The Performance Level of Critical Care Nurses Toward Two Systems of Endotracheal Suction among Mechanically Ventilated Patients

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Abstract

Background: There are a two-system suction of the endotracheal, in which a closed-system suction improves oxygen desaturation by decreasing the lung tidal volume compared to an open-system suction. Most nurses' practices are unobserved and require improvement in those critical practices. **Aim:** This study aimed to compare the performance level of critical care nurses toward two systems of endotracheal suction among mechanically ventilated patients. **Subject and Methods:** A cross-sectional comparative research design study was conducted at adult critical care units at Suez Canal University hospitals in Ismailia city. They were sorted into two groups by random selection: group (I) included 32 nurses for whom open suction was utilized, 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 the performance of critical care nurses in open and closed system suction (68%; 47%) consecutively. However, there was a statistically significant correlation in both groups with age, educational level, and experience year. **Conclusions:** More of those studied nurses had a technical institute in both study groups. Also, there is an overall difference in satisfactory performance levels between open endotracheal suction group I and closed endotracheal suction group II. **Recommendations:** In-service-led continuous training courses improve nurses' performance in the closed suction system and upgrade open suction. Critical care nurses ought to be attentive sequentially to the use of the suction system and updated nursing guidelines in regular practice. Further replication of the study in all intensive care units in the aforementioned setting is needed for data generalization.

Keywords: Critical care, endotracheal suction, mechanically ventilated patients, nurses, performance.

Introduction

The use of an endotracheal tube (ETT) can preserve and enhance the natural airway while enabling the administration of mechanical ventilator assistance, hence saving lives [1]. For patients requiring mechanical breathing, it is the most common invasive procedure carried out by critical care nurses [2]. It eliminates secretions from the endotracheal tree, ensures proper tissue ventilation and perfusion, lessens respiratory exertion on the patient, prevents tube clogging, and guards against bronchus infection and atelectasis [3]. It prevents atelectasis and bronchus infection, ensures proper tissue ventilation and perfusion, eases the patient's breathing difficulty, and frees the endotracheal tree from secretions [3].

There are two systems at play: the open suction system (OSS), which is still the standard suction technique and necessitates using a single-use catheters and removing the ventilator from the patient. [6] Nevertheless, it is claimed that when using ETS procedures, a closed suction system (CSS) can stay in line with a multiple-use catheter for a full day through the plastic sheath of the multi-use drain [7].

Nowadays, closed-system suctioning (CSS) is the most commonly used type in intensive care units and has gained a lot of popularity because it preserves positive end-expiratory pressure (PEEP), reduces environmental pollution, avoids gas exchange impairment and lung volume loss during the suction procedure, and is convenient for the system, which may save costs. Patients feel less anxious when using this method, and equipment setup and cleanup take less time [8–9].

Nursing practice in the ETS process for critically sick patients differs significantly among organizations and practitioners. It could be due to

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 comprehend it, competing workload pressures, insufficient knowledge about this procedure, and nurses' practice based on personal experiences [10-11].

Significance of the study:

Intensive care nurses are essential members of a multidisciplinary team who play an important role in the care of hospitalized patients [12]. Endotracheal tube suction can be life-threatening; thus, it should be used in accordance with established protocols and standards to reduce mortality, morbidity, hospital costs, and length of stay while also improving quality outcomes by hastening patient recovery [13].

Furthermore, it is estimated that 20 percent or more receive care that is potentially dangerous [14-15]. CSS has lately been implemented and remains a fresh issue in the Suez Canal University hospitals. Hence, the present observational study was necessary to investigate and compare the performance level of critical care nurses toward two systems of endotracheal suction among mechanically ventilated patients.

Aim of the study:

This study aimed to compare the performance level of critical care nurses toward two systems of endotracheal suction among mechanically ventilated patients in Suez Canal University hospitals in Ismailia city. The following objectives were pursued:

1. To assess the performance level of critical care nurses toward two systems of endotracheal suction among mechanically ventilated patients.
2. To compare the performance level of critical care nurses toward two systems of endotracheal suction among mechanically ventilated patients.
3. To Identify relation between the performance level of critical care nurses toward two systems of endotracheal suction among mechanically ventilated patients with their demographic profile.

Subject and Methods

Design of the study:

A cross sectional comparative research design was utilized in the current study.

Setting:

The study was conducted from October 2021 to March 2022 in adult intensive care units affiliated with Suez Canal University hospitals in Ismailia City, Egypt.

Sampling:

The participants of both groups in the existing study were sixty-four nurses from the aforementioned settings. They were organized into two groups by random selection: group (I) involved thirty-two nurses for whom open suction was utilized, while group (II) comprised thirty-two nurses for whom the closed suction method was utilized.

The sample size and power utilizing an epidemiological information system, 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.

The data collection process of this research

Two tools were utilized to collect data:

(1) A self-administrated questionnaire: It was adapted by the researchers based on related studies, guidelines, and textbooks. It was consisted of two parts:

Part I: It is used to assess the studied nurses' demographic features (such as age, gender, experience, place of work, etc.)

Part II: It is used to assess the studied nurses' level of knowledge, 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].

(2) 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 described as a satisfactory level of practice if it is more than or equal to 75%. [20, 21].

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 was 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.

Tools developments:

The researchers made some modifications to the tools after reviewing recent literature and previous related studies in the same concern of the research variables.

Content Validity and Reliability:

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 anesthesia 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, and observational checklist, were evaluated using Cronbach's alpha test, which was 0.82, 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.

Ethical 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.

Fieldwork

The researchers conducted the study in the following manner:

1) Pilot study:

Before beginning the primary study, a pilot study of sixty students 10% was conducted to assess the study's clarity, applicability and feasibility. There were no changes, and the findings were incorporated into the study. The author contacted the students via their what's-up group, explained the purpose of the study and encouraged them to participate in the current study though a submitted online link within 3-6 minutes. Furthermore, the shared link contained a section explaining the study aim and confirming that their participation was voluntary, and they have the right to withdraw at any time.

2) Current study:

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.

Results:

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 in both groups with 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 ($t = 19.47$; $p < 0.001$).

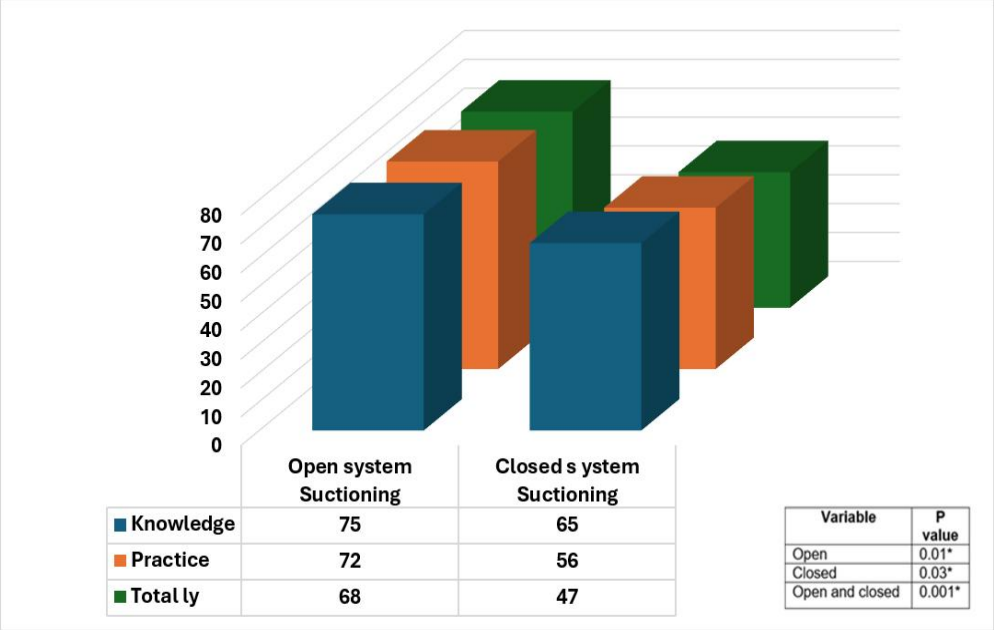
However, based on the Pearson correlation coefficient test in the current results, there is a statistically significant correlation between nurses' knowledge score in group I open suction and nurses' self-efficacy score in both groups with a P value (≤ 0.05). Compared to group II closed suction, there 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. Range	26.8 ±6.7 19-34		27.2 ±6.1 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).

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	Group (II): Overall Closed ET suction's score	
	r	P
Group (I): Overall open ET suction's score		
knowledge.	0.32	0.001**
practice.	0.085	0. 53
(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 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 system 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 system 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
r Pearson Correlation coefficient				*p* significant at the ≤0.05 level				

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 [14-25].

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 of the participants had ≥25 years with a mean (SD) of 26.8 (6.7) years. More than two-quarters were females, about half had a technical institute, and less than three-quarters had 4-6 years of experience in group I open suction. While compared to group II, closed suction showed that less than three-quarters had ≥25 years, with a mean (SD) of 27.2 (6.1) years. More than two-quarters (71.9%) were female, more than half had a technical institute, and less than half 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].

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 system suction as it has been done unusually, and the fact that most of the nurses had a technical institute. 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 were the use of the direct observation technique, which can influence nurses' behavior. The researcher sought to greatly control this impact by repeating the observation twice and remaining present throughout several work shifts.

Conclusion

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. However, there was a statistically significant correlation between overall nurses' performance in both groups.

Recommendations

According to this current study's findings,

It was recommended that in-service-led continuous training courses improve nurses' performance in the closed suction system and upgrade open suction. Critical care 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. Further replication of the study in all intensive care units in the aforementioned setting for data generalization.

Abbreviations

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

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Competing interests

This study showed no conflicts of interest.

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Availability of Data

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

Author Contribution

The author automated data collection, methodology preparation, introduction, interpretation, conceptual framework, and tool conceptualization, as well as reference, manuscript design, and journal submission.

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