Mansoura Nursing Journal (MNJ) Vol. 10. No. 1 – 2023
Print ISSN: 2735 – 4121 Online ISSN : 2735 – 413X

Original Article

Critical Care Nurses' Practice of Endotracheal Tube Suctioning in Intensive Care Units: an Observational Study

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1.ABSTRACT

Background: Endotracheal tube (ETT) suctioning is one of the most frequent airway procedures in mechanically ventilated patients. Critical care nurses' (CCNs) practice regarding ETT suctioning play a vital role to maintain airway clearance and prevent infection, particularly ventilator-associated pneumonia (VAP). **Aim:** This study aimed to assess CCNs' practice of ETT suctioning in intensive care units (ICUs) at Emergency Hospital, Mansoura University. **Method:** A descriptive observational research design was used to conduct this study with a convenience sample of 50 CCNs working in three ICUs affiliated with Emergency Hospital Mansoura University in Egypt. One tool was used for data collection of this study. The tool was **"Nurses' Practice of Endo-Tracheal Tube Suctioning Observation Checklist"** in addition to nurses' socio-demographic characteristics. **Results:** The results revealed statistically significant differences were found between the total and sub-total score of nurses' practice. The results showed that the total practice score of the participant nurses was unsatisfactory (100%) with a mean ± SD of 55.49 ± 6.51. **Conclusion:** The current study concluded that CCNs' practice regarding ETT suctioning was unsatisfactory. These findings may have a negative effect on patients' outcomes. **Recommendations:** The CCNs need a training program application to improve their practice regarding ETT suctioning to improve health for large numbers of critically ill patients, prevent complications and significantly saving costs.

Keywords: *Critical care, Nurses' practice, Endotracheal Tube Suctioning, Intensive care units*

2.Introduction:

Critical care is the process of caring of patients who either have life-threatening conditions or are at risk of developing them **(Jackson & Cairns, 2021)**. The main goals of emergency and critical care are to revive critically ill patients, give them time to recover, or apply specialized therapy to enhance outcomes and avert death. Emergency and critical care are used to refer to any forms of care given to severely ill patients in a broad sense **(Perkins et al., 2021)**.

Emergency and critical care can be provided everywhere in the hospital, such as the emergency room, intensive care unit (ICU), general wards, post-operative recovery units, and high-dependency units, for patients who are critically ill upon arrival or who were stable but later deteriorated **(Peate, 2020)**. Critical disease can strike anyone, regardless of their age, gender, or social standing. It can start in the hospital or in the community, and it disregards conventional lines between medical specializations **(Schell et al., 2018)**.

An ICU is a structured system for providing care to critically ill patients. It offers them specialized, intensive medical and nursing care, increased monitoring capabilities, and a variety of physiologic organ support modalities to keep them alive during a period of life-threatening organ system insufficiency **(Phua et al., 2020)**. In contrast to a ward, alevel 1 intensive care unit can offer oxygen, noninvasive monitoring, and more intensive nursing care, while a level 2 ICU can offer invasive monitoring and temporary basic life support. The care of severely ill patients is provided by a level 3 ICU, which offers the entire range of monitoring and life support equipment **(Marshall et al., 2017)**.

For severely ill patients with life-threatening illnesses and respiratory conditions, mechanical ventilation (MV) is an essential, life-saving therapy. It is one of the

most popular technological interventions in the ICU that improves gas exchange to the lung in conditions of poor breathing **(Marasinghe, Fonseka, Wanishri, Nissanka, & De Silva, 2015; Majeed, 2017)**. One of the essential treatments provided to patients in the ICU is mechanical ventilation through an endotracheal tube (ETT). ETTs are linked to the development of biofilms, which increases the likelihood of patients getting ventilator-associated pneumonia (VAP) **(Dsouza et al., 2021)**.

Critical care nurses (CCNs) are essential in the treatment of seriously ill patients in order to deliver the greatest standard of patient care, guarantee the patients' safety, and avert future complications. **(Bergman, Falk, Wolf, & Larsson, 2021)**. CCNs regularly interact with urgent situations requiring quick decisions in order to save the patient's life. Therefore, nursing practice must take into account evidence in order to provide patients with care that is based on science. **(Salem, 2019)**.

In patients with artificial airways, an ETT suction is a technique used to physically remove accumulated pulmonary excretions in order to maintain a clear airway **(Majeed, 2017)**. There are two types of systems used for endotracheal tube suctioning: open and closed. In contrast to the closed suction system (CSS), which can be used multiple times and allows suction without disconnecting the ventilator, the open suction system (OSS) is only ever used once **(Elmansoury & Said, 2017)**. In order to maintain the permeability of the airways, offer adequate oxygenation, reduce the risk of ventilator-associated pneumonia (VAP), and prevent atelectasis and pulmonary consolidation, it primarily aims to remove accumulated lung excretion **(Mwakanyanga, Masika, & Tarimo, 2018)**.

One of the most frequent airway operations in mechanically ventilated patients is endotracheal tube (ETT) suctioning. However, there are many approaches to this procedure's execution. ETT suction complications are frequent, occurring in about a quarter of ETS episodes, and clinical treatment varies greatly (**Mohamed & Ahmed, 2022**). Alveolar decruitment, reduced saturation, and cardiovascular functionality are complications that affect patients and may lengthen the time spent in an intensive care unit. Large numbers of critically sick patients could benefit from ETS therapies that are themost effective and least complicated while also experiencing significant cost savings (**Schults et al., 2020**).

2.1Significance of the Study

Endotracheal suctioning of mechanically ventilated patients with artificial airways as Clinical Practice Guidelines, issued by the American Association for Respiratory Care (AARC), in 2010. **(Higgs et al., 2018)**. These recommendations include avoiding routine normal saline instillation prior to ETT suctioning and only doing ETT suctioning when absolutely necessary. Suction tube diameter is less than 50% the lumen of ETT in adults, maximal suction duration is between 10 and 15 seconds, and it also requires the use of CSS for adults with high FiO2 or PEEP (**Elsaman, 2017**).

Suctioning has been identified as a potentially dangerous treatment associated with a variety of consequences, including trauma, bronchoconstriction, hypoxemia, cardiac arrest, and mortality. As a result, CCNs managing those patients with ETT require excellent technical capabilities in suctioning procedures **(Pinto, D'silva, & Sanil, 2020; Scholtz, Nel, Poggenpoel, & Myburgh, 2016)**. In order to prevent these issues, it is crucial to evaluate the CCNs' ETT suctioning procedures (**Sheta & Mohamed Tantaewy, 2022**).

According to a prior study, endotracheal suctioning can have less negative impact on patients when nurses conduct it correctly. By implementing evidence-based suggestions in their work, nurses can enhance patient care, prevent avoidable deaths and medical procedures, shorten hospital stays and lower patients' costs. **(Maggiore et al., 2013)**. These results highlight the need for more research to evaluate CCNs' ETT suctioning practices in Egypt and pinpoint areas that require improvement.

2.2Aim of the study

The aim of this study is to assess critical care nurses‟ practice of endotracheal tube suctioning in intensive care units at Emergency Hospital, Mansoura University.

2.3Research Question

To fulfill the aim of the study, the following research question is formulated:

Q: What is critical care nurses' level of practice regarding endotracheal tube suctioning in intensive care units?

3Method

3.1Research design

In order to perform this study, a descriptive observational research approach was employed. Without respect to causes or other theories, it was created tocharacterize the distribution of one or more variables. (**Aggarwal & Ranganathan, 2019**). It was the most appropriate design for the current study as it aimed to assess the critical care nurses' (CCNs) practice of endotracheal tube suctioning in ICUs. Direct observation was potentially a more comprehensive method to ascertain how nurses performed in the real situation and to determine variations in nurses' practice.

3.2Setting

This study was conducted in the ICUs of the Emergency Hospital, Mansoura University. There were 3 ICUs numbered as surgical 1, 2 and 3. Each unit included 10 beds except unit 3 which involved 8 beds. These ICUs received patients with trauma, brain spontaneous hemorrhage, and poisoning. These ICUs received patients from the Emergency Rooms (ER) and the Operating Rooms (OR) on 3 days per week; Sunday, Tuesday, and Thursday. According to the hospitals records, about 18-30 patients admitted to these ICUs per week and more than 60 patients per month. These ICUs are well equipped with advanced medical devices that are required for different patient care. The nurse-patient ratio in the selected ICUs is nearly 1:2.

3.3Subjects

A convenience sample of 50 CCNs working in the above-mentioned ICUs who were involved in direct patient care and who had at least one year of work experience in ICUs were invited to participate in this study. CCNs who agreed to participate were included in this study.

3.4Tools of Data Collection

One tool was used to collect data for this study. "The Practice of Endotracheal Tube Suctioning". This tool included two parts as follows:

Part I: "Nurses' Socio-Demographic Characteristics":

This part was developed by the primary investigator (PI) to gather the nurses' socio-demographic characteristics. It includes gender, age, level of education, and years of work experience …, etc.

Part II: "Nurses' Practice of Endo-Tracheal Tube Suctioning Observation Checklist":

This part was adapted from the **American Association for Respiratory Care (AARC, 2010), Day, Farnell, Haynes, Wainwright, & Wilson‐Barnett (2002), McKillop, (2004), and Özden & Görgülü, (2012).** It aimed to assess the nurses'practice of ET suctioning in ICUs.

The Scoring System was distributed as follows: Each "done correctly" step was given 1 mark, while "done incorrectly or not done" steps were given a zero mark. . The total scoring involved two categories: satisfactory or unsatisfactory. Satisfactory if score ≥85% of the maximum score while unsatisfactory if score <85% of the maximum score.

3.5Validity

The tool was tested for its validity by seven experts in Critical Care and Emergency Nursing and Medicine. Necessary modifications were done accordingly. Part two of the tool was modified by adding additional steps and putting two options; "done correctly" and "done incorrectly or not done".

3.6Reliability

The reliability of the tool (part II) was tested by Cronbach's Alpha test and was 0.828 indicating a reliable tool.

3.7Pilot Study

A pilot study was carried out on 10% of the total sample. It was done to test the feasibility and clarity of the tool. Participants in the pilot study were not included in the main study.

3.8Ethical Considerations

The Faculty of Nursing at Mansoura University's Research Ethics Committee (REC) granted its ethical approval. After outlining the purpose of the study, the administrative authority at the hospital granted official approval. All CCNs were informed about the details of the study. Informed consent was obtained from the nurses who accepted to participate in the study. They were also informed that they had the right to refuse to participate or withdraw from the study at any stage without any penalty. The anonymity and confidentiality of the collected data were maintained. Participant nurses were assured that the observed practice was not a part of their annual evaluation.

3.9Data Collection

Data were collected from October to December 2020 after obtaining official approval from the hospital's administrative authority. This study was conducted in three phases; preparation, implementation, and evaluation phases.

1. Preparation phase

- Ethical approval was obtained from the REC.
- The data collection tool was modified by the PI and was tested for its validity and reliability.
- Permission to conduct the study was obtained from the responsible authorities of the study setting after providing them with an explanation of the aim of the study.
- The informed consent for the participant nurses was prepared.

2. Implementation phase:

- Firstly, the PI started data collection by explaining the aim and the purpose of the study to the nurses and invited them to participate in the study. The data collection sheets were coded to assure the anonymity of the subjects.
- Then the socio-demographic data were recorded by the participant nurses themselves using part one of the tool.
- Participant nurses' performance of ETT suctioning was observed practically in the morning and afternoon shifts using part two of the tool. The participant nurses were observed three times during the period of the study.
- Each participant nurse applied the procedure for at least 10 minutes and the procedure was assessed by filling out the checklist form involving all steps of the procedure using part II of the tool.

3. Evaluation phase:

At this phase, the participant nurses' performance was evaluated. Each nurse was observed three separate times. The mean of the three observations was calculated to get the total scores in order to determine whether the participant nurses' performance level was satisfactory or unsatisfactory.

3.10Data Analysis

Data analysis was undertaken using the Statistical Package for Social Science (SPSS) version 22.0. Descriptive statistics were used to interpret the demographic data; age, sex, and working experience in ICU. Descriptive measures included frequency and percentage of categorical variables. The quantitative data were described using means and standard deviations. Also, numbers and percentages were used to represent qualitative data. The t-test (t) was used to compare the difference between the means of variables. P-value $\leq$ 0.05 was considered significant and a highly significant level value was indicated when p-value $\leq$ 0.001.

3.11Limitation of the current study:

The sample was drawn from one hospital in one geographical area in Egypt that restricts the generalization of findings. Our

sample comprised of 50 nurses, where a larger sample would have been more appreciated.

4.Results

Table 1 presents the socio-demographic characteristics of participant nurses. It showed that nearly half of the nurses were in the age group between 25 - 30 years old with a mean ± SD of 27.48 ± 3.11, and more than half of them were females. Additionally, more than one third of the participant nurses were graduates of the technical nursing institute. Also, half of the participants had from 1 to ≤ 5 years of work experience in the ICU with a mean ± SD of 7.16 ± 1.23. Furthermore, only one third of the participant nurses attended educational programs or workshops on endotracheal tube suctioning.

Table 2 describes the participant nurses' preparation for suctioning procedure. The majority of nurses prepared the required equipment for suctioning correctly such as the oxygen source, suction apparatus, and connecting tubes, sterile normal saline or sterile water, and disposable container, and a container for waste material.

In addition, more than the half selected the appropriate catheter size, and prepared the manual resuscitation bag. However, Majority of the nurses did not put on sterile gloves, aprons, and goggles. Statistically significant differences were noted between the participant nurses concerning their preparation of the patient for suctioning procedure (p=0.000*).

Table3illustrates the participant nurses' practice of the suctioning procedure. The majority of the participant nurses correctly flushed the suction catheter between suction passes using normal saline solution and lubricated the suction catheter with normal saline solution. Additionally, nearly two-thirds of the participant nurses correctly performed up to 3 passes only if secretions remain in the airway and hyper-oxygenated the patient for at least 30 seconds by pressing the suction button on the ventilator.

On the other side, most of the participant nurses did not wear sterile gloves, aprons, and goggles and incorrectly allowing the patient to rest for 20 to 30 seconds between suction passes with hyper- oxygenation and hyperinflation for 5 breaths over 30 seconds before and after each suction pass. The results also showed that all of the participant nurses did essential steps in suctioning procedure incorrectly such as disconnecting thepatient from the ventilator and administering several breaths (5 breaths) over 30 seconds using a manual resuscitation bag before suctioning.

Table 4 clarifies the participant nurses' practice of post-suctioning care. The results showed statistically significant differences in nurses' performance of post suctioning care of the patient. The majority of the nurses correctly performed the patient's post suctioning care including reconnecting the patient to Oxygen or mechanical ventilation, reassessing the patient, and repositioning the patient.

The results also illustrated that all nurses managed the equipment post suctioning correctly including turning off the suction apparatus and disconnecting the catheter from the connecting tube, correctly performed hand washing and documented the date, time, and indications for suctioning. On the other hand, the results depicted that all participant nurses did not document the amount of negative pressure or the number of suction passes. Moreover, the majority did not document the size of the suction catheter used or the patient's response to tracheal suctioning and any complications.

Table 5 compares between the total and subtotal score of the participant nurses' practice regarding ETT suctioning. The results showed that the total practice score of the participant nurses was unsatisfactory with a mean ± SD of 55.49 ± 6.51.

Table 6 delineates the correlation between participant nurses' socio-demographic characteristics and their practice domains. Statistically significant correlations were found between the nurses' socio-demographic characteristics and their practice of the endotracheal suctioning procedure.

Table ISocio-demographic Characteristics of Participant Nurses

Nurses' socio-demographic characteristics	n = 50		Significance test	
	Frequency	%	X^2	*P*
Age				
< 20 years	0	0.0		
20 – 25 years	9	18.0	5.560	.062
>25 – 30 years	22	44.0		
> 30 years	19	38.0		
Mean ± SD	27.48 ± 3.11			
Gender				
Male	21	42.0	1.280	.258
Female	29	58.0		
Educational level:				
Secondary nursing school	16	32.0		
Technical nursing institute	18	36.0	0.160	**.023**
Bachelor of nursing sciences	16	32.0		
Post-Graduate degree	0	0.0		
Years of work experience in ICU:				
1 - ≤ 5 years	25	50.0		
> 5 -10 years	5	10.0	13.000	**.002**
> 10 years	20	40.0		
Mean ± SD	7.16 ± 1.23			
Attended previous educational training programs or workshops about Endotracheal tube suctioning				
Yes	17	34.0	5.120	**.024**
No	33	66.0		
Number of training programs they attend				
1	**5**	**10.0**		
2	**3**	**6.0**		
3	**7**	**14.0**	8.000	**.002**
4	**1**	**2.0**		
>4	1	2.0		

Data are expressed as numbers (N) and frequency (%), $\bar{X}$: mean, SD: standard deviation, ICU: intensive care unit, $\chi 2$: Pearson Chi-square

Table 2Participant Nurses' Preparation for Suctioning Procedure

A. Preparation for the suctioning procedure:	Nurses' Practice (n=50)				Significance test	
	Done correctly		Done incorrectly or not done			
	No.	%	No.	%	X^2	P
Environment:						
1. Preparing equipment needed for suctioning procedure:						
• Sterile suction catheter package (size of suction catheter is less than half of the internal diameter of the Endotracheal tube)	30	60.0	20	40.0	25.514	**.000***
• Sterile gloves, aprons and goggles	1	2.0	49	98.0	79.367	**.000***
• Manual resuscitation bag (Ambu bag)	31	62.0	19	38.0	26.240	**.000***
• Oxygen source	46	92.0	4	8.0	74.208	**.000***
• Suction apparatus and connecting tubes	47	94.0	3	6.0	41.649	**.000***
• Sterile normal saline or sterile water and disposable container	47	94.0	3 2	6.0	41.649	**.000***
• Container for waste material	48	96.0		4.0	46.193	**.000***
2. Maintaining patient's privacy (close curtains & doors)	38	76.0	12	24.0	69.861	**.000***

Nurse:						
3. Washing hands	20	40.0	30	60.0	16.425	.232
Patient:						
4. Explaining the procedure to the patient or family if present	25	50.0	25	50.0	23.663	**.000***
5. Positioning the patient in a comfortable position:						
• If conscious: in semi-fowler or high fowler's position	2	4.0	48	96.0	48.580	**.000***
• If unconscious: in supine position with the patient's head facing the nurse	24	48.0	26	52.0	19.746	**.000***
6. Assessing the patient's need for suctioning:						
• Auscultating the patient's adventitious lung sound (crackles) over the trachea or main stem bronchi	9	18.0	41	82.0	53.228	**.000***
• Increasing peak airway pressure on MV	8	16.0	42	84.0	52.980	**.000***
• Increasing respiratory rate or frequent cough	46	92.0	4	8.0	37.229	**.000***
• Gradual or sudden decrease in PaO2 or SpO2	42	84.0	8	16.0	61.346	**.000***
7. Putting a towel or dressing across the patient's chest	41	82.0	9	18.0	59.632	**.000***

Data are expressed as numbers (N) and frequency (%), (*) statistically significant at $p \leq 0.05$, Pao2: partial pressure of oxygen, Spo2: oxygen saturation value, $\chi 2$: Pearson Chi-square

Table 3 *Participant Nurses' Practice of Suctioning Procedure*

B. Suctioning procedure:	**Nurses' Practice (n=50)**				**Significance test**	
	Done correctly		**Doneincorrectly or not done**		**X^2**	**P**
	No.	**%**	**No.**	**%**		
1. Turning on the suction apparatus to the appropriate suction pressure according to the patient's age	10	20.0	40	80.0	**29.261**	**.000***
2. Opening a sterile suction catheter package	20	40.0	30	60.0	**24.025**	**.000***
3. Pouring about 100cc of normal saline or sterile water in a disposable container	11	22.0	39	78.0	**31.680**	**.000***
4. Hyper-oxygenating the patient for at least 30 seconds by:						
a. Pressing the suction button on the ventilator	31	62.0	19	38.0	**16.038**	**.008**
b. Disconnecting the patient from the ventilator and administering several breaths (5 breaths) over 30 seconds using a manual resuscitation bag before suctioning	0	0.0	50	100.0	**36.008**	**.000***
5. Donning sterile gloves, aprons and goggles	7	14.0	43	86.0	**62.361**	**.000***
6. Picking up the suction catheter without impairing its sterility	18	36.0	32	64.0	**29.200**	**.000***
7. Wrapping the suction catheter around the dominant hand and securing it to the connecting tube in the non-dominant hand	14	28.0	36	72.0	**38.201**	**.000***
8. Suctioning small amount of normal saline solution or sterile water for lubricating the suction catheter and checking efficiency of the suction apparatus	46	92.0	4	8.0	**41.604**	**.000***
9. Maintaining aseptic technique during suctioning	13	26.0	37	74.0	**39.365**	**.000***
10. Inserting the suction catheter to the ET-tube gently and quickly until resistance is met then pull back for 1cm	17	34.0	33	66.0	**19.229**	**.003**
11. Applying suction on withdrawal of the suction catheter only	11	22.0	39	78.0	**43.960**	**.000***
12. Using intermittent rather than continuous suctioning, rotate gently in one smooth uninterrupted motion	11	22.0	39	78.0	**15.680**	**.000***
13. Flushing the suction catheter between suction passes using normal saline solution or sterile water until become clean	48	96.0	2	4.0	**42.320**	**.000***
14. Allowing the patient to rest for 20 - 30 seconds between suction passes with hyper- oxygenation and hyperinflation for 5 breaths over 30 seconds before and after each suction pass as indicated	9	18.0	41	82.0	**50.920**	**.000***
15. Performing up to 3 passes only if secretions remain in the airway and the patient is tolerating the procedure	32	64.0	18	36.0	**27.040**	**.000***
16. Restricting each suction time to less than or equal 10-15 seconds	27	54.0	23	46.0	**22.840**	**.000***

Data are expressed as numbers (N) and frequency (%), (*) statistically significant at p ≤0.05, CC: cubic centimeter, ET- tube: endotracheal tube, cm: centimeter, χ2: Pearson Chi-square

Table 4 *Participant Nurses' Practice of Post-suctioning Care*

C. Post - Suctioning Care:	Nurses' Practice (n=50)				Significance test	
	Done correctly		Done incorrectly or not done		X^2	P
	No	%	No.	%		
Patient:						
1. Reconnecting the patient to oxygen or mechanical ventilator within 10 seconds	47	94.0	3	6.0	44.846	.000*
2. Reassessing the patient's cardiopulmonary status, chest sounds and presence of cyanosis, secretions or dyspnea	46	92.0	4	8.0	81.739	.000*
3. Repositioning the patient to a comfortable position	45	90.0	5	10.0	76.803	.000*
Equipment:						
4. Turning off the suction apparatus	50	100.0	0	0.0	50.319	.000*
5. Disconnecting the catheter from the connecting tube	50	100.0	0	0.0	51.887	.000*
6. Discarding the contaminated equipment safely	49	98.0	1	2.0	58.003	.000*
Nurse:						
7. Removing gloves	49	98.0	1	2.0	47.117	.000*
8. Washing hands	50	100.0	0	0.0	52.367	.000*
9. Documentation						
• Date and time	50	100.0	0	0.0	54.816	.000*
• Indications for suction	50	100.0	0	0.0	52.648	.000*
• Chest auscultation, pulse oximeter and vital signs pre and post suctioning procedure	46	92.0	4	8.0	38.016	.000*
• The size of suction catheter used	1	2.0	49	98.0	52.978	.000*
• The amount of negative pressure	0	0.0	50	100.0	61.369	.000*
• The number of suction passes or times	0	0.0	50	100.0	61.369	.000*
• Color, amount, odor and consistency of suctioned secretions	16	32.0	34	68.0	36.111	.011
• Patient's response to tracheal suctioning and any complications	5	10.0	45	90.0	55.123	.000*

Data are expressed as numbers (N) and frequency (%), (*) statistically significant at p ≤0.05, χ2: Pearson Chi-square

Table 5 *Comparison between the Total and Sub-total Score of Practice*

Items	Nurses' Practice (n=50)				Significance test	
	Satisfactory		Unsatisfactory		X^2	*P*
	N	%	N	%		
A. Preparation for Suctioning Procedure	0	0.0	50	100.0	28.720	.017
Mean ± SD	19.23 ± 3.12					
B. Suctioning procedure	4	8.0	46	92.0	25.600	.019
Mean ± SD	18.22 ± 3.75					
C. Post-Suctioning Care:	0	0.0	50	100.0	44.920	.000*
Mean ± SD	17.69± 2.94					
Total practice score	0	0.0	50	100.0	22.000	.005
Mean ± SD	55.49 ± 6.51					

Data are expressed as numbers (N) and frequency (%), (*) statistically significant at *p* ≤0.05, χ2: Pearson Chi-square, $\overline{X}$: mean, SD: standard deviation

Table 6 *Correlation between Participant Nurses' Socio-demographic Characteristics and their Practice*

Nurses' socio-demographic characteristics	Practice domains (n=50)					
	Preparation for the suctioning procedure		Suctioning procedure		Post - Suctioning Care	
	r/F	P	r/F	P	r/F	P
Age						
< 20 years	- .459	.002	-.523	.000*	-.426	.000*
20 – 25 years	-.364	.008	-.419	.001	-.395	.000*
>25 – 30 years	-.789	.000*	-.790	.000*	-.812	.000*
> 30 years	-.441	.001	-.528	.007	-.472	.000*
Gender						
Male	- .526	.000*	-.522	.000*	-.496	.019
Female	-.401	.000*	-.468	.000*	-.480	.023
Educational level:						
Secondary nursing school	.782	.014	.550	.000*	-.463	.000*
Technical nursing institute	.452	.000*	.412	.000*	-.530	.000*
Bachelor of nursing sciences	.612	.003	.701	.000*	-.624	.000*
Post-Graduate degree	.539	.001	.811	.000*	-.496	.000*
Years of work experience in ICU:						
1 - ≤ 5 years	- .305	.001	-.492	.000*	.776	.001
> 5 -10 years	-.412	.000*	-.437	.000*	.821	.000*
> 10 years	-.311	.007	-.716	.009	.687	.000*
Attended previous educational training programs or workshops about Endotracheal tube suctioning	-.971	.005	-.974	.005	-.468	.030
Number of training programs they attend	.862	.042	.810	.001	.749	.038

Data are expressed as numbers (N), *F*: Annova test, (*) statistically significant at $p \leq 0.05$, ICU: intensive care unit

5. Discussion

In the ICU context, safe and sterile endotracheal suctioning has been a significant health challenge. A suction catheter is inserted into the endotracheal tube during endotracheal suction to remove the discharge. For a patient receiving mechanical ventilation, endotracheal tube suctioning is necessary to maintain a clean, infection-free airway. Additionally, it has been linked to some negative effects like hypoxia and pneumonia brought on by a ventilator.

In this regard, the knowledge and skills of ICU nurses should be in accordance with the established standards for the ETT suctioning technique **(Pinto, D'silva, & Sanil, 2020)**. Thus, if the endotracheal suctioning procedure is not carried out correctly, it will result in a number of complications, including respiratory and cardiac defects, tracheal endothelial trauma, bleeding, hypoxemia, and cardiac arrhythmias, as well as increased intracranial pressure that may result in cardiac arrest and death **(Yilmaz, Ozden, & Arslan, 2021)**.

Hence, the present study aimed to assess critical care nurses' practice of endotracheal tube suctioning in ICUs of the Emergency Hospital at Mansoura University. Firstly, as regard socio-demographic characteristics of participant nurses. It was found that the total number of participant nurses sampled in the present study was 50. Regarding their age and gender, the findings of the present study showed that nearly half of them were in the age group between >25 and 30 years old, and more than half of them were females. This may be because ICUs are a specialization that calls for young, qualified nurses in order to give better nursing care and have better capacity to handle the demand.

The majority of nurses in Egypt have been female for many years, and until 10 years ago, their numbers were still higher than those of men in the nursing profession, which

accounts for the rising proportion of females. Additionally, nursing is a naturally feminine occupation, and traditionally, women have symbolized dominance in this field. In the same line with our result **Bano, Hussain, Afzal, and Gilani, (2020)** studied measurement of knowledge and performance of ICU nurses about endotracheal suctioning showed that the majority of the nurses were of the age group from 20 to 29 years old.

In this study, concerning the level of education, more than one-third of the participant nurses graduated from the technical nursing institute, followed by the secondary nursing school and the Bachelor's degree in nursing who were one third only. This may be attributed to that as it was known in the past that the nursing schools were familiar than the faculties. So, the old nurses with nursing schools formulated a higher proportion than the younger ones. Also, the number of faculty graduates up-till now is not enough to cover all units as most of them work as administrators in the ICUs.

Similarly, **Mamdouh, Mohamed, and Abdelatief, (2020)** conducted a study about nurses' performance in ICU and showed that less than half of them had nursing institute, but **Mwakanyanga, Masika, and Tarimo, (2018)** conducted an observational study in Tanzania and found that the majority of their study participants had a diploma in Nursing.

On the contrary, in Ethiopia, **Afenigus et al., (2021)** studied nurses' skills on suctioning in ICU and declared that nearly three-quarters of these nurses had Bachelor's degrees, but those with diploma degrees represented about only one-tenth. This difference may be because of the difference in settings. Also, **Maraş, Güler, Eşer, and Köse, (2017)** found that about two thirds of the studied nurses had Bachelor's degrees.

Secondly, concerning the participant nurses' practice regarding suctioning procedure. The present study showed that nearly three-quarters of them did not wrap the suction catheter around the dominant hand and securing it to the connecting tube in the non-dominant hand, and incorrectly maintained an aseptic technique during suctioning. Most of the nurses incorrectly turned on the suction apparatus to the appropriate suction pressure. About two thirds of the nurses incorrectly inserted the suction catheter to the ET-tube gently and quickly until resistance is met then pull back for 1cm, and incorrectly picked up the suction catheter without impairing its sterility.

Supporting our result **Alladam, (2016)** found that about half of the studied nurses did not turn suctions on to appropriate pressure, set up sterile container; pour sterile saline or sterile water into it, and majority of them did not wear sterile gloves; keep dominant hand sterile & other hand clean, and attach distal end of catheter to tubing on suction machine. This may be explained by that the mainstream of contributors had experienced less than ten years in ICU. These experiences, reflect on their practice.

Conversely, **Haghighat, and Yazdannik, (2015)** found that about the majority of the participants inserted the appropriate length of catheter, and applied negative pressure for less than 10 seconds based on continuous method, which is found in most of the guidelines. This discrepancy may be due to the majority of participants had a bachelor degree with more than two to four years of experience which reflected on their suctioning practices.

In relation to the participant nurses' practice of post-suctioning care. The current study noted that the majority of the nurses correctly performed the patient's post suctioning care including reconnecting the patient to oxygen or mechanical ventilation, reassessing the patient, and repositioning the patient. In the same line with our results, **Bano, Hussain, Afzal, and Gilani, (2020)** found that most of nurses did post suctioning hyperoxygenation, and reassured patient respiratory status. Conversely, **Mwakanyanga, Masika, and Tarimo, (2018)** found that most of the nurses did not perform post-suctioning hyper oxygenation, and post-ETs assessments as patient's chest auscultation after suctioning. Also, the majority of them don't reassure the patient.

In addition, the current results illustrated that all nurses managed the equipment post

suctioning correctly including turning off the suction apparatus and disconnecting the catheter from the connecting tube, performed hand washing and documented the date and majority of them discarded the contaminated equipment safely. Supporting our findings, **Bano, Hussain, Afzal, and Gilani, (2020)** noted that about all of nurses reassessed the patient's respiratory status, discarded equipment after suction, performed hand wash, monitored any changes in the vital signs, and most of them documented the suction procedure.

Also, **Majeed, (2017)** found most of nurses discards equipment after suction, perform hand wash, monitor any changes in the vital signs, and document the suction procedure. On the other hand, **Mwakanyanga, Masika, and Tarimo, (2018)** at post suctioning; most of nurses did not auscultate chest, did not hyper-oxygenate the patient and the majority of them did not check cuff pressure. Furthermore, a large proportion of participants were observed not reassuring the patients after the procedure whereas most of them did not disinfect their hands post-suctioning procedure.

Thirdly, regarding the comparison between the total and subtotal score of the participant nurses' practice regarding ETT suctioning. The current study statistically significant variations between the total and subtotal score of nurses' practice were found. The results showed that the total practice score of all participant nurses was unsatisfactory. In the same line with our results, **Alladam, (2016)** revealed that, the majority of the studied sample had unsatisfactory practice level.

Also, **Shrestha, and Shrestha, (2018)** studied knowledge and practice regarding endotracheal suctioning among nurses of selected teaching hospitals. They found that more than half of the nurses had unsatisfactory practice on endotracheal suctioning. On the other hand, **Zeb, Ali, Hussain, Shah, and Faisal, (2017)** studied knowledge and practice of ICU nurses regarding endotracheal suctioning in tertiary care hospitals, and they revealed that the mean practice level of the participants regarding ETT suctioning was 80.37%±18.37%, which is expressed as satisfactory practice.

Finally, concerning correlation between participant nurses' socio-demographic characteristics and their practice domains. Concerning the age and gender of the participant nurses and their practice, the results showed a negative weak correlation between the age and gender of the participants and their practice in both the preparation for the suctioning procedure, the suctioning procedure, and post-suctioning care. Similarly, **Zeb, Ali, Hussain, Shah, and Faisal, (2017)** revealed that the gender had significant relation with knowledge and practice regarding endotracheal suctioning.

Furthermore, in Egypt, **Hesham, (2016)** depicted that there was a statistically significant relationship between nurses' practice and their demographic characteristics. They attributed that to the fact that the nurses' practice depends more on experience training and imitation and because of no or very few training courses were available for them.

6. Conclusion

The current study concluded that CCNs' practice regarding ETT suctioning was unsatisfactory. These findings may have a negative effect on patients' outcomes.

7. Recommendations:

The CCNs need a training program application to improve their practice regarding ETT suctioning to improve health for large numbers of critically ill patients, prevent complications and significantly saving costs.

8. Acknowledgment

We would like to express our gratitude to all patients who consent to take a part in this study and the health care staff for their support during the study.

9. Financial support

This study research did not obtain any particular finance from any communal, commercial, or private agencies.

10.Conflict of interest

The authors acknowledged no latent conflicts of interest regarding this study, authorship, and/or publication of this research.

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