Original Article

Nurses' Performance And Self-Efficacy About Open Versus Closed Suction On Intubated Adult Patients: A Comparative Study

Fatma Mohamed Elmansy[1,2]

[1]Department of Medical Surgical Nursing, College of Nursing, Qassim University, Saudi Arabia.
[2]Medical Surgical Nursing Department, Faculty of Nursing, Suez Canal University, Ismailia, Egypt.
E-mail: f.elmansy@qu.edu.sa
ORCID: https://orcid.org/0000-0002-1709-0132
DOI: 10.47750/pnr.2023.14.04.300

Abstract

Background: Closed-system endotracheal suction improves oxygen desaturation by reducing the lung tidal volume that follows open-system endotracheal suction. Evidence-based practices: more of these nurses' practices are unobserved and not upgraded. It is necessary to improve their knowledge and skills to be more competent at suctioning. This study aimed to compare nurses' performance and self-efficacy about open versus closed suction on intubated adult patients.

Materials and Method: A cross-sectional comparative research design study was conducted at adult intensive care units in Suez Canal University hospitals. They were sorted into two groups by random selection: group (I) included 32 nurses for whom open suction, while group (II) included 32 nurses for whom closed suction was utilized. Utilizing self-administered questionnaires to assess nurses' demographic features and level of knowledge, self-efficacy, and observational checklists to assess nurses' practice.

Results: There was a highly statistically significant difference between intensive care nurses' performance in open and closed suction (68% and 47%) consecutively. However, there was no statistically significant correlation between their self-efficacy about open and closed suction (P = 0.06). **Conclusions:** More of those studied nurses had a technical institute in both groups of suction. Also, there is an overall difference in satisfactory performance levels between open ET suction group I and closed ET suction group II. Additionally, their self-efficacy level is high in open group I compared to the ET closed suction group II.

Recommendations: In-service-led continuous training courses improve nurses' performance in the closed suction system and upgrade open suction in addition to enhancing their self-efficacy level in both. ICU nurses ought to be attentive sequentially for the use of the suction system and updated nursing guidelines in regular practice.

Keywords: Critically ill patients, Intensive care nurses, Open versus closed endotracheal Suction, Self-efficacy.

1. INTRODUCTION

The endotracheal tube (ETT) is a life-saving practice that can improve and protect the natural airway while also allowing mechanical ventilator support to be delivered [1]. It is the most commonly performed invasive practice for those individuals who need mechanical ventilation by critical care nurses [2]. It clears the endotracheal tree from secretions, assures adequate tissue ventilation-perfusion, reduces the patient's strain of breathing, inhibits clogging of the tube flow, and guards against atelectasis and bronchus infection [3]. Unfortunately, when the patient is interfacing with the ventilator, disrupting the normal airway, coughing, and subsequently secretion accumulation in the lungs and in the tube might cause microbial activity, airway obstruction, hypoxia, bronchospasm, bronchiectasis, a rise in intracranial pressure, tachycardia, cardiac arrest, and eventual death [4–5]. There are two systems involved: the open suction system (OSS), which remains the traditional suction skill, which requires the ventilator to be detached from the patient and using a single-use catheter [6].

However, it is stated that a closed suction system (CSS) can remain in line for 24 hours with a multiple-use catheter through the multi-use drain's plastic sheath during ETS techniques [7]. CSS is now very popular and is partially the most used type in intensive care units because ventilation continues during the suction procedure, reducing lung volume loss and avoiding gas exchange impairment, preserving positive end-expiratory pressure (PEEP), reducing environmental pollution, and system convenience, which potentially lowers costs. One benefit of this approach is that equipment setup and clean-up take less time, and patients experience less anxiety [8-9]. Nursing practice in the ETS procedure for critically ill patients varies greatly among both organizations and practitioners. It is possibly because of barriers to change, a lack of managerial support, a loss of adult intensive care unit (ICU) training, a lack of easy access to the

literature, a lack of time to read and understand it, competing workload pressures, inadequate knowledge about this procedure, and nurses' practice based on their personal experiences [10-11].

Intensive care nurses are integral members of a multidisciplinary team and play a crucial role in the care of hospitalized patients [12]. Endotracheal tube suction can cause life-threatening effects and should be implemented in accordance with established protocols and guidelines to reduce mortality, morbidity, expenditures, and duration of hospital stays and increase quality outcomes by hastening patient recovery [13]. Furthermore, it is anticipated that about 20% or more receive care that is possibly unintentionally harmful [14-15]. Self-efficacy can be broadly described as people's assessments of their capacities to plan and carry out the steps necessary to achieve specific sorts of performance; it is less concerned with one's skill set than with assessments of what one can accomplish using the skills they do have. The definition of general self-efficacy is the belief that one can do well in a variety of scenarios [16]. CSS has recently been adopted and is still a new challenge in the Suez Canal University hospitals. Hence, the present observational study was necessary to investigate and compare nurses' performance and self-efficacy about open versus closed suction on intubated adult patients.

2. MATERIAL AND METHOD

2.1 Design and setting

This cross-sectional comparative research design was utilized in the current study from October 2021 to March 2022 in adult intensive care units affiliated with Suez Canal University hospitals in Ismailia City, Egypt.

2.2 Population and Sampling technique

The participants in the current study were sixty-four nurses from the previously mentioned settings. They were sorted into two groups by random selection: group (I) encompassed 32 nurses for whom open suction was utilized, while group (II) encompassed 32 nurses for whom the closed suction method was utilized. Using an epidemiological information system, sample size and power were estimated with a 95% confidence level, a 10% dropout rate for each group, and a 90% power of the study [17, 18]. The inclusion criteria involved both nurses who work in the ICU, both genders, and agreed to participate in the current study, while the exclusion criteria comprised pregnant nurses who had a debilitating medical condition, a planned vacation, or/and refused to participate in the study.

2.3 Data collection

Three tools were utilized to collect data: a self-administered questionnaire adapted by the researchers to assess the studied nurses' demographic features (such as age, gender, experience, place of work, etc.), level of performance (knowledge and practice), and self-efficacy about open versus closed ET suction on critically ill patients. These tools are stated as follows: Part (I): self-administrated questionnaire: It comprised thirty items into two sections to assess the studied nurses' knowledge level in the open ET suction group (15 items) versus the closed ET suction group (15 items) as definitions and purposes, indications and contraindications, procedures, and precautions of open or closed ET suction. Each right answer was given one mark, while the wrong answer was given a zero mark. The total score ranged from zero to fifteen for each part; it is interpreted as a satisfactory level of knowledge if it is more than or equal to 75% in the used part [14, 19].

Part (II) Observational Checklist: It was adopted by the researchers and consisted of thirty-two steps into two sections equally to assess the studied nurses' level of practice about open ET suction group (16 items) and closed ET suction group suction (16 items) as pre-procedure, procedure, and post-procedure of closed or open ETT suction. The participants were observed at the time of applying the utilized procedures. Each correct, complete step was given one grade, while an incorrect, incomplete step was given zero. The total score varies from zero to sixteen in the used section; it is explained as a satisfactory level of practice if it is more than or equal to 75%. [20, 21]. Part (II): Adapted self-efficacy scale: An adapted 10-item self-report scale was designed by Schwarzer & Jerusalem (1995) to assess the perceived self-efficacy of the studied nurses. A 4-point scale is used for responses. Add up the answers to each of the 10 questions to get the final composite score, which can be anywhere from 10 to 40. One is untrue, two is actually true, three is moderately true, and four is absolute truth. The self-efficacy level was deemed adequate if the score was 60% or more and inadequate if it was less than 60%. [22, 23].

It was accomplished by a panel of five experts (two professors of medical-surgical nursing, two professors of critical care nursing, and one professor of anaesthesia medicine), while minor modifications were completed to their feedback relying on a 3-item Likert scale containing necessary, suitable, but unnecessary, and unnecessary to clarify tools' comprehensiveness, clarity, and simplicity. Moreover, the reliability of the knowledge questionnaire, observational checklist, and self-efficacy scale were evaluated using Cronbach's alpha test, which was 0.82, 0.79, and 0.89 consecutively. Once we got it, a piloting sample was conducted on eight nurses to confirm the data collection methods were comprehensive, practical, understandable, and relevant. There have been no changes made to the study or the participants.

The present study has been conducted for six months, from October 2021 to March 2022. After getting all necessary administrative approvals to conduct the study and following an explanation of the study's purpose and the method of data collection, each nurse was individually approached and invited to participate in the study. Data were gathered at the end of each shift, three days per week. Their responses' confidentiality and anonymity were guaranteed. The data collection forms and instructions for filling them out were

distributed by the researcher. The completed forms to assess the studied nurses' knowledge and self-efficacy were gathered on schedule and checked for accuracy to ensure that no information was left out. Answering each sheet took 5–10 minutes on average.
The researcher was always on hand to clear up any doubts and queries. The researcher observed the nurse's practice twice using the observational checklist, either closed-path or open-path suction, based on the selected random group in three periods of observation used to evaluate the nurse's practice at the time of preparing the procedure, the actual procedure, and post-procedure. The researcher spent 5–10 minutes observing each nurse for each practice. Total data collection took seventy-one sessions within an average of twelve hours for knowledge and self-efficacy assessment and nine hours for observing nurses' practices. After data collection, the researcher rechecked the collected data, provided simple feedback about the questionnaires' outcomes, and greeted the participant nurses and supported healthcare workers in the study setting.

2.4 Statistical analysis

Data was accumulated, tabulated, and analyzed statistically using the statistics program SPSS (version 24). The Kolmogorov-Smirnov test was used to determine if the acquired data were normal, which concluded that it was a parametric date. The collected data was reviewed using frequency and distribution to describe characteristics. Variable differences during evaluation periods were independent sample t-tests (t) for related groups, and the Pearson correlation coefficient (r) was used to gauge the degree to which two variables are correlated. At p 0.05, the significance level was established.

3. RESULT

Table 1: clarify among the research subjects, that the participants' mean (SD) age for the open suction group was 26.8 (6.7) years, while for the closed suction group it was 27.2 (6.1) years. Findings revealed that more than two-quarters (62.5%) of nurses were female in group I, compared to (71.9%) in group II. About more than half (53.2%), (56.2%) of nurses had 4:6 experience in group I compared to group II consecutively. There was a statistically significant correlation between both groups at age, educational level, and experience year (0.001, 0,05, and 0.01), respectively.

Figure 1: shows that the overall satisfaction level of knowledge in group I was less than two-thirds (75%), as compared to more than half (65%) in group II, while practice level varied significantly by 72% and 56%respectively in groups I and II. Furthermore, the independent sample t-test results made it clear that there was a significant correlation statistically between overall nurses' performance in group I and group II of suction ($t = 19.47$; $p < 0.001$).

Figure 2: demonstrates that approximately one-third (33%) of the studied nurses in group I had a high self-efficacy level, as compared to less than one quarter (25%) in group II. Moreover, the independent sample t-test results made it clear that there was no significant correlation statistically between overall nurses' self-efficacy in groups I and II of suction ($t = 43.8$; $p < 0.06$).
However, based on the Pearson correlation coefficient test in the current results, there is a statistically significant correlation between nurses' knowledge score in group I open suction and nurses' self-efficacy score in both groups with a P value (≤0.05). Compared to group II closed suction, there was a statistically significant correlation between nurses' knowledge and practice score and nurses' self-efficacy score in both groups with a P value (≤0.05). It is described in
(Table 2).

Table 3: presents that there was a statistically significant correlation between nurses' knowledge and practice score in group I with their demographic features (P value ≤0.05). Additionally, there was a statistically significant correlation between nurses' knowledge in group II and their demographic features with a P value (≤0.05). However, there was a statistically significant correlation between nurses' self-efficacy scores in both groups with age as well as between nurses' self-efficacy scores in group I and gender with a P value (0.002 and 0.01) sequentially.

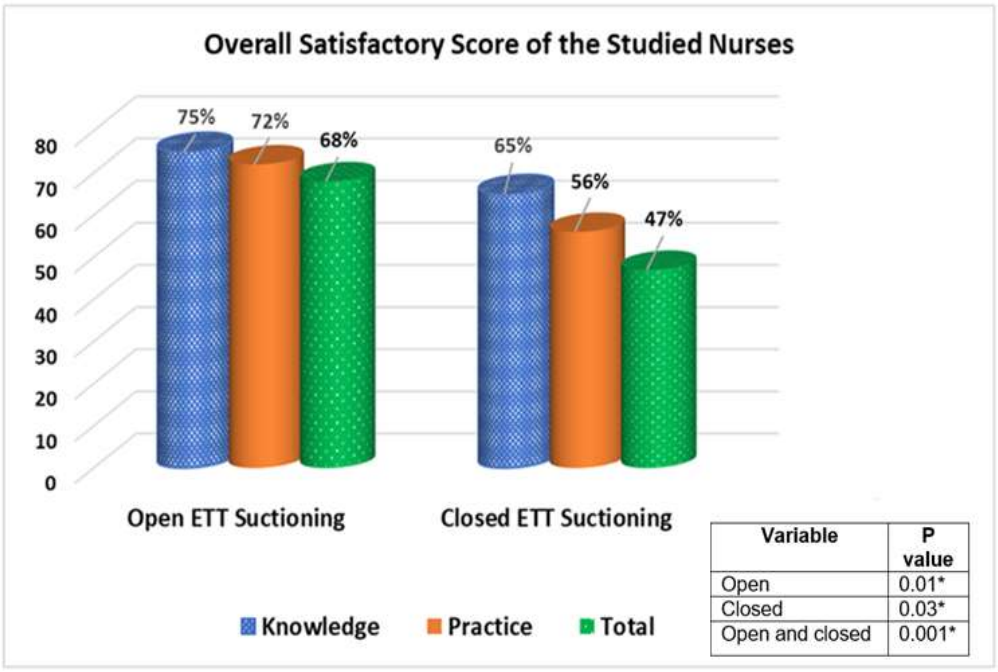
Table 1: Demographic features of the studied intensive care nurses (n=64).

Variables	**(Group I) Open suction. (n=32)**		**(Group II) Closed suction. (n=32)**		**P. Value**
	No.	%	No	%	
Age years					
<25	13	40.6	11	32.4	0.001
≥25	19	59.4	21	65.6	
Mean±SD.	26.8 ±6.7		27.2 ±6.1		
Range	19-34		20-35		

Gender					
Females	20	62.5	23	71.9	0.68
Males	12	37.5	9	28.1	
Education level					
Bachelors	3	9.4	5	15.6	0.05
Technical institute	16	50	17	53.1	
Technical bachelors	4	12.5	2	6.3	
Diploma	9	28.1	8	25	
Experience years					
1-3 years	10	31.2	8	25	0.01
4- 6years	17	53.2	18	56.2	
7- years	5	15.6	6	18.8	
Mean ± SD	3.6±6.8		2.9±5.8		
Receiving training courses.					
Received	9	28.1	6	18.8	0.54
Not received	23	71.9	26	81.2	
Availability of policies and procedure in the unit					
Yes	8	25	5	15.7	0.062
No	24	75	27	84.3	

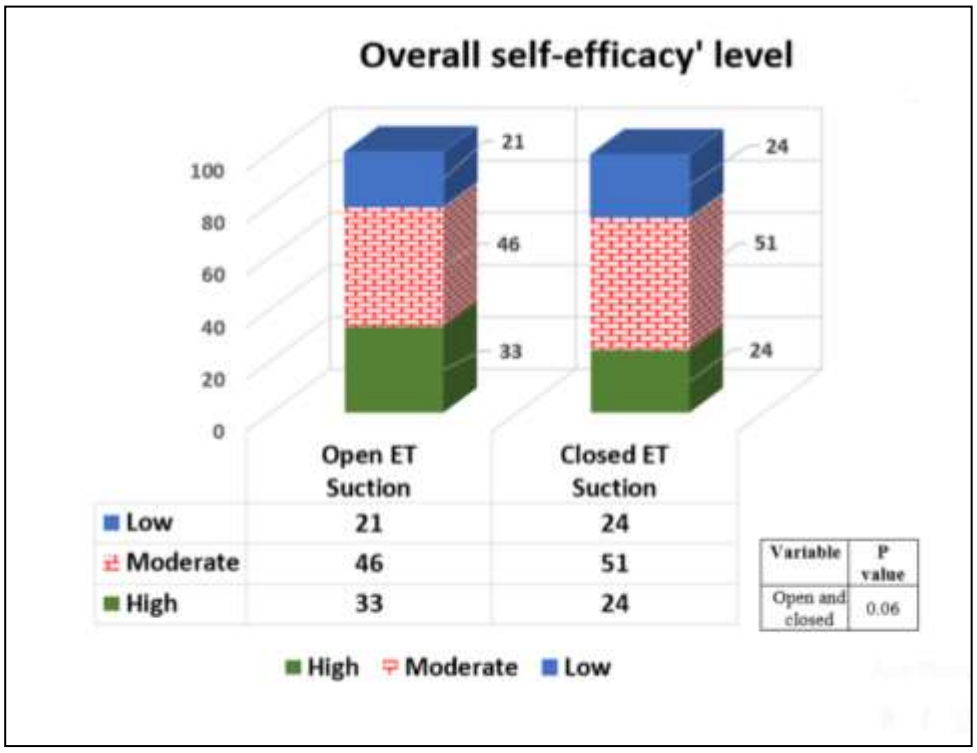
SD: Standard deviation **Significant level at P value < 0.05**

Chi square test for qualitative data, while Independent T-test quantitative data



t- independent sample t- test **significant level at P value < 0.05**

Figure 1: The studied nurses' overall satisfactory knowledge score about open versus closed endotracheal suction on critically ill patients (n=64).



t- independent sample t- test **significant level at P value < 0.05**

Figure 2: The studied nurses' overall self-efficacy level about open versus closed endotracheal suction on critically ill patients (n=64).

Table 2: Correlation matrix between overall the studied nurses' performance of open versus open ET suction and their overall self-efficacy score (n=64).

Variables	Overall nurses' self-efficacy score			
	Group (I) Open ET suction.		Group (II) Closed ET suction.	
	r	P	r	P
Group (I): Overall open ET suction's score				
knowledge.	0.32	0.001**	0.40	0.002**
practice.	0.085	0. 53	0.95	0.41
Group (II): Overall closed ET suction's score				
knowledge.	0.47	0.01**	0.29	0.01**
practice.	0.17	0.05*	0.83	0.01**

(r) Pearson Correlation coefficient ***significant at the 0.05 level** **** significant at the 0.01 level.**

Table 3: Correlation matrix between overall the studied nurses' performance, and the self-efficacy score of open versus open ET suction and their demographic features (n=64).

Variables	Demographic features							
	Age		Gender		Educational level		Experience year	
	r	P	r	P	r	P	r	P
Group (I): Overall open ET suction's score								
knowledge.	.65	0.01	.56	0.01	.64	0.02	.63	0.05
practice.	.84	.001	.74	0.05	.38	0.02	.28	0.01
Group (II): Overall closed ET suction's score								
knowledge.	.21	0.05	.85	0.05	.54	0.01	.77	0.01

practice.	.32	0.11	.26	0.26	.44	0.06	.11	0.78
Group (I & II): Overall nurses' self-efficacy score								
Open ET suction.	.56	0.002	.87	0.01	.13	0.54	.13	0.22
Closed ET suction	.11	0.01	.44	0.74	.29	0.61	.22	0.16

(r) Pearson Correlation coefficient **significant at the 0.05 level**

4. DISCUSSION

Endotracheal suction (ETS) is necessary for any seriously ill patient who requires invasive mechanical breathing, with the main objective of clearing secretions and avoiding airway blockage of the ETT [21]. Failure to remove secretions could result in a clogged or blocked artery. The suction system consists of two open suction techniques: first, the patient is customarily disconnected from the ventilator, and second, an endotracheal tube is fitted with a suction catheter. As an alternative, a ventilatory circuit with a closed suctioning system can be used, allowing the suction catheter to be inserted into the patient's airways without removing it from the ventilator [14, 24].

Regardless of the method used for suctioning, intensive care nurses are vital in peri-suctioning, involving baseline screening for signs of respiratory distress and monitoring for frequent problems such as bradycardia and hypoxia [16]. Following the procedure, it is important to pay attention to any complaints the patient may have, as symptoms like light-headedness, breathing problems, a racing heart, and harsh breathing, among others, may indicate suction-related issues and document the procedure. So, the current study was conducted to compare intensive care nurses' performance and self-efficacy about open versus closed endotracheal suction on critically ill patients [13, 25].

The current study found that, regarding the demographic features of the studied nurses (Table 1), more than half (59.4) of the participants had ≥25 years with a mean (SD) of 26.8 (6.7) years. More than two-quarters (62.5%) were females, about half (50%) had a technical institute, and less than three-quarters (53.2%) had 4-6 years of experience in group I open suction. While compared to group II, closed suction showed that less than three-quarters (65.6%) had ≥25 years, with a mean (SD) of 27.2 (6.1) years. More than two-quarters (71.9%) were female, more than half (53.1%) had a technical institute, and less than half (56.2%) had 4-6 years of experience. The study revealed that there were statistically significant differences between the open and closed suction groups regarding age, education, and experience level.

The researchers' point of view confirms that most of the Egyptian nurses are female, and the recruited nurses graduated from university nursing institutes. These two groups were compatible, being aware of the impact of adult suction progress, psychological status, and clearly describing medical procedures and anticipated results. In these concerns, Dastdadeh, and Vahedian stated that these findings are compatible with their research study findings [21]. While these findings were incompatible with Aboalizm, & Elhy clarified that nurses aged 22–31 years had more than eight years of experience at a high and educational level [24].

Regarding the studied nurses' performance level (knowledge and practice), the results of this study (Figure 1) in both groups showed that the overall satisfaction level of knowledge and practice scores were significantly dissimilar. Moreover, in group I, less than two-thirds had a satisfactory level of knowledge regarding open suction as compared to more than half in group II regarding closed suction. Furthermore, their practice level regarding open suction was satisfactory in more than two quarters as compared to more than two quarters II. Thus, the independent sample t-test results made it clear that there was a significant correlation statistically between overall nurses' performance in both groups of suction ($t = 19.47$; $p < 0.001$).

In this interest, the researchers' point of view may be due to the high experience of the studied nurses in the open suction group, individual bias, the traditional practice of open path suction, and the availability of resources to use the open path as compared to the closed suctioning path. In the same issue, these results agreed with Pinto, D'Silva, & Sanil, demonstrating that the similarity of the study findings indicates an adequate level of nurses' performance regarding the open suction path compared to the closed suction path [8]. Otherwise, Mwakanyanga, et al. cited disagreement with these findings, which found a non-significant correlation between nurses' performance about open and closed endotracheal suction [26].

In terms of the self-efficacy of the nurses who were studied, the findings of this study (Figure 2) in both groups revealed that the overall self-efficacy level was significantly dissimilar in both studied groups. Likewise, in the group I open suction method, approximately one-third of the studied nurses had a high self-efficacy level, as compared to less than one-quarter in the group II closed suction method. Additionally, the independent sample t-test results made it clear that there was no significant correlation statistically between overall nurses' self-efficacy in the studied groups of suction ($t = 43.8$; $p < 0.06$).

The researchers' perspective in this area of interest may be relevant to the nature of the study sample, the low experience in the closed suction group, closed path suction as it has been done unusually, and the fact that most of the nurses had a technical institute. In the same issue, these results agreed with Hegazy, et al., who explained that the similarity of the study findings is that the studied nurses had a moderate to higher level of self-efficacy with the open suction path than with the closed suction method [22]. Or else, Ludwigson, L., and Boin illustrated that an argument with these findings was that the studied nurses had a low level of self-efficacy regarding suction and there was a significant correlation between their self-efficacy level in both suction groups [23].

However, in the current results, there was a statistically significant correlation between nurses' knowledge and practice score and nurses' self-efficacy score in both groups with a P value (≤0.05), except overall all nurse practice in group I with a P value (>0.05). It is described

in (Table 2). Moreover, there was a statistically significant correlation between nurses' knowledge and practice scores in group I and their demographic features with a P value (≤0.05). Additionally, there was a statistically significant correlation between nurses' knowledge in group II and their demographic features with a P value (≤0.05). However, there was a statistically significant correlation between nurses' self-efficacy scores in both groups with age as well as between nurses' self-efficacy scores in group I and gender with a P value (0.002 and 0.01) sequentially. It is described in (Table 3).

The viewpoint of the researchers in this field of study emphasizes or is related to the highly satisfactory level of self-efficacy of group I open suction compared to group II closed suction. More of the studied nurses had valuable experience and graduated from the university institute. These related findings are compatible with Hu, et al. mention of a statistical correlation between the studied nurse's performance regarding open and closed ETT suction [27]. but disagreed with another research study by Negro, et al. that clarified that there was no significant relationship between nurses' practice and their knowledge [28]. The study's limitations are was the use of the direct observation technique, which can have an effect on nurses' behavior. The researcher sought to greatly control this impact by repeating the observation twice and remaining present throughout several work shifts.

5. CONCLUSION AND RECOMMENDATION

According to this current study's findings, it can be concluded that more of those studied nurses had a technical institute in both groups of suction, and more of them did not receive a training course regarding suction. Their overall difference in the satisfactory performance level of open ET suction group I compared with closed ET suction group II. Additionally, their self-efficacy level is higher in the open group I than in the ET closed suction group II. However, there was a statistically significant correlation between overall nurses' performance in both groups. It was recommended that in-service-led continuous training courses improve nurses' performance in the closed suction paths and upgrade open suction in addition to enhancing their self-efficacy level in both. ICU nurses ought to be attentive sequentially for the use of the suction system and updated nursing guidelines in regular practice, and these must be accessible in all adult intensive care units and carry out the study in more places and with larger probability samples for data generalization.

Abbreviation: Endotracheal Tube (ETT), Endotracheal Tube Suction (ETS), Open Suction System (OSS), Closed Suction System (CSS), Positive End-Expiratory Pressure (PEEP), Intensive Care Unit (ICU).

Ethical Approval and Considerations: The study's approval to progress obtained from the institutional Research Ethics Committee (REC) was accomplished (Reference number 139/1-2022). Faculty of Nursing, Suez Canal University, Egypt. Official permission was gained from the director of adult intensive care units at the study set to start the study.

Author Contribution: Data assembly preparing methodology, the introduction, interpretation, conceptual framework, and conceptualization of the tool were all contributions organized reference, designing manuscript and journal submission was industrialized by the author.

Data Availability: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: This study showed no conflicts of interest.

Funding Statement: The current research did not gain funding or economic support for any purposes.

Acknowledgements: I genuinely value the contributions made by the nurses working in the intensive care units at the study sites. Also, I would like to thank Dr. Mohamed Goda Elbqry for his time and counseling during research.

6. REFERENCE

1) Blakeman, T. C., Scott, J. B., Yoder, M. A., Capellari, E., & Strickland, S. L. AARC Clinical Practice Guidelines: Artificial Airway Suctioning. Respir Care. 2022; 67(2), 258-271. doi:10.4187/respcare.09548
2) Atrous, A. E. H., & Hassan, M. Evaluation the Gap between Knowledge and Practice in Open System Endo-Tracheal Suctioning among Critical Care Nurses. Egyptian Journal of Health Care. 2017; 8(3), 248-260.
3) Baird, M. S. Manual of Critical Care Nursing-E-Book: Nursing Interventions and Collaborative Management: Elsevier Health Sciences. 2021; 233-240
4) Hassan, A. M. A. (2018). Effect of Educational Program on Nurses' practice Regarding Care of Adult Patients with Endotracheal Tube. Port said scientific journal of nursing, 5(2), 142-169. Available at: https://pssjn.journals.ekb.eg/article_33320.html
5) Kadhim & Mhabes, (2020): Effectiveness of an educational program on critical care nurses' practices regarding endotracheal suctioning of patients who are mechanically ventilated in hospitals at AL-Najaf, Iraq, Indian Journal of Forensic Medicine & Toxicology, Vol. 14, No. 4.

6) Day T, Farnell S, Haynes S, Wainwright S & Wilson-Barnett J. (2015): Tracheal suctioning: an exploration of nurses' knowledge and competence in acute and high dependency ward areas. J Adv Nurs; 39(1):35±45. Available at: http://doi.wiley.com/10.1046/j.1365-2648.2002.02240.x PMID: 12074750
7) Schults JA (2021): Appropriate use criteria for endotracheal suction interventions in mechanically ventilated children: The RAND/UCLA development process, Australian Critical Care, https://doi.org/10.1016/j.
8) Pinto, H. J., D'Silva, F., & Sanil, T. S. Knowledge and Practices of Endotracheal Suctioning amongst Nursing Professionals: A Systematic Review. Indian J Crit Care Med. 2020; 24(1), 23-32. doi:10.5005/jp-journals-10071-23326
9) Yilmaz, I., Ozden, D., & Arslan, G. G. (2021). Intensive care nurses' evidence-based knowledge and experiences regarding closed suctioning system. Nigerian Journal of Clinical Practice, 24(6), 883-891.
10) De Freitas, J. R., Pires Di Lorenzo, V. A., Lourenco da, S. S. M. M., Guerra, J. L., & Jamami, M. Effects of Zero PEEP and < 1.0 FIO2 on SpO2 and PETCO2 During Open Endotracheal Suctioning. Respir Care. 2020; 65(12), 1805-1814. doi:10.4187/respcare.07435
11) Bulbul Maras, G., Kocacal Guler, E., Eser, I., & Kose, S. Knowledge and practice of intensive care nurses for endotracheal suctioning in a teaching hospital in western Turkey. Intensive Crit Care Nurs. 2017; 39, 45-54. doi: 10.1016/j.iccn.2016.08.006
12) American Association for Respiratory Care. (2010). AARC Clinical Practice Guidelines. Endotracheal suctioning of mechanically ventilated patients with artificial airways 2010. Respiratory care, 55(6), 758-764.
13) Hu, J., Yu, L., Jiang, L., Yuan, W., Bian, W., Yang, Y., & Ruan, H. (2019). Developing a guideline for endotracheal suctioning of adults with artificial airways in the Perianesthesia setting in China. Journal of PeriAnesthesia Nursing, 34(1), 160-168.
14) Mwakanyanga ET, Masika GM, Tarimo EA. Intensive care nurses' knowledge and practice on endotracheal suctioning of the intubated patient: A quantitative cross-sectional observational study. PloS one. 2018 Aug 16;13(8):e0201743.
15) Ackley, B. J., Ladwig, G. B., Makic, M. B. F., Martinez-Kratz, M., & Zanotti, M. Nursing diagnosis handbook E-book: An evidence-based guide to planning care: Elsevier Health Sciences. 2019; 454-460.
16) Shamali, M., Abbasinia, M., Ostergaard, B., & Konradsen, H. Effect of minimally invasive endotracheal tube suctioning on physiological indices in adult intubated patients: An open-labelled randomised controlled trial. Aust Crit Care. 2019; 32(3), 199-204. doi: 10.1016/j.aucc.2018.03.007
17) Ngamjarus C. n4Studies: sample size calculation for an epidemiological study on a smart device. Siriraj Medical Journal. 2016 Jun 9;68(3):160-70.
18) Chen W, Hu S, Liu X, Wang N, Zhao J, Liu P, Chen K, Hu J. Intensive care nurses' knowledge and practice of evidence-based recommendations for endotracheal suctioning: a multisite cross-sectional study in Changsha, China. BMC nursing. 2021 Dec;20:1-2.
19) Lewis SL, Bucher L, Heitkemper MM, Harding MM, Kwong J, Roberts D. Medical-Surgical Nursing-E-Book: Assessment and Management of Clinical Problems, Single Volume. Elsevier Health Sciences, 9th ed.; 2016 Sep 8., Mosby.
20) Davies, J. D., Huang, Y. C., & MacIntyre, N. R. Evaluation of a novel endotracheal tube suctioning system incorporating an inflatable sweeper. Can J Respir Ther. 2021; 57, 138-142. doi:10.29390/cjrt-2021-026
21) Dastdadeh, R., Ebadi, A., & Vahedian-Azimi, A. Comparison of the effect of open and closed endotracheal suctioning methods on pain and agitation in medical ICU patients: a clinical trial. Anesthesiology and pain medicine. 2016; 6(5).
22) Hegazy, S. M., Hussein, M. A. A., Abualruhaylah, M. M., Aljohani, S. M., & Mayyas, S. M. Ventilator Associated Pneumonia: Assessment of Nurses Awareness and Self–Efficacy with Bundle Prevention Protocol. Vol. 7, Issue 2, pp: (491-499), Month: May - August 2020, Available at: www.noveltyjournals.com
23) Ludwigson, L. & Boin , M. ICU Nurse Perception of Self-Efficacy Following Participation in a Formal ECMO Education Program , 11th Annual Centura Health Evidence-Based Practice, Research & Innovation Conference November 2 (2018).
24) Aboalizm, S. E., & Elhy, A. H. A. Effect of Educational Intervention on Nurses' Knowledge And Practices Regarding Endotracheal Tube Suctioning. SSRG International Jurnal of Nursing and Health Science. 2019; 5(3).
25) Mousa, H. M., & Ahmed, N. A. Effect of nursing guidelines on patients' outcomes regarding closed suction at intensive care uni. Assiut Scientific Nursing Journal. 2019; 7(18), 32-40.
26) Mwakanyanga ET, Masika GM, Tarimo EA. Intensive care nurses' knowledge and practice on endotracheal suctioning of the intubated patient: A quantitative cross-sectional observational study. PloS one. 2018 Aug 16;13(8):e0201743. Available at: https://doi.org/10.1371/journal.pone.0201743.
27) Hu, J., Yu, L., Jiang, L., Yuan, W., Bian, W., Yang, Y., & Ruan, H. Developing a Guideline for Endotracheal Suctioning of Adults with Artificial Airways in the Perianesthesia Setting in China. J Perianesth Nurs. 2019; 34(1), 160-168 e164. doi: 10.1016/j.jopan.2018.03.005
28) Negro A, Ranzani R, Villa M, Manara D. Survey of Italian intensive care unit nurses' knowledge about endotracheal suctioning guidelines. Intensive and Critical Care Nursing. 2014 Dec 1;30(6):339-45. Available at: https://doi.org/10.1016/j.iccn.2014.06.003 PMID: 25193542.