baccalaureate degree	0	0.0	0	0.0	4	100.0	4	100.0	0	0.0
Clinical institute	3	12.0	2	8.0	20	80.0	25	100.0	0	0.0
Diploma degree	1	9.1	1	9.1	9	81.8	9	81.8	2	18.2
Monte Carlo (P-Value)	1.016 (0.906)						4.408(0.062)			
Marital status										
Married	1	4.8	2	9.5	18	85.7	20	95.2	1	4.8
Single	3	15.8	1	5.3	15	78.9	18	94.7	1	5.3
Monte Carlo (P-Value)	1.521 (0.470)						0.005 (0.942)			
Training courses of the studied nurses										
Yes	2	20.0	0	0.0	8	80.0	10	100.0	0	0.0
No	2	6.7	3	10.0	25	83.3	28	93.3	2	6.7
Monte Carlo (P-Value)	2.020 (0.310)						0.702 (0.402)			

Table (6): Correlation Between the Studied Nurse's Knowledge and Practice scores with Selected Personal and professional Characteristics (n=40)

Items		Pretest		Posttest after 3 months	
		Knowledge	Practice	Knowledge	Practice
Age	R	-0.012	-0.135	**0.303**	0.105
	P – value	0.940	0.407	**0.049***	0.518
Years of experience	R	0.027	0.189	**0.433**	0.078
	P – value	0.870	0.243	**0.005****	0.632
Total practice scores	R	0.088		0.191	
	P – value	0.590		0.239	

*Correlation is significant at the 0.05 level   *** Correlation is significant at the 0.01 level.*

Table (1): Shows that, 67.5% of the studied nurses had less than 25 years old with mean ± SD 25.10±2.416, while 90% were female and two thirds of them had technical institute of nursing while the minority had baccalaureate degree. In addition, 85% of nurses had less than 5 years of experience with mean years 4.63, however,72.5% of them didn't attend training courses

Table (2): Clear that, there were increase in the percentage of correct answer regarding general knowledge about endotracheal suction in posttest compared to pretest with statistically significant differences P-value 0.0001, except for definition of endotracheal tube suction and assessment for the need for suction show no statistically significant differences.

Table (3): Illustrates that, the percentages of correct answers regarding endotracheal tube suctioning guidelines was increased in immediate posttest and follow-up test after three months compared to pretest regarding the recommended duration of suctioning each time for preterm, the relation of suction catheter to endotracheal tube, the size of endotracheal tube ,saline instillation during endotracheal suction, effect of instilling saline in endotracheal suction procedure, the recommended suction pressure for preterm ,the importance of preoxygenation before suctioning ,the use of shallow suctioning is recommended than deep suctioning, endotracheal suctioning without disconnection is suggested in neonates, closed system is recommended than open suction system in neonates, with statistically significant differences p-value 0.0001 and P. value 0.006 and

0.012*respectively regarding when endotracheal suctioning should be done and the importance of preoxygenation before suctioning

Table (4): Shows that, there was an increase in percentage of done practice regarding endotracheal tube suction in immediate posttest and follow-up test after three months compared to pretest with statistically significant differences in the area of test pressure of suction and patency of catheter , detach the oxygen tubing from endotracheal tube with non-dominant hand, suction for 5 seconds and rotate the catheter gently, attach oxygen tubing and do chest physiotherapy, monitor Spo_2, pulse and respiration, allow 30-60 seconds interval between each suction, wipe off catheter with sterile gauze and remove gloves with statistically significant differences 0.0001,0.036, 0.0001,and 0.018 respectively.

Figure (1): Show that, the total mean score was increased in post-test compared to pretest regarding general knowledge, guidelines' knowledge and total score of nurses' knowledge about endotracheal tube suction. The mean score was 5.4 in pretest versus 9.9 and 9.6 in immediate post -test and follow-up test after three months for general knowledge while it was 6.7 in pretest versus to 9.2 and 8.6 for guideline knowledge and it was 12.1 in pretest compared to 19.1 and 18.2 in immediate posttest, and follow-up test after three months regarding total nurses' knowledge. Concerning to mean score of nurses' practice, the current study results proved that the total mean score was improved in immediate posttest and follow-up test after three months compared to pretest 14.1and 13.9 compared to 9.6 respectively.

Figure (2): Illustrates that 82% of nurses had good knowledge compared to 100% in immediate posttest and in follow-up test after three months. On the other hand, 7.5% and 10% of nurses had average and poor knowledge respectively, in pretest compared to 0.0% in immediate and after three months posttest.

Figure (3): Illustrates that, 5% of nurses had competent level of practice in pretest compared to 100% and 97.5% in immediate posttest and follow-up test after three months, while 95% of the studied nurses had incompetent level of practice pretest compared to 0.0% and 2.5% in immediate and follow-up test after three months respectively.

Table (5): Clears that, there were no statistically significant relation between nurses' knowledge, practices and their qualification, marital status and training courses.

Table (6): Shows a positive association between neonatal nurses' knowledge about endotracheal tube suctioning on with their age and years of experience (r=0.303, P. value < 0.049*; r=0.433, P. value < 0.0.005); in follow-up test after three months but there were no statistically significant association

between nurses' knowledge and their practices. and between practice and nurses' age and years of experience

Discussion

The current study results proved that, more than two thirds of the studied nurses had less than25 years old with mean ± SD 25.10±2.416, while the vast majority were female and two thirds of them had technical institute of nursing while the minority had baccalaureate degree. In addition, the majority of nurses had less than 5 years of experience with mean years 4.63, however nearly three quarters of them didn't attend training courses

he findings from this study were contradicted with **Ebrahimi et al. (2020)** about the effect of simulation-based suction education on the knowledge and performance of pediatric intensive care unit nurses, indicated that, more than half of nurses their age ranged from 40-49years with   mean age 38.18 years, and the average work experiences were 13.24 years. They also cleared that; and the vast majority had bachelor's degree. But regarding sex of the studied nurses the study was consistent with our study and cleared that majority of them were female.

Regarding nurses' qualification, the high percentage had technical institute of nursing ,this may be due to in Egypt nursing education showed noticeable growth of academic degrees and replacement of technical secondary school of nursing by technical institute of nursing this make bridging to allow carriers of secondary school diploma degree to increase their qualification and therefore, to be recruited in the critical care units believing that these cadres could have better knowledge and skills of caring for high -risk neonates.

Our study results were also congruent with **Ahmed, (2019)** about the effect of teaching program on nurse's knowledge and practice of endotracheal suctioning procedure, indicated that more than two thirds of the study subjects did not attend previous training on endotracheal suction. Also, the study by **Haghighat and Yazdannik (2015)** about the practice of intensive care nurses using the suctioning system: An observational study indicated that, more than two thirds of the studied nurses had technical institute degree of nursing.

Nurses' knowledge about clinical guidelines of endotracheal tube suctioning

The current study results cleared that, the percentages of correct answers regarding endotracheal tube suction guidelines were increased in immediate posttest and follow-up test after three months compared to pretest with highly statistically significant difference in the areas of ,the recommended duration of suctioning each time for

preterm, the relation of suction catheter to endotracheal tube, the size of endotracheal tube, saline instillation during endotracheal suction, effect of instilling saline in endotracheal suction procedure, the recommended suction pressure for preterm ,the importance of preoxygenation before suctioning, the use of shallow suctioning is recommended than deep suctioning, endotracheal suctioning without disconnection is suggested in neonates, closed system is recommended than open suction system in neonates.

The study by **Chen et al. (2021)** about intensive care nurses' knowledge and practice of evidence-based recommendations for endotracheal suctioning indicated that, the nurses lacked knowledge of certain aspects of the endotracheal suction guidelines.

The current study results were supported with **Ahmed, (2019)** who revealed that, two third of the studied nurses, knew the importance of preoxygenation, recognized the normal saline instillation and their side effects compared to one third in pretest. On the other hand, one third compared to less than two thirds of nurses identify recommended size of the suction catheter and depth respectively, in posttest. In addition, less than two third, the majority and more than three quarters identify suction pressure, duration and frequency in posttest compared to near one third, two fifth and more than half in pretest with statistically significant difference p. value 0.0001.

The study done by **Fisk, (2018)** about endotracheal suctioning and their effects in the pediatric population, indicated that, neonatal endotracheal suctioning should not be performed routinely and should only be performed when indicated. Also, he proved that; suctioning catheter should not exceed 50% of the diameter of the ETT and using the small suction probe is recommended and capable of properly removing secretions.

On the other hand, **Gonçalves, (2015)** who studied endotracheal suctioning in intubated newborns: an integrative literature review concluded that, endotracheal suctioning produces a greater risk of damage to the tracheal mucosa and hypoxemia if the duration increased and the duration of each time suction shouldn't exceed 15 seconds.

Regarding the normal saline instillation, the study by **Edwards, (2021)** about suctioning principles in infants, children and young people indicated that, instillation of normal saline during endotracheal suctioning is vital topic in pediatrics, especially in neonatology, it increases the possibility of cardiac arrhythmia, bronchospasm, hypoxemia, infection, atelectasis, mucosal and respiratory tract injury and increases intracranial pressure. Also, the study by **Schults et al. (2020)** about adverse events and

practice variability associated with pediatric endotracheal suction indicated that, selection of catheter size is important as it affects the degree of secretion accumulation and lung volume loss. Moreover, they cleared that, shallow suction should be used to the distal end of the endotracheal tube.

Nurses' general knowledge about endotracheal tube suction

There was an increase in the percentage of correct answer regarding general knowledge about endotracheal suction in posttest compared to pretest with statistically significant differences P-value 0.0001. Except for definition of endotracheal tube suction and assessment for the need for suction show no statistically significant differences.

Moreover, the study by **Mohamed (2016)** about nurses knowledge regarding endotracheal suctioning for mechanically ventilated patients in East Nile Hospital, Khartoum cleared that, knowledge level about clinical indications ,contraindications for endotracheal suctioning, assessment before suctioning was decreased in pretest .Also, nurses had lack of knowledge about in ability to recognize clinical indications and suction a contraindications   for the patient and thus expose the patient to sputum accumulation and infections and increase intracranial pressure.

The study by **Herting et al. (2020)** about less invasive surfactant administration: best practices and unanswered questions,   cleared that, such as uncontrolled intracranial pressure, and the measures to control it must be adopted prior to endotracheal suctioning in newborns also, endotracheal suctioning is avoided in newborns 15 to 30 minutes after surfactant administrations**.** On the other hand**, Schults, et al. (2020)** reported that, endotracheal suctioning produce complications such as trauma, mucosal injury, bleeding, and atelectasis and the most serious complications are increased blood pressure, hypoxemia, increased ICP and pneumothorax.

Regarding knowledge levels among nurses

The current study results proved that, the majority of nurses had good knowledge in pretest compared to all of them in immediate posttest and in follow-up test after three months. On the other hand, the minority of nurses had average and poor knowledge respectively, in pretest compared to none of them in immediate and after three months posttest.

The study was congruent with **Heidari, & Shahbazi, (2017)** found that, the level of knowledge and skills of nursing staff about endotracheal tube suctioning in neonatal intensive care unit was average and low and their level of knowledge and skills were increased after training

Also, the study results were reinforced by **El-saman, (2017)** who studied effect of application of

endotracheal suction guidelines on cardiorespiratory parameters of mechanically ventilated patients found that, there was an increase of nurses' knowledge after application of endotracheal suction guidelines.

The current study results indicated that, nurses' knowledge level was improved after giving clinical guidelines for endotracheal tube suctioning, these results were due to the effectiveness of these instructions for improving nurses' knowledge scores about endotracheal tube suction.

Regarding the nurses' practice about endotracheal tube suctioning

The current study results cleared that ,there was an increase in percentage of performed steps regarding endotracheal tube suction in immediate posttest and follow-up test after three months compared to pretest in the area of, test pressure of suction and patency of catheter, detach the oxygen tubing from endotracheal tube, suction for 5 seconds and rotate the catheter gently, attach oxygen tubing and do chest physiotherapy, monitor Spo_2, pulse and respiration, allow 30-60 seconds interval between each suction, wipe off catheter with sterile gauze and remove gloves with statistically significant differences 0.0001,0.036, 0.0001,and 0.018 respectively.

Our study results were supported with the study done by **Sharma et al. (2014)** about endotracheal suctioning protocol and its effect on knowledge and practices of nursing personnel, and he cleared that, the score of performed steps was increased in post intervention phase. They also found that, most of nurses washed their hands in correct manner, wore sterile glove, hyper oxygenated for 30-60 seconds before suctioning, check the suction pressure, removed the suction catheter from the package and attached it to the suction tubing. Also, all of them wipe the suction catheter and flush with normal saline until clear and the vast majority documented the recommendations and additional ventilator settings, such as FiO2, flow rate etc.

Regarding levels of nurses' practice

Our study results proved that, minority of nurses had competent level of practice in pretest compared to all of nurses and the most in immediate posttest and follow-up test after three months, while most of the studied nurses had incompetent level of practice pretest compared to none of them and the minority in immediate posttest and follow-up test after three months respectively.

The current study results were in the same line with **Azizian et al. (2020)** who studied the effect of performance feedback and educational video on endotracheal-suctioning practices of critical care nurse, showed that, in pretest the nurses' practice of endotracheal suctioning was poor.

Providing clinical guidelines and also the application of these guidelines during endotracheal suctioning procedure for nurses in neonatal unit through actual demonstration on preterm who was connected with mechanical ventilator leads to improvement in their performance of this procedure

Regarding the total mean score of knowledge and practice

The current study results cleared that, the total mean score of knowledge was increased in post-test compared to pretest regarding general knowledge, guidelines' knowledge and total nurses' knowledge about endotracheal tube suction. Also, the total mean score of practice was improved in immediate posttest and follow-up test after three months compared to pretest 14.1, 13.9 compared to 9.6 respectively.

The study results were consistent with the study by **Kargar, et al (2019)** who studied the effect of endotracheal tube suction education on the knowledge and performance of neonatal intensive care nurses, mentioned that, average score in the two groups at two days and two months after the intervention show statistically significant difference (p = 0.001), they also revealed that, when the nurses had low level of knowledge and skills can be improved if training that based on the needs is conducted according to standardized protocol.

Also, the current study results were congruent with the results of the study by **Sharma et al. (2014)** found that, the mean score of knowledge post-implementation for nurses regarding different aspects of endotracheal suctioning (ETS)such as concept, event and assessment was higher than the mean pre-intervention knowledge score. Also, the study done by **Ebrahimi et al. (2020)** concluded that, the mean score of knowledge and performance after the intervention was increased than before with statistically significant differences (p <0.001).

On the other hand, the current study results were also supported by **Farsi et al. (2015)** who studied the result of the scientific review process at the level of endotracheal suctioning skill in nurses working in intensive care units, their result clarified that, the nurses in the study group had higher total score of nursing skill about endotracheal suction in the post-test and improved after weeks than pre-intervention with statistically significant difference. The study done by **Khanjari, et al. (2019)** about the effect of training on the performance of nurses in the endotracheal suctioning of neonates cleared that, the mean score of practice for nurses after intervention was increased compared to pre intervention with statistically significant difference P. value 0.001.

Relations and correlation between nurses' knowledge and practice and their personal and professional characteristics

The study results cleared that, there were no statistically significant relation between nurses' knowledge and practices and their qualification, marital status and training courses. As well as, there was a positive association between neonatal nurses' knowledge about endotracheal tube suction with their age and years of experience in follow-up test after three months but there were no statistically significant association between nurses' knowledge and their practices.

The current study results were in the same line with the study by **Mwakanyanga et al. (2018)** about knowledge and practice of intensive care nurses on endotracheal suctioning of the intubated patient, indicated that, no significant difference was found in knowledge and practice between nurses with nurses' level of educational.

Our study results were inconsistent with the study by **Rad et al. (2021)** who studied evidence- based in pediatric endotracheal suctioning by nurses cleared that, the nurse experience did not increase the use of evidence-based suction practice.

The current study results were in the same line with **Aboalizm & Elhy (2019)** who studied educational intervention on nurses' knowledge and practices regarding endotracheal tube suctioning and the study by **Ghorbanpoo et al. (2018)** about knowledge and practices of nurses in intensive care units on endotracheal suctioning, their findings showed that, there were statistically differences between age and years of experience with nurses' knowledge regarding endotracheal suction (P>0.05) while, relationship was no significant with the performance of nurses (P<0.05)

The current study results were supported with the study by **Chen et al. (2021**) about evidence-based recommendations about endotracheal suctioning for intensive care nurses' knowledge and practice found that, endo tracheal tube suction training experience of nurses leads to significantly higher awareness of ETS recommendations (p = 0.000).

The current study results may be due to when the age and years of experience of nurses increase the level of knowledge also increases, this may be due to exposure to many situations, experiences and training programs during their work years which leads to improving their knowledge.

Conclusion:
The current study concluded that:
The there was an improvement in the nurses' knowledge and practice this improvement was evident as increased in total mean score of knowledge in post-test compared to pretest regarding general knowledge, guidelines' knowledge and total nurses' knowledge about endotracheal tube suction. Also, the mean score of nurses' practice was improved in immediate posttest and follow-up test after three months compared to pretest. In addition, there was a positive association between nurses' knowledge about endotracheal tube suction with their age and years of experience with statistically significant differences P. value 0.049and 0. 005 respectively in follow-up test after three months.

Recommendations
- The same study should be replicated in various neonatal intensive care units with increasing the sample size and comparative study are suggested between university and ministry of health and private hospitals.
- Hospital administration should adopt the clinical guidelines of endotracheal suctioning in neonatal intensive care units to be practiced by nurses
- The hospital administration should provide the nurses with continuous training and education about care for high-risk neonates through conducting workshops, seminars conferences on endotracheal suction.
- The neonatal intensive care units should be provided with booklets, brochure and posters about clinical guidelines for endotracheal suctioning.

References
- **American Association for Respiratory Care. (2010):** AARC Clinical Practice Guidelines. Endotracheal suctioning of mechanically ventilated patients with artificial airways. Respiratory care, *55*(6), 758-764.
- **Aboalizm, S., & Elhy, A.. (2019):** Effect of educational intervention on nurses' knowledge and practices regarding endotracheal tube suctioning. SSRG International Journal of Nursing and Health Science, 5(3).
- **Ahmed, R. (2019):** Effect of teaching program on ICU nurse's knowledge and practice of endotracheal suctioning procedure at Omdurman military hospital 2019 (Doctoral dissertation, Yousif Mohammed yousif).
- **Alawama, M., Alkhatib, H., Wakileh, Z., kju Elqaisi, R., AIMassad, G., Badran, E., & Hatman, T. (2019):** Bubble CPAP therapy for neonatal respiratory distress in level III neonatal unit in Amman, Jordan: a prospective observational study, international journal of general medicine, 12(2), 25.
- **Alphonse Mary, S. (2017):** Effectiveness of endotracheal suctioning with normal saline Versus without normal saline on airway clearance among intubated patients at Government Rajaji Hospital,

Madurai (Doctoral dissertation, College of Nursing, Madurai Medical College, Madurai).

▪ **Azizian, K., Azadi, A., Veisani, Y., & Bastami, M. (2020):** The effect of performance feedback and educational video on endotracheal-suctioning practices of critical care nurses. Journal of education and health promotion, 9.

▪ **Chen, W., Hu, S., Liu, X., Wang, N., Zhao, J., Liu, P., & Hu, J. (2021):** Intensive care nurses' knowledge and practice of evidence-based recommendations for endotracheal suctioning: a multisite cross-sectional study in Changsha, China. BMC nursing, 20(1), 1-12.

▪ **Diaconu, O., Siriopol, I., Poloşanu, L., & Grigoraş, I. (2018):** Endotracheal tube biofilm and its impact on the pathogenesis of ventilator-associated pneumonia. Critical Care Medicine, 4(2), 50-55. doi:10.2478/jccm-2018-0011.

▪ **Ebrahimi, H., Jafarnejad, S., Sohrabi, S., Abbasi, A., & Esmaeilian, S. (2020):** Effect of simulation-based suction education on the knowledge and performance of pediatric intensive care unit nurses. Journal of Critical Reviews, 7(4), 685-694.

▪ **Edwards, E. (2021):** Principles of suctioning in infants, children and young people. Nursing children and young people, 33(4).

▪ **El-saman S., (2017):** Effect of Application of Endotracheal Suction Guidelines on Cardiorespiratory Parameters of Mechanically Ventilated Patients. IOSR-JNHS, Volume 6, Issue 1 Ver. I (Jan. - Feb. 2017)

▪ **Farsi, Zahra F.,, Fatimah K.,, Maryam N., & Sara R., (2015):** Effect of clinical audit process on the level of endotracheal suctioning skill in nurses and anesthesia technicians working in intensive care units Nurs Pract Today; 2(2): 76-83

▪ **Fisk, A.C. (2018):** The effects of endotracheal suctioning in the pediatric population: An Integrative Review. Dimensions of Critical Care Nursing, 37(1), 44-56. doi:10.1097/dcc.0000000000000275.

▪ **Ghorbanpoor, A., Jouybari, L., Vakili, M., Sanagoo, A., & Kavosi, A. (2018):** Knowledge and practices of nurses in intensive care units on endotracheal suctioning. Journal of Nursing Education, 7(4), 9-17.

▪ **Grove, S., & Gray, J. (2018):** Understanding Nursing Research E-Book: Building an Evidence-Based Practice.7th.ed. Elsevier Health Sciences

▪ **Gonçalves, R., Tsuzuki, L., & Carvalho, M. (2015):** Endotracheal suctioning in intubated newborns: an integrative literature review. Revista Brasileira de Terapia Intensiva, 27, 284-292.

▪ **Haghighat, S., & Yazdannik, A. (2015):** The practice of intensive care nurses using the closed suctioning system: An observational study. Iranian journal of nursing and midwifery research, 20(5), 619.

▪ **Heidari, M., & Shahbazi, S. (2017):** Nurses' awareness about principles of airway suctioning. Journal of clinical and diagnostic research: JCDR, 11(8), LC17.

▪ **Hendy, A., Al-Sharkawi, S., & Abd Al-Moniem, I. (2020):** Nursing Competency for Caring of High-Risk Neonates at Neonatal Intensive Care Unit. Egyptian Journal of Health Care, 11(2), 200-213.

▪ **Herting, E., Härtel, C., & Göpel, W. (2020):** Less invasive surfactant administration: best practices and unanswered questions. Current opinion in pediatrics, 32(2), 228.

▪ **Hockenberry, M., & Wilson, D. (2018):** Wong's nursing care of infants and children – E- book. Elsevier Health Sciences

▪ **Javadi, M., Hejr, H., Zolad, M., Khalili, A., & Paymard, A. (2017):** Comparing the effect of endotracheal tube suction using open method with two different size catheters 12 and 14 on discharge secretion, pain, heart rate, blood pressure, and arterial oxygen saturation of patients in the intensive care unit: A randomized clinical trial. Annals of Tropical Medicine and Public Health, 10(5), 1312-1317.

▪ **Kalia (2015):** Pediatric nursing procedure,2nd ed, Rajakamal. electrical press, Jaypee brother medical publisher, Chapter 15. endotracheal suctioning P.15

▪ **Kargar, M., Shirazi, Z., Edraki, M., Pishva, N., Ghaem, H., & Chohedri, A. (2019):** The effect of ETT suction education on the knowledge and performance of neonatal intensive care nurses. Anaesthesia, Pain & Intensive Care.

▪ **Khanjari, S., Bayati, N., & Haghani, H. (2019):** Effect of training on the performance of nurses in the endotracheal suctioning of neonates. Iran Journal of Nursing, 32(118), 43-53.

▪ **Mahmoud, F., M Khalaf, S., & G Mohammed, E. (2017):** The effect of endotracheal suction intervention on oxygen saturation level in preterm infants. Egyptian Journal of Health Care, 8(2), 136-146.

▪ **Mohamed, M. (2016):** knowledge of intensive care unit nurses regarding endotracheal suctioning for mechanically ventilated patients in East Nile Hospital, Khartoum Bahry Locality, Khartoum State, Sudan (2015) (Doctoral dissertation, University of Gezira).

▪ **Mwakanyanga, E., Masika, G. , & Tarimo, E. (2018):** Intensive care nurses' knowledge and practice on endotracheal suctioning of the intubated

patient: A quantitative cross-sectional observational study. PloS one, 13(8), e0201743.

▪ **Rad, L., Carter, B., Curley, M., Copnell, B., & Tume, L. (2021):** Is paediatric endotracheal suctioning by nurses' evidence based? An International Survey. Nursing in critical care, 26(5), 372-379.

▪ **Rocha, G., Soares, P., Gonçalves, A., Silva, A., Almeida, D., Figueiredo, S., & Guimarães, H. (2018):** Respiratory care for the ventilated neonate. Canadian respiratory journal, 2018.

▪ **Schults, J., Long, D., Mitchell, M., Cooke, M., Gibbons, K., Pearson, K., & Schibler, A. (2020):** Adverse events and practice variability associated with paediatric endotracheal suction: an observational study. Australian Critical Care, 33(4), 350-357.

▪ **Sharma, S., Sarin, J., & Kaur Bala, G. (2014):** Effectiveness of endotracheal suctioning protocol, In terms of knowledge and practices of nursing personnel. Nursing and midwifery research journal, 10(2), 47-60.

▪ **Shubhasini S (2017):** Effectiveness of learning package regarding care of a patient on mechanical ventilator to the staff nurses of a selected hospital in mangalore. india: rajiv gandhi university of health sciences, karnataka;

▪ **Varghese, S., & Moly, K. (2016):** Exploratory study on the knowledge and skill of critical care nurses on endotracheal suctioning. The Journal of National Accreditation Board for Hospitals & Healthcare Providers, 3(1), 13-13.

▪ **World Health Organization (WHO), (2020)** https://www.who.int/news-room/fact-sheets/detali/newborns-reducing-mortality.

▪ **Zeb, A., Ul Haq, S., Ali, F., Hussain, N., Haidar Ali Shah, S., & Faisal, S. (2017):** Knowledge and practice of ICU nurses regarding endotracheal suctioning in tertiary care hospitals, Peshawar. JOJ Nurse Health Care, 2(4), 555-595.