

## Correlation Between Current Nurse's Performance Regarding Endotracheal Suctioning and Patient's Cardiorespiratory Parameters

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### Abstract

**Background:** Endotracheal Tube Suctioning (ETS) is one of the most common invasive procedures carried out in the critical care units, many life-threatening complications can occur when the ETS procedure is not performed correctly; Nurses' play a crucial role in preventing these complications. **Aim of the study:** Is to assess the correlation between current nurse's practice regarding endotracheal suctioning and patient's cardiorespiratory parameters at critical care units. **Research design:** Descriptive correlative research design was utilized for conduction of this study. **Sample:** Subjects included in the study were two groups; (50) nurses and (50) patients according to the inclusion criteria. **Setting:** The study was conducted in the critical care units of Qena University Hospital and international Hospital in Luxor. **Data collection tools: First Tool:** Structured questionnaire sheet, it includes (three parts): **First part:** Personal data sheet of the nurses. **Second part:** Selected Personal and medical data sheet of the patients. **Third part:** Structured knowledge questionnaire sheet about endotracheal suctioning. **Second Tool:** Observational checklist regards endotracheal suctioning. **Third Tool:** Cardiorespiratory parameters. **Study duration:** Data collection of this study was carried out within ten months from 1st January to the end of October. **Results:** the study revealed that the mean ages among the studied nurses group ranged between (28.60 ± 4.65 years) and the mean ages between studied patients group was between (48.39 ± 12.75). Majority of nurses had unsatisfactory knowledge and unsatisfactory practice 70%, 75%, respectively, regarding endotracheal suctioning. There was significant relation between nurses 'knowledge and practices and patients' cardiorespiratory parameters (heart rate, tidal volume, arterial oxygen saturation and partial pressure of oxygen and partial pressure of carbon dioxide). **Conclusion:** Based on the results of the current study, it can be concluded that, there was significant relation between nurses' performane and patients 'cardiorespiratory parameters. **Recommendation:** Updating knowledge and practice for ICU staff nurses and newly employed nurses through carrying out periodic training educational programs about endotracheal suctioning through in-service training hospital office. Instruct the critical care units' manager and head nurse in study setting to use evidence based practice guidelines regarding endotracheal suctioning.

**Key words:** Correlation, Cardiorespiratory parameters, Endotracheal Suctioning, Nurse's performance.

### Introduction:

Breathing is essential to get oxygen into the body and expel carbon dioxide. The lung normally performs this function by expanding and drawing in air and contracting and expelling it. The lung has millions of tiny air sacs (alveoli) that transfer the oxygen into the blood supply that flows to the heart and remove the carbon dioxide from the blood flowing into the lungs from the heart. Certain illnesses prevent the lung from functioning normally. So mechanical ventilation is required when a patient needs assistance with breathing. (Hirsch, 2019)

Endotracheal suctioning is therefore needed to avoid accumulation of secretions into the lung, and its associated complications. Nevertheless, endotracheal suctioning is an invasive procedure, and is not free from hazards and, exceptionally, from lethal adverse events. Some studies on selected patient populations suggested a high frequency of specific adverse events, such as oxygen desaturation and arrhythmia. (Salvatore et al 2013).

Endotracheal suctioning (ETS) is the removal of secretion from tracheobronchial tree through the endotracheal tube with the help of mechanical suction device to maintain the patient airway and to prevent the respiratory tract infection because of lodgment of secretion. It is a common procedure which is performed by intensive care nurses for the purpose of establishing and maintaining gas exchange, adequate

oxygenation and alveolar ventilation in critically ill mechanical ventilated patients.( Soussan et al .,2019)

Despite of endotracheal suctioning (ETS) being a necessary procedure to both children and adult patients, if the procedure is not performed with correct techniques, it can lead to serious complications, such as bleeding, infection, hypoxia, bronchoconstriction, atelectasis, and increase in intra-cranial pressure, cardiac arrest and sudden death. Since the procedure can cause harm to the patient if it is done incorrectly, it is important therefore that Intensive Care Unit (ICU) nurses have the necessary knowledge and skills based on valid scientific evidence in performing ETS and aspects related to it. (Azizian et al, 2020)

Nurse's knowledge and compliance to proper suctioning techniques are very important for prevention of these complications. Research shows that nurses are unaware of current suctioning recommendations and their practice is often based on ritual and tradition techniques as opposed to empirical evidence. In 2010 the American association of respiratory care (AARC) published the AARC clinical guidelines on endotracheal tube suctioning of mechanically ventilated patients with artificial airway, which is based on 10 guidelines recommendations.( Zeb et al .,2017)

Evidence-based recommendations regarding ETS are available, but many of these have not been observed in nurse's clinical practice, thus many life-threatening complications can

occur when the ETS procedure is not performed correctly. The majority of ICU nurses does not have desirable knowledge and skills of ETS, and are currently not following current ETS recommendations. A descriptive cross-sectional study design involving 103 Intensive Care Unit (ICU) nurses indicates 80.6% demonstrated undesirable overall knowledge on ETS evidence-based recommendations. (Mwakanyanga et al., 2018)

#### Significance of the study:-

Today, about 7.8% of the patients require respiratory care in intensive care units and coronary care units. Since the main problem of these patients is the respiratory system, thus endotracheal intubation and mechanical ventilation are increasing in these units. Endotracheal intubation (ETI) and endotracheal suctioning is a frequently used life-saving procedure. (Dasgupta, 2018)

The flow rate of patients who performed intubation and needed suctioning in Qena university hospital (from 2019 to the end of 2021) was nearly about 1500 patients in (Statistical unit of Qena university hospital). The researcher viewed from working experience that there was a gap between the actual practice and expected endotracheal suctioning care according to the adopted guideline of care.

#### Aim of the Study

Is to assess the correlation between current nurse's practice regarding endotracheal suctioning and patient's cardiorespiratory parameters at critical care units

#### Research Hypotheses

- There is a positive correlation between current nurse's practice regarding endotracheal suctioning procedure and negative patient's cardiorespiratory parameter.
- There is a correlation between patient's cardiorespiratory parameter and their socio demographic characteristics.

#### Research Design:

Descriptive correlative research design was utilized for conducting this study.

#### Subjects:

Subjects included in the study were two groups, fifty (50) nurses and fifty (50) patients according to the inclusion criteria.

#### Inclusion Criteria for the patients:

- Newly admitted (48-72hr).
- Free from chest infection.
- Most of studied patients had normal cardiorespiratory parameters.

#### Exclusion Criteria for the patients:

- Diagnosed with chronic obstructive pulmonary disease.
- Covid 19 (Corona viruses)

#### Exclusion Criteria for nurses:

- Nurses who refused participation in the study.

#### Setting:

The study was conducted in the critical care units of Qena University Hospital and Luxor international Hospital.

#### Study duration:

Data collection of this study was carried out through ten months from 1st January to the end of October.

#### Tools of data collection:

##### Data collection tools:

Three tools were utilized to fulfill the aim of the study, as follows:

##### First Tool: "Structured questionnaire sheet" it includes (three parts):

Formulated by researcher based on extensive literature review, it was included from three parts.

**1<sup>st</sup> part:** - Personal data sheet of the nurses who worked at critical care units, at the time of conducting the current study such as age- gender- department of working-years of experiences.

**2<sup>nd</sup> part:** - Selected Personal and medical data sheet of the patients who worked at critical care units and according to inclusion criteria such as age – gender- medical diagnosis.

**3<sup>rd</sup> part:** - Self-administered structured knowledge questionnaire sheet about endotracheal suctioning procedure. Its aim was to evaluate nurses 'knowledge regarding ETS. It contained (10) questions in the form of multiple choice questions and translated into Arabic language by the researcher then checked by expert in Arabic language. The researcher administered the questionnaire to the nurses to fill it and provided explanation and clarification for any question.

##### Scoring System:

Each right answer takes one point with a total score of correct answer score (< 60%) was considered unsatisfactory, while a score of (≥60) was considered satisfactory.

##### Second Tool: "Observational guideline regarding endotracheal suctioning steps (ETS)":

These guidelines about endotracheal suctioning (ETS) were adapted from (Wendy et al., 2017) for evaluating nurses 'practice regarding endotracheal suctioning for critically ill patients. The researcher converted these guidelines into a checklist. This checklist consisted of thirty three steps. This sheet was filled by the researcher while critical care nurse was performed ETS procedure to the patients. It was classified into sixteen steps before connecting suction catheter with patients, and seventeen steps during and after connection of suction catheter during ETS.

##### Scoring System:

The score for each step ranged from zero to two (0, 1, 2), when the nurses not done steps take score zero (0), done inaccurate steps take score one (1), done accurate steps take score two (2). Total score was thirty three (33). So (≤ 70% from 33 score) was considered unsatisfactory, more than (>70% from 33 score) considered satisfactory.

##### Third Tool: Cardiorespiratory parameters.

It was formulated by the researcher to measure patients cardiorespiratory parameters .It included cardiac parameters (Heart Rate and Mean Arterial Pressure),

respiratory parameters (respiratory rate and tidal volume) and selected arterial blood gases (PaCO<sub>2</sub>, PaO<sub>2</sub>, and SaO<sub>2</sub>). All these parameters were measured in intermittent times (immediately before ETS and after one, two, and three after ETS procedure).

#### **Scoring system:**

This tool (base line measured patients cardiorespiratory parameters pinch mark for the five cardiorespiratory parameters) adapted by the researcher based on extensive literature review and included (NCBI, book shelf, 2021), (med scap, 2019).

- Normal Heart Rate ranged from 60 to 100 b/m
- Normal Mean arterial blood pressure range from 70-100 mmhg
- Normal Respiratory rate ranged from 16-20 b/m
- Normal Tidal volume around 500ml
- Normal Arterial blood gases (SaO<sub>2</sub> from 95-100%)(PaO<sub>2</sub> from 75-100 mmhg) (PaCo<sub>2</sub>-35-45)

#### **Tools validity and reliability:**

- The study tools were developed after reviewing the related literature. To establish validity, the tools were tested by a Jury committee that consisted of a panel of five experts in the field of medical surgical nursing staff, the necessary modifications were done.
- Tools were tested for content reliability using Cronbach's Alpha test. It was estimated for tool one (part three) as (0.843) also estimated for tool two as (0.791)

#### **Pilot study:**

A pilot study was carried out on 10% of the total nurses' sample (5) to test the feasibility of the study and applicability of the data collection tool. Based on the results of the pilot study, no refinement/ modifications were done for data collection tools; nurses who shared in the pilot study were included in the actual study sample. Also a pilot study was conducted on 10% of the total sample (5) among patients to ensure applicability of tool three and to enable the researcher to measure patients' cardiorespiratory. Pilot studies from patients were included in our actual sample because no modifications were needed.

#### **Ethical considerations:**

The study was approved by the researcher ethics committee of the faculty of nursing. Minia University, then formal written letter outlining the research title to conduct the study was sent to the manager of the study setting, the researcher obtained official permission from the manager of Qena and Luxor university hospital, she also obtained oral consent from the head nurse of critical care units and from the studied nurses group, who were informed that the obtained data would not be included in any further researches without a second consent, the studied nurses group who participated in this study were volunteers, they were informed about the purpose, benefits, and nature of the study, and they had the

right to withdraw from the study at any time without any rationale.

#### **Study Procedure:-**

**Part 1:** After obtaining the agreement from studied nurses group, the researcher started to collect data from the first group through the first three months of the study duration this was occurred by the researcher who went to the study setting two days per week in the morning shift. The researcher coordinated with the head nurse of the study sitting to collect within average of 2-3 nurses in every session to collect this tool, this session took 15-20 minutes as follows:-

The researcher began to fulfill part one from the first tool (personal data of studied nurses group) within 5 minutes, Then the researcher filled in the first tool (part three), the researcher was distribute a questionnaire sheet that contained ten questions about endotracheal suctioning procedure, This sheet took about (10 to 15) minutes according to nurses' tolerance and every nurse allowed to ask any question to the researcher to clarify any misunderstanding.

**Part2:-** After finishing of the first tool (Part one and part three) the researcher began to fill in the first tool (part two), the second and third tool, The researcher assessed one to two nurses and patient weekly according to the inclusion and exclusion criteria of patients. The researcher filled this tools within twenty five (25) sessions for over all studied nurses and patients in the same days and shift that was mentioned above in the previous paragraph, every session took from 55 to 60 minutes as follows:-

The researcher began to fill in part two in the first tool (patients' personal and medical data), This took from 5 to 10 minutes for every patient, Then the researcher filled in the Second Tool (the Observational checklist for evaluating nurse' practice regarding endotracheal suctioning procedure). Each nurse was observed for 10 to 15 minutes while performing each step of the procedure in the observational checklist, then the researcher began to measure the patient's cardiac parameters (Heart Rate and Mean Arterial Pressure) and respiratory parameters (PaCO<sub>2</sub>, PaO<sub>2</sub>, SaO<sub>2</sub>, respiratory rate and tidal volume). All these parameters were evaluated at intermittent times immediately before implementation of endotracheal suctioning procedure and after (1, 10 and 30 minutes) of suctioning procedure.

#### **Statistical analysis:**

Data entry and data analysis were done using SPSS version 22 (Statistical Package for Social Science). Data were presented as number, percentage, mean, and standard deviation. Chi-square test and Fisher Exact test were used to compare between qualitative variables. An independent sample t-test was used to compare quantitative variables between two groups and ANOVA test was used for more than two groups. Paired samples t-test was done to compare quantitative data between baseline and follow-up. Pearson correlation was done to measure correlation between quantitative variables. P-value was considered statistically significant when  $P < 0.05$ .

Results:

Table (1): Percentage distribution of personal data among the studied nurses (n=50).

Personal characteristics	(n=50)	%
<b>Age: (years)</b>		
≤ 26	17	34.0
<30	19	38.0
> 30	14	28.0
<b>Mean ± SD</b>	28.60 ± 4.65 (20.0-37.0)	
<b>Gender:</b>		
Male	15	30.0
Female	35	70.0
<b>Department:</b>		
ICU	33	66.0
CCU	17	34.0
<b>Years of experience:</b>		
≤ 3	15	30.0
4 – 5	25	50.0
> 5	10	20.0

Table (1): Illustrated the percentage distribution of personal data among the studied nurses. It shows that the average mean of age among studied nurses were (28.60 ± 4.65 years). With respect to sex, it was found that, females had the highest percentage (70%). As regarding to department of working; it was found that, more than half (66%) among studied nurses worked in the Intensive care unit. Lastly (50%) of the studied nurses had from 4 to 5 years of experience, While only (20%) among them had above five years of experience in their department.

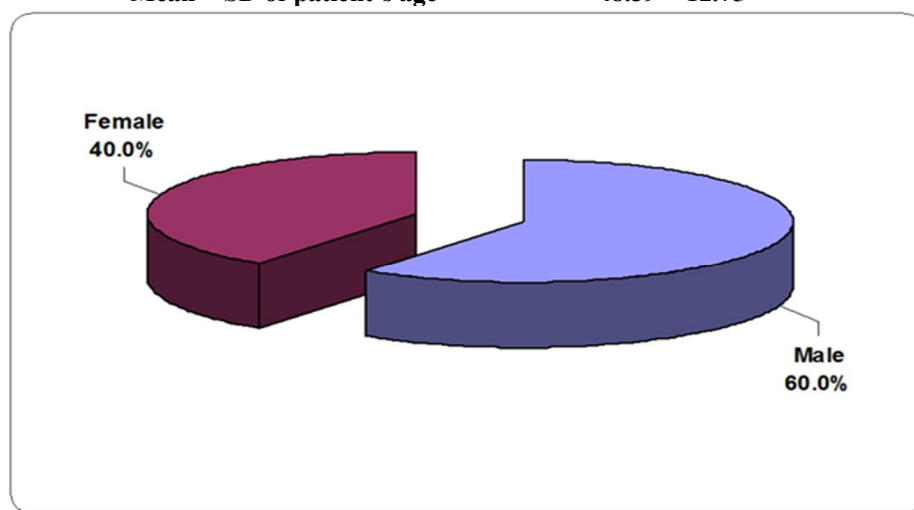
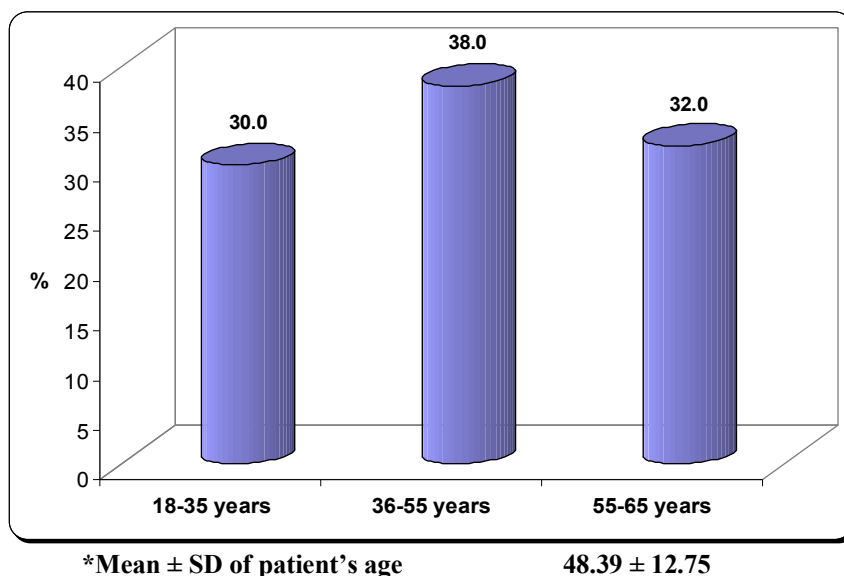


Figure (1&2): Percentage distribution of age groups and gender among studied patients group (n=50).

Figure (1&2): Percentage distribution of age groups and gender among studied patients group. It showed that the majority (38%) of the studied patients 'age ranged from (36 to 55years), with a mean average of 48.39. The studied patients group was males who constituted (60%) while the lowest among them were females who constituted (40%).

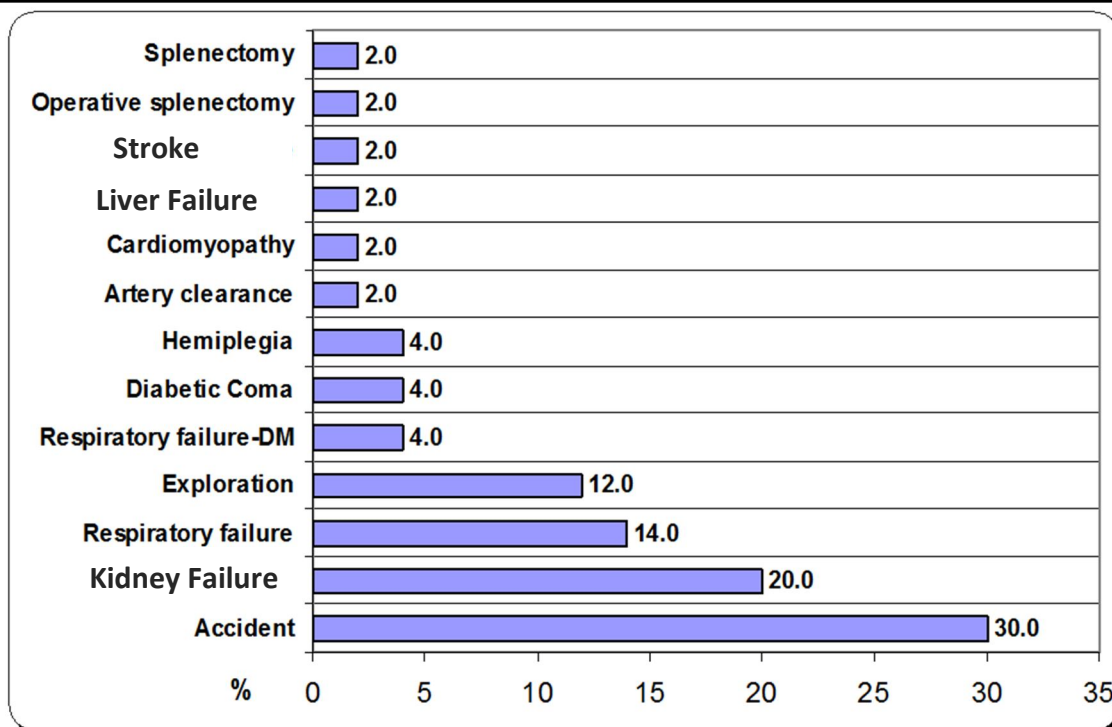


Figure (3): Percentage distribution of patients’ medical diagnosis among studied patients throughout the study period (n=50).

Figure (3): Percentage distribution of patients’ medical diagnosis among studied patients throughout the study period .It illustrated distribution of the studied patients group according to their diagnosis, it shows that, (30%) highest percentage from patients had accident, (2%) had splenectomy, cardiomyopathy and artery clearance.

Table (8): Relation between level of nurses ‘knowledge and level of cardiorespiratory parameters.

cardiorespiratory parameters	Knowledge level		P-value
	Unsatisfactory	Satisfactory	
	Mean ± SD	Mean ± SD	
HR	93.06 ± 21.45	68.48 ± 10.57	0.000*
Map	83.69 ± 14.07	79.49 ± 13.42	0.333
RR	24.70 ± 4.36	24.05 ± 4.07	0.625
VT	447.08 ± 89.86	521.27 ± 45.67	0.005*
SaO <sub>2</sub>	90.82 ± 2.99	93.26 ± 3.30	0.014*
PaO <sub>2</sub>	70.23 ± 10.06	81.57 ± 12.10	0.001*
PaCO <sub>2</sub>	40.13 ± 4.45	39.77 ± 3.59	0.786

\* Statistical significant (P ≤ 0.05)

\*\* highly Statistical significant (P ≤ 0.01)

Table (8): It illustrates the relation between level of nurses ‘knowledge and level of cardiorespiratory parameters. It shows that there was a statistically significant difference between satisfactory and unsatisfactory knowledge level. There was a significant relation between nurses ‘knowledge and patients’ heart rate, tidal volume, arterial oxygen saturation and partial pressure of oxygen.

Table (9): Relation between level of nurses ‘practices and level of patients ‘cardiorespiratory parameters.

cardiorespiratory parameters	Practices level		P-value
	Unsatisfactory	Satisfactory	
	Mean ± SD	Mean ± SD	
HR	86.82 ± 22.94	80.50 ± 20.97	0.000*
Map	83.19 ± 14.80	80.46 ± 11.42	0.538
RR	24.88 ± 4.84	23.54 ± 1.87	0.319
VT	447.08 ± 89.86	521.27 ± 45.67	0.005*
SaO <sub>2</sub>	90.71 ± 3.17	93.71 ± 2.44	0.003*
PaO <sub>2</sub>	71.20 ± 11.75	79.88 ± 9.80	0.018*
PaCO <sub>2</sub>	44.03 ± 4.33	39.04 ± 5.34	0.000*

\* Statistical significant (P ≤ 0.05)

\*\* highly Statistical significant (P ≤ 0.01)

Table (9): It illustrates the relation between level of nurses ‘practices and level of patients ‘cardiorespiratory parameters. It shows that there was statistically significant difference between satisfactory and unsatisfactory practice level. There was a significant relation between nurses ‘practices and patients’ heart rate, tidal volume, arterial oxygen saturation and partial pressure of oxygen and partial pressure of carbon dioxide.

**Discussion**

Endotracheal suctioning (ETS) is among the most frequently conducted invasive procedures in the intensive care unit (ICU) for mechanically ventilated patients .As a crucial procedure, if ETS is not performed with correct techniques, it will lead to numerous adverse effects, such as tracheobronchial edema, ulceration, and denudation of the epithelium. These areas of mucosal damage increase the risk

of infection and bleeding. Moreover, ETS is considered an extremely distressing and painful experience for ICU patients. Nurses should have adequate knowledge and skills to perform endotracheal suctioning based on the best evidence. Little is known about intensive care nurses’ knowledge and practice of evidence-based endotracheal suctioning. (Chen et al., 2021).

Regarding personal data among studied nurses the current study it was found that the mean average ± SD age of

study subjects was ( $28.60 \pm 4.65$ ) years: This may be due to the desire of university and Luxor international hospital to provide high quality health care services, through employing new graduates nurses from the faculty of nursing or nursing technical institute who are professional in critical case units.

Results of the current study were compatible with (Hafez, 2016) as around two thirds of the studied sample was young adults (less than forty years old). In this regard also (Ansari et al., 2012) found half of the studied nurses to be approximately in the same age groups of the current study's subjects with mean average ( $29 \pm 2.8$ ) years.

This result contrast with (Forta et al., 2013) who found the mean age of (40-56) years old, was disagreeing with the current study. With regard to gender, findings of the present study showed that majority of studied nurses were females (70%). this may be explained by the fact that nursing is a universally feminine profession especially in our social culture in Upper Egypt (Qena and Luxor).

This result was in the same line with (Zeb et al., 2017) who found that most of the nurses were females (70.8%) and (29.2%) were males, also (Ansari et al., 2016) who found that the majority of studied nurses were females (95.5%) of studied nurses. The study of (Hafez, 2017) was in contrast with the current study, as he found that most of studied nurses were males (70%).

Concerning to years of experience the present study found that, half of the study sample had experience in (4 - 5) years in critical care unit because participants were new graduates. This result is in contrast with (Aboalizm & Elhy, 2019) who found that studied nurses had (6 - 10) years of experience.

#### Percentage distribution of age groups, gender and medical diagnosis among studied patients group.

The present study found that the mean average and standard deviation between studied patients 'age group was ( $48.39 \pm 12.75$ ), (60%) of them were males and the highest percentage from patients had accidents and kidney failure. This is because at this age of productivity as people tend to go out from their homes daily to work and earn money, especially men, because they are the ones who bear the responsibility of earning money to support their families, and therefore they are more likely to have accidents, Also kidney failure was the result of water and food contamination and the spread of chronic disease, As regard to age, this result is compatible with (Elsaman, 2017).

#### Relation between level of nurses ('knowledge and practice) and level of cardiorespiratory parameters.

The current study found that there was a statistically significant difference between satisfactory and unsatisfactory knowledge and practice level and patients' cardiorespiratory parameters (**Heart rate, Tidal volume, and arterial oxygen saturation, partial pressure of oxygen and partial pressure of carbon dioxide**). This was due to not providing periodic training educational programs about endotracheal suctioning, not following standard guidelines about ETS, Absence of continuous monitoring by trained head nurse to the nurses 'staff, Also not providing high quality nurses for working in critical care units.

This in turn leads to unsatisfactory nurses' performance and affects patients 'cardiorespiratory parameters negatively and many life-threatening complications occurs. This result is compatible with (Aboalizm & Elhy, 2019) that

discovered a highly statistical relationship between nurses 'performance and patients' complications.

The present study illustrated that, there were a significant increase in heart rate (HR) and significant decrease in MAP after endotracheal suctioning compared to before endotracheal suctioning. This finding may be due to not giving pre-oxygenation before introducing suction catheter. Moreover irritation and pain are caused by suction catheter movements and prolonged time of catheter inserted inside endotracheal tube (more than 15 second).

These results were in the same line with (Elsaman, 2017) who found an increase in heart rate after endotracheal suctioning among control group and found decreased in MAP during routine ETS method in control group. Also there is further validation by (Liu et al., 2015) who stated that heart rate increased after endotracheal suctioning. This result is contrary with (Shamali et al., 2019) who found an increasing in mean arterial blood pressure after routine suctioning.

The current study indicates that there is a significant increase in respiratory rate and decrease in tidal volume after ETS, This could be due to inappropriate suction catheter diameter (large or small diameter) also using inappropriate suction pressure, long period of patient disconnection from mechanical ventilator as suctioning was done for more than 15 seconds, increased heart rate and mistakes done by critical care nurses that may lead to patients 'feeling of pain produced by ETS technique itself.

This finding this result was in the same line with (Brenda, 2016), whose study demonstrates that endotracheal suctioning frequently causes an immediate drop in lung dynamic and tidal volume. It also agreed with (Futter et al., 2016) who found that there was a significant elevation in RR after ETS Procedure. While (Alavi et al., 2014) in contrary with this finding, found that respiratory was negligible and changes were not significant during study sample who were done on endotracheal suctioning.

This study found that, there were a decrease in arterial oxygen saturation ( $\text{SaO}_2$ ) and partial pressure of oxygen ( $\text{PaO}_2$ ) and significant increase in partial pressure of carbon dioxide ( $\text{PaCO}_2$ ) after endotracheal suctioning and this may be due to long time of patients disconnection from mechanical ventilator for suctioning, not hyper-oxygenate patient before as well as after suctioning, reduction in lung volume also using inappropriate suction catheter size due to most of critical care nurses perform ETS procedure using routine method not using standardized practice.

This result was compatible with (Feroogh et al., 2017) who stated that arterial oxygen saturation decreased after routine endotracheal suctioning. In the same line (Shamali et al., 2019) who found that a significant drop in arterial oxygen saturation after endotracheal suctioning. Further validation with (Elsaman, 2017) who found decrease in arterial oxygen saturation and partial pressure of oxygen after routine method and increase in partial pressure of oxygen, this result were compatible with (Zahran et al., 2011) who significant increase in  $\text{PaCO}_2$  after ES.

#### Conclusion

Based on the results of the current study, it can be concluded that, there was a significant relation between nurses 'performance and patients 'cardiorespiratory parameters, Nurses had unsatisfactory knowledge and practice regarding endotracheal suctioning procedure. Also there was a

significant difference in patients 'cardiorespiratory parameters at intermittent times after endotracheal suctioning.

### Recommendations

Based on the results of the current study the following are recommended:

- 1- Updating knowledge and practice for ICU staff nurses and newly employed nurses through carrying out periodic training educational programs about endotracheal suctioning through in-service training hospital office.
- 2- Instructing the critical care units' manager and head nurse in study setting to use evidence based practice guidelines regarding endotracheal suctioning.
- 3- Providing learning resources such as articles, Journals and electronic resources such as computers and internet that would increase nurses updating knowledge to use evidence based practice to change their 'behavior in their hospital setting.
- 4- Continuous follow-up must be provided by the manager and head nurse to the nurses' staff while they perform the ETS procedure to the patient, and imposing punishment for those who don't perform standard practice.
- 5- Providing continuous awareness to the critical care nurses that incorrect suctioning technique threatens the patient's safety and thus increases patients' stay in the hospital, and this in turn affects the hospital budget negatively.

### Recommendation for further researchers:

1. Further studies on larger samples from different geographical areas in Egypt to obtain more generalizable data.
2. Encouraging other researchers to implement evidence based nursing practice guidelines for open and closed endotracheal suctioning at critical care units to improve patients' health outcome.
3. Comparison study between the effect of routine and standard procedure on patients cardiorespiratory parameters.
4. Use of more descriptive studies to identify the factors that affect nurses' implementation for standard ETS procedure.

### Reference

1. Hirsch L.(2019). Lungs and Respiratory System, access at 2/3/2019. Availableat:<https://kidshealth.org/en/parents/lungs.html>.
2. Salvatore M, Francois L, Claudia P& Emmanuelle G, Bernard M, Laurent B (2013). Decreasing the Adverse Effects of Endotracheal Suctioning During Mechanical Ventilation by Changing Practice. *Respir Care* ,58(10):1588 –1597.
3. Soussan R., Schimpf C., Pilmis B& Degroote T., Tran M (2019), Ventilator-associated pneumonia: The central role of transcolonization, *Elsevier Journal of Critical Care*,50(2019)155-161.

4. Zeb A., ul-Haq S., Ali F & Hussain N., Shah S., Faisal S (2018), Knowledge and Practice of ICU Nurses Regarding Endotracheal Suctioning in Tertiary Care Hospitals, Peshawar, *JOJ Nurse Health Care* 2(4): JOJNHC.MS.ID.555595.
5. Mwakanyanga E., Masika G., Tarimo E (2018), Intensive care nurses' knowledge and practice on endotracheal suctioning of the intubated patient, *PLoS One Journal*, 13(8): e0201743.
6. Turner J., Bucca A., Propst S & Ellender T (2020), Association of Checklist Use in Endotracheal Intubation With Clinically Important Outcomes , *JAMA Network Open* ,3(7):e209278.
7. Wendy C, Leigh S, Rose K & Armstrong L , Boyle M, Karina G (2017). Suctioning an adult ICU patient with an artificial airway .*Intensive care coordination &Monitoring unit*, 952-0.
8. Sapra A, Malik A & Bhandari P.(2021). Vital Sign Assessment. access at25/1/2021.Avalableat: [https://www.ncbi.nlm.nih.gov/books/NBK553213/#\\_NBK553213\\_pubdet\\_](https://www.ncbi.nlm.nih.gov/books/NBK553213/#_NBK553213_pubdet_)
- 9.
10. Charbek E (2019). Normal Vital Signs. access at25/1/2021.Avalableat: <https://emedicine.medscape.com/article/2172054-overview>.
11. Chen W , Hu S, Lio X & Wang N, Zhao J,Liu P, Chen K, Hu J (2021).Intensive care nurses'knowledge and practice of evidence – based recommendations for endotracheal suctioning.*Reaserch square*,10.21203.
12. Hafez M (2016). Assessment of nurses 'knowledge and practices regarding endotracheal tube suctioning procedure at the intensive care units,
13. Ansari K,Alvali N,Hajbagheri M &Afazel M (2012). The gab between knowledge and practice in standard endotracheal suctioning of ICU nurses. *Iran gournal critical care nurses*,5(2):71-76.
14. Forta O, Loureiro M &Ferreira A (2014). Knowledge about endotracheal suctioning on the part of intensive care nursing professionals .*Online Brazilian Journal of Nursing*, 12(3).
15. Aboalizm & Abd Elhy (2019). Effect of Educational Intervention On Nurses' Knowledge And Practices Regarding Endotracheal Tube Suctioning. *International Journal of Nursing and Health Science*, 5(3), 1-8.
16. Elsaman S (2017). Effect of application of endotracheal suctioning guidelines on cardiorespiratory parameters of mechanically ventilated patients .*ISOR Journal of nursing and health science* 2320-1959
17. Liu X, Jin Y, Ma T & Qu B, Liu Z (2015). Differential Effects of Endotracheal Suctioning on Gas Exchanges in Patients with Acute Respiratory Failure under Pressure-Controlled and Volume-Controlled Ventilation. *Hindawi Publishing Corporation Bio Med Research International*, 10.1155/2015/941081.
18. Shamali M, Abbasinia M, Konradsen H (2019). Effect of minimally invasive endotracheal tube suctioning on physiological indices in adult intubated patients, *Australian Critical Care*, 10.1016.
19. Futter M, Morrow B & Argent A (2016). Effect of endotracheal suction on lung dynamics in mechanically- ventilated patients. *Journal of physiotherapy*, 52(2):121-6.
20. Alvali C , Adib M& Ghanbari A (2014). Effect of endotracheal suctioning with and without normal saline on hemodynamic and respiratory parameters in patients undergoing mechanical ventilation in ICU hospital.*Biomedical and pharmacology Journal*,7(2):515-23.
21. Brenda A, Abbaszadeh A, Enayati H & Borhani F, Rafiei H (2016). Effect of endotracheal suctioning on lung dynamics of the patients hospitalized in intensive care unit. *Iranian Journal of ctical care nursing*,6(4):243-50.
22. Zahran E & El-Razik A (2011). Tracheal suctioning with versus without saline instillation. *Journal of American science*,7(8): 23-32.