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Evaluation the Gap between Knowledge and Practice in Open System Endo-Tracheal Suctioning among Critical Care Nurses

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Abstract

Although endotracheal suctioning (ETS) is essential, the procedure, however, is not free of risks and complications especially when performed incorrectly. These risks and complications can seriously affect the stability of critically ill patients**.** Therefore, it is very important to perform this procedure with professional competence, which means not only having the necessary skills, but also knowledge based on recent scientific evidence, and ensures efficiency and the safety of the patient. **The aim** of this study is to evaluate the gap between knowledge and practice in open system ETS among critical care nurses (CCNs)**. Methodology:** Sixty CCNs working at the Intensive Care Units (ICUs) of Alexandria Main University Hospital (AMUH) and providing direct care for patients with an artificial airway were included in the study. **Two different tools** were used to collect the data; Endotracheal suctioning knowledge 'structured questionnaire, and Endotracheal suction observational checklist**. Result**s: more than two thirds of the study sample were female, and had bachelor degree either intern or staff nurses. 63.3 % of them had working experience of less than 5 years. Knowledge of CCNs regarding ETS was higher than their performance. **Conclusion & recommendations:** it can be concluded that CCNs had inadequate knowledge and poor performance in relation to ETS and there was a gap between knowledge and practice of CCNs in relation to ETS**.** These findings suggest that CCNs should be continuously assessed for their knowledge and practices regarding ETS and CCNs' performance in relation to ETS should be improved. In service educational programs should be conducted for critical care nurses regarding ETS.

Key words: endotracheal suctioning, knowledge, practice, critical care nurses.

Introduction

Critically ill patients with artificial airway are unable to clear secretions effectively; because of compromised glottis closure and impaired normal mucociliary function. Therefore, all patients with an artificial airway require ETS which is an important intervention in caring for those patients. Endotracheal suctioning, in the critically ill patients, is an essential aspect of effective airway management (Sharma, et al., 2014, Kelleher,et al.,2008). It has become a routine part of mechanically ventilated patients' care in the ICUs (Arbon & Siew,2011). The primary purpose of ETS is removing secretions and preventing airway obstruction, it aims to prevent atelectasis whilst optimizing oxygenation and ventilation and reducing the work of breathing (Morrow, et al., 2006). It was reported that successful suctioning improves gas exchange, breath

sounds, decreases the peak inspiratory pressure (PIP), decreases airway resistance, increases dynamic compliance, increases tidal volume (Vt), and improve oxygen saturation (Gardner, et al., 2009).

Methods for ETS include open and closed suctioning (Elsaman, 2017) . Open ETS means suctioning the airway after disconnection the endotracheal tube from the mechanical ventilator. While, closed suctioning is defined as suctioning via a tight-fitting device on the endotracheal tube that allowing the connection and working of ventilator during suctioning. The closed system suctioning devices are designed to prevent hypoxemia induced by suctioning, especially in critically ill patients who require high levels of PEEP to maintain oxygenation (Nishamol, 2011). Although, open suction systems is associated with many complications rather than closed system (Frota, et al., 2014). It is widely used in our country because of our economic status. Despite ETS is essential, the procedure is not free of risks and complications especially when it performed incorrectly (Frota, et al., 2013). These complications include increase arterial and intracranial pressure, hypoxemia, respiratory arrest, bronchospasm, atelectasis, nosocomial infections, vagal stimulation, tracheobronchial tree damage, hemorrhage, cardiovascular instability, changes in neurological status and even death (Frota, et al., 2014).

Recently and all over the world, unsafe ETS practices has been noticed. Because of adverse reactions, health care providers need to take all necessary precautions to ensure patient safety and a high quality of nursing care. Moreover, CCN should be aware of the risks and practice in a manner that ensures effectiveness of ETS (Jansson, et al., 2013; Kelleher, et al., 2008, AARC, 2010). So, it is essential that this procedure should be performed with professional competence, meaning that not only having the necessary skills, but also evidence based scientific updated knowledge, guaranteeing efficiency and the safety of the patient (Frota, et al., 2014). But, research revealed that CCNs have no sufficient knowledge of the current recommendations for ETS and, according to empirical evidence, the practice is often depending on rituals and traditions (Frota, et al., 2014). Many complications of open ETS were observed in our ICUS before, during and or after implementing this procedure by CCNs such as hypoxia, cardiac dysrhythmias, bleeding due to traumatic injury, blood pressure changes and even death. These explained as it may be due to lack of knowledge or inadequate skills or presence of gap between knowledge and practice of CCNs. Therefore, this study was conducted.

Aim of the study:

to evaluate the gap between knowledge and practice in open endo-tracheal suctioning among CCNs.

Research question: Is there a gap between knowledge and practice in open endo-tracheal suctioning among CCNs?

Subjects and method:

Materials:

Research design:

A descriptive research design was used to conduct this study.

Setting:

The study was conducted at the ICUs of AMUH namely; Unit I and the Unit III.

Sampling:

A convenience sample of 60 CCNs who are providing direct care for critically ill patients with an artificial airway in the previous settings were included in the study.

Tools for Data Collection: Two tools were used to collect the data:

Tool (I): "Endotracheal suctioning knowledge 'structured questionnaire" was developed by researcher after reviewing the relevant literature (Davies, 2008, Ansari, et al., 2012, Frota, et al., 2014) to assess the knowledge of CCNs regarding ETS and it consists of two parts:

First part: It included demographic data of CCNs such as age, sex, level of education, years of experience and type of ICU.

Second part: It was concerned with nurses' knowledge of ETS. This part consisted of 28 questions in different aspects of nurses' knowledge in three areas of ETS: before ETS (11 items) such as assessment the needs for suction by auscultation the patient chest, frequency of suction (as needed or according to routine of the unit), explanation and assuring the patient, hyperoxygenation, hyperinflation, infection control measures (hand washing wearing gloves , maintain sterility of suction catheter), size of suction catheter, etc…), during ETS (8 items) such as appropriate negative pressure, appropriate depth of entering the catheter, duration of suction, numbers of catheter passes, instillation of normal saline, method of entering the catheter), and post ETS (9 items); such as rapid connection of the patient to ventilator, hyperoxygenation, hyperinflation, re-assuring the patient, listening to the lung, assess heart rate and rhythm, hand washing, documentation and reporting unexpected outcomes).

Scoring system:

Score of one was given to the right answer to each question and the score of zero was given to wrong answer. So each nurse could get a score of zero to twenty eight.

Tool (II): "Endotracheal suction observational checklist": This tool was developed by the researcher after reviewing the relevant literature (Davies, 2008, Ansari, et al., 2012, Frota, et al., 2014) and according to questionnaire sheet to assess nurses' performance of ETS. The observational check list of ETS also included 28 skills which was concerned about nurses' performance in suctioning in three areas of prior, during and post ETS. Performance of each nurse was observed three times.

Scoring system:

The average of three scores for each nurse considered as their final score. Each items in observational checklist was rated as: done (scored 1), or not done (scored zero).

Content validity:

The tools were validated by 6 experts in the field of critical care nursing (service and education) who reviewed the tools for clarity, relevance, comprehensiveness, and applicability.

The tools also were tested for reliability using Cronbach's alpha reliability method on a sample of 10 subjects. The correlation coefficient was (0.75) for ETS questionnaire and (0.85) for observational checklist which was accepted.

Ethical considerations:

The present study was approved by the Scientific Research Ethics Committee of the faculty of nursing- Alexandria. Informed consent was obtained from CCNs before conducting the study after explaining the aim of the study and the right to refuse to participate in the study was emphasized to subjects. Critical care nurses' anonymity, confidentiality and privacy were maintained during implementation of the study

Pilot study:

The pilot study was conducted on 10 CCNs to test the feasibility and applicability of the tools and necessary modifications were done.

Field work:

The actual field work was carried out over a period of 3months from the beginning of May 2014 to the end of July 2014. Informed consent was obtained from CCNs before conducting the study after explaining the aim of the study and the right to refuse to participate in the study was emphasized to subjects. Critical care nurses who are involved in the care of critically ill patients were assessed for endotracheal suction knowledge using (tool 1) after explanation of the research purpose and asking to respond to each items in questionnaire after reading it well. They were observed during the three phases of ETS for three times using (tool 2).

Administrative design:

An official letter from the Faculty of Nursing was taken to the hospital responsible authority to obtain permission to conduct the study after explaining of the aim of the study. Tools were developed by researcher after reviewing the relevant literature.

Statistical design:

The raw data was revised, coded and fed to statistical software IBM SPSS version 20. Chi-square test and Fisher exact test were used alternatively to test the association between two qualitative variables or to detect the difference between two or more proportions. The 0.05 level or below was used as the cutoff value for statistical significance. The collected data was analyzed by using the appropriate statistical test to identify gap between the knowledge and performance of ICU nurses in ETS.

Results:

Table (1) represents the distribution of critical care nurses regarding to demographic data. This table shows that near two thirds of CCNs were female (65%) aged between 20 to 25 years old (60 %) and the majority of nurses had less than 5 years nursing experience. It was observed from this table that 70% of the study sample had bachelor degree either intern or staff nurses. This table also shows that 58.3% of nurses working at ICU3 of AMUH while the other nurses working at the causality care unit. **Table (2) represents averages of critical care nurses' score in knowledge and performance in ETS.** It was observed that from 28 possible scores, the average scores of knowledge and performance were 20.57 and 16.98 respectively**.** In addition, this table revealed that the mean scores of knowledge and performance of CCNs during the ETS were lower than the mean scores of knowledge and performance in the other phases of suction (before and after the suction technique).

Table (3) represents the relation between demographic data and nurses' scores in knowledge and performance in endotracheal suctioning. It was seen that there was a significant relation between nurse's age, sex, experience, level of education, the two different ICUs and scores of knowledge and performance of CCNs in ETS. **Table (4) shows the distribution of the study sample according to their knowledge**. It was observed that majority of the CCNs had knowledge deficit in frequency of ETS, hyperoxygenation and hyperinflation before and after ETS, duration of suction, frequency of suction passes. **Table (5) shows the distribution of the study sample according to their performance.** it can be seen from this table that majority of the CCNs had inadequate skills in assessment the need for suction by auscultation the chest, explaining the ETS procedure to the patients, following aseptic technique (hand washing, wear sterile gloves) hyperoxygenation and

hyperinflation the patients before and after ETS, number of suction passes and suction duration. **Table (6) represents the gap between knowledge and practice of critical care nurses in endotracheal suctioning**. it was observed that there was a significant relation between knowledge of CCNs and its related practice in relation to frequency of ETS , hand washing before suction, hyproxygenation and hyperinflation before and after suction, number of suction passes, and suction duration.

Table (1): Distribution of critical care nurses regarding to demographic data

Demographic data	Categories	N (60)	% (100%)
Age	20 - 25 Years	36	60.0
	25 - 30 Years	7	11.7
	30 -35 Years	8	13.3
	≥ 35 Years	9	15.0
Sex	Male	21	35.0
	Female	39	65.0
Years of experience	< 5 Years	38	63.3
	5 - 10 Years	8	13.3
	10 - 15 Years	9	15.0
	≥15 Years	5	5.3
Level of education	Diploma degree	15	25.0
	Bachelor degree (intern nurses)	32	53.3
	Bachelor degree (staff nurse)	10	16.7
	Technical	3	5.0
Type of critical care unit	ICU I	25	41.7
	ICU3	35	58.3

Table (2): Averages of critical care nurses' score in knowledge and performance in ETS

Phases of ETS	Knowledge			Performance		
	X±SD	Min Score	Max Score	X±SD	Min Score	Max Score
Before Suctioning (11 items)	7.60±1.51	4	11	5.97±2.09	2	11
During Suctioning (8 items)	5.72±1.74	2	8	4.48±1.81	1	8
After Suctioning (9 items)	7.25±1.74	4	9	6.53±2.30	2	9

Min: Minimum Score Max: Maximum Score

Table (3): Relation between demographic data and nurses' scores in knowledge and performance in endotracheal suctioning

Demographic data		N	%	Average Scores of Knowledge	Average Scores of Performance
Age	20-	36	(60.0%)	21.92	19.33
	25-	7	(11.7%)	17.29	12.14
	30-	8	(13.3%)	19.00	13.63
	35+	9	(15.0%)	19.11	14.33
				P=0.0000	**P=0.0000**
Sex	Male	21	(35.0%)	19.10	16.71
	Female	39	(65.0)	15.85	25.00
				P=0.023	**P=0.029**
Years of experience	<5	38	(63.3%)	21.74	19.08
	5-	8	(13.3%)	18.38	12.88
	10-	9	(15.0%)	18.78	14.22
	15+	5	(8.3%)	18.40	12.60
				P=0.013	**P=0.0000**
Type of critical care Unit	ICU1	25	(41.7%)	19.88	16.71
	ICU3	35	(58.3%)	21.06	25.00
				P=0.232	**P=0.029**
Level of education	Diploma	15	(25.0%)	17.60	12.07
	Bachelor(1)	32	(53.3%)	22.06	19.47
	Bachelor(2)	10	(16.7%)	20.80	17.80
	Technical	3	(5.0%)	18.67	12.33
				P=0.001	**P=0.000**

Bachelor(1) = new graduate nurse, Bachelor(2) = staff nurse *Significant at $P< 0.05$*

Table (4): Distribution of the study sample according to their knowledge.

knowledge before ETS	**True (1)**		**False (0)**	
	No	%	No	%
1. Assessment patient's need for suction by auscultation the patients' chest.	58	96.7	2	3.3
2. Frequency of ETS	21	35.0	39	65.0
3. Proper size of suction catheter	45	75.0	15	25.0
4. Explanation the procedure and assuring the patient	52	86.7	8	13.3
5. Hyperoxygenation and hyperinflation	21	35.0	39	65.0
Infection control measures				
1. Hand washing	50	83.3	10	16.7
2. Wearing sterile gloves	57	95.0	3	5.0
3. Maintain sterility of tracheal suction catheter before and during ETS	48	80.0	12	20.0
knowledge during ETS				
1. Appropriate negative pressure	47	78.3	13	21.7
2. Suction duration	28	46.7	32	53.3
3. Suction passes	32	53.3	28	46.7
4. Instillation of normal saline	55	91.7	5	8.3
knowledge after ETS				
1. Heproxygentaion/ hyperinflation	26	43.3	34	56.7
2. Hand washing	58	96.7	2	3.3

Table (5): Distribution of the study sample according to their performance

Performance before ETS	Done (1)		Not done (0)	
	No	%	No	%
1. Assessment patient's need for suction by auscultation the patients' chest.	17	28.3	43	71.7
2. Performing ETS as needed (Frequency of ETS)	23	38.3	37	61.7
3. Selection proper size of suction catheter	41	68.3	19	31.7
4. Explanation the procedure to patients	13	21.7	47	78.3
5. Hyperoxygenation and hyperinflation the patients	18	30.0	42	70.0
Infection control measures				
1. Hand washing	36	60.0	24	40.0
2. Wearing sterile gloves	22	36.7	38	63.3
3. Maintain sterility of tracheal suction catheter	53	88.3	7	11.7
Performance during ETS				
1. Using appropriate negative pressure	57	95.0	3	5.0
2. Follow recommended suction duration	28	46.7	32	53.3
3. Follow the recommended number of suction passes	18	30.0	42	70.0
4. Instillation of normal saline	44	73.3	16	26.7
Performance after ETS				
1. Heproxygentaion/ hyperinflation	27	45.0	33	55.0
2. Hand washing	38	63.3	22	36.7

Table (6): Gap between knowledge and practice of critical care nurses in endotracheal suctioning

Phases of suction	Knowledge		Related practice		Total	FET Sig
Before suction			**Not done (0)**	**Done (1)**		
Frequency of ETS	False(0)	No	31	8	39	0.000*
		%	79.5%	20.5%	100.0%	
	True (1)	No	6	15	21	
		%	28.6%	71.4%	100.0%	
Hyproxygenation / hyperinflation	False(0)	No	39	2	41	0.000*
		%	95.1%	4.9%	100.0%	
	True (1)	No	3	16	19	
		%	15.8%	84.2%	100.0%	
Infection control measures						
Hand washing before suction	False(0)	No	10	0	10	0.000*
		%	100.0%	0.0%	100.0%	
	True (1)	No	14	36	50	
		%	28.0%	72.0%	100.0%	
During ETS						
Suction passes	False(0)	No	25	3	28	0.004*
		%	89.3%	10.7%	100.0%	
	True (1)	No	17	15	32	
		%	53.1%	46.9%	100.0%	
Suction duration	False(0)	No	25	7	32	0.000*
		%	78.1%	21.9%	100.0%	
	True (1)	No	7	21	28	
		%	25.0%	75.0%	100.0%	
After ETS						
Heproxygentaion/ hyperinflation	False(0)	No	26	8	34	0.000*
		%	76.5%	23.5%	100.0%	
	True (1)	No	7	19	26	
		%	26.9%	73.1%	100.0%	

Significant at $P< 0.05$

Discussion:

The practice of ETS is often depending on rituals and traditions (Ania, et al., 2004, Day, et al., 2009).Therefore, this study was conducted to identify knowledge and practice of CCNs regarding ETS and if there is a gap between them. Regarding demographic data, the findings of this study revealed that the majority of CCNs were female and in their early twenties. This indicates that the ongoing trend of a female-dominated profession in Egypt and male gender in the field of nursing is still low in numbers. Abd El-Halem et al. in 2011, that there are still an insignificant number of male genders in nursing work (Oermann & Garvin 2002, Abdel El-Halem, et al., 2011). Experience of less than 5 years in the majority of CCNs in this study reflects their young age.

Results of the current study revealed that level of knowledge of CCNs was higher than their performance in relation to ETS. This reflects presence of gap between knowledge and performance of nurses in relation to ETS. This may be due to most of CCNs were novice nurses whose skills are inadequate and their experience is low. It was

observed that the knowledge scores of the CCNs in the three phases of suction (prior to, during and after suctioning) were much higher than their practice scores in the same ETS phases and this is an important point to be considered. Varghese et al., 2016 revealed that nurses have more knowledge regarding ETS than practice. This is also similar to Ansaari, et al 2012 and Day *et al* 2002 findings that revealed presence of gap between knowledge and performance of nurses. In contrast, Sharma et al 2014 findings that practice was better than knowledge.

Moreover, the result of the current study revealed presence of significant relation between demographic data of CCNs and their scores of knowledge and performance in ETS. This may be due to the younger age of majority of them, low experience, and differences in educational levels. In addition to, clinical settings where causality ICU is more crowded, more stressful and its design and environment may affect on performance of CCNs in addition overloaded nurses in causality ICU1 mandate them to not participate in any educational program or any workshop and this may be the reason of decreased their knowledge level. On contrary Ansaari et al 2012 and Shrma etal 2014 revealed no significant relation between age, type of ICU, working experience and scores of knowledge and performance of CCNs in ETS.

Results of the current study revealed presence of gap between knowledge and practice of CCNs in the 3 phases of ETS. On evaluating each step in detail, it was found that majority of CCNs had inadequate knowledge about assessment the need for suction by auscultation patients' chest, hyperoxygenation before and after ETS, frequency and duration of ETS, number of suction passes. Furthermore, findings of the current study revealed that majority of CCNs neglect or did not perform many essential steps of ETS according to current recommendations including assessment the need for suction by auscultation patients' chest, explaining the procedure, follow aseptic technique during suction (hand washing before and after suction, wear sterile gloves) hyperoxygenation and hyperinflation before and after suction, suction negative pressure, and suction passes.

According to best practice ETS recommendations, CCNs should auscultate the patient’s chest to confirm the need for ETS (Thompson 2000, Day et al 2002, Wood 1998). The result of the current study revealed that almost CCNs had knowledge about the importance of auscultation of patient's chest to assess needs for ETS. However, the majority of them did not auscultate the patient' chest before suction. This may be due to workload of CCNs. Besides that, they depend on presence of visible secretions, or breathe sound, and or ventilator high pressure alarm. This is similarly to Kelleher et al 2007 stated that participants generally failed to auscultate the chest. Moreover, Day et al 2002 reported that the majority of participants failed to auscultate lung sounds prior to ETS.

Despite a lot of evidences on the negative consequences of suctioning induced hypoxemia (Wood 1998, Day, et al., 2001, Day, et al., 2002, Barnett 2005, Freeman 2011). In addition, risks of hyperinflation such as barotraumas, cardiovascular instability and increased intracranial pressure (Day, et al., 2002). Findings of the present study revealed that more than two thirds of the study sample had lack of knowledge about hyper oxygenation and hyperinflation the patients before or after ETS. Besides that, they failed to provide hyperoxgenation/ hyperinflation before and or after suctioning. This result reflects that CCNs depend on routine or tradition in performing the ETS procedure and also reflects low experience of nurses. This result should be considered as it affects the patients' safety and reflected negatively on the quality of care and outcomes. Frota et al 2013 reported that only 63% of nurses answered the question related

to pre-oxygenation correctly. This is similarly to Day et al 2002 and Kelleher et al 2007 revealed 37% of their sample failed to provide hyper-oxygenation / hyperinflation either before and/or after ETS. Also Varghese et al 2016 revealed that only 54% of the participants performed pre-suctioning hyperoxygenation, though it is worth noting that 74% of the participants performed hyperoxygenation post-suctioning.

Explaining procedures to the patients support their feeling as a human being and it is essential strategy for decreasing stress, anxiety, in addition maximizing the results of ETS (Ania, et al., 2004). Results of the current study showed that the majority of CCNs had knowledge about importance of explanation the procedure to the patients before suction. However, majority of them did not explain the procedure to patients before ETS but reassured the patients after suctioning. This may be due to lack of time and CCNs focused only on the procedure itself to aspirate the pulmonary secretions and avoid airway obstruction and at the same time most of patients had disturbed level of consciousness and they are rarely communicated with unconscious or mechanically ventilated patients. Frota et al 2013 reported that 92.6% of participants stated that it is necessary to explain the procedure to the patient. While, Varghese et al 2016 find that only about one third of the nurses explained the procedure to the patient before suctioning. On contrary to, Jansson *et al* 2013, where 61.5% of the participants explained the procedure to the patient before suctioning.

Despite most researchers recommend limiting the application of negative pressure to 10–15 seconds because longer durations are associated with hypoxemia, mucosal injury, and decreased lung volume (Day, et al., 2002, Pedersen et al., 2009). The current study findings showed that about half of the CCNs had knowledge deficit about **duration of suction** as well as the number of passes of suction catheter. In addition, the majority of them failed to suction the airway in less than 15 second. They did not consider the time and number of passes of suction catheter and this increase the risk for hypoxia and trachea bronchial injury. This is a worrying result and this point should be considered as the consequences of long time of suction and increased number of catheter passes lead to the serious complications of ETS. Frota et al 2013 reported poor knowledge of the study sample as only 33.3% answered the question of the duration of the suction procedure correctly. Varghese (2016) reported that 64% of nurses failed to suction the airway for less than 15 second.

The value of aseptic technique and hand washing before and after ETS is highly confirmed in the literature (Wood 1998, Thompson 2000, Day, et al., 2002). Result of the current study revealed that majority of CCNs had knowledge about the importance of **hand washing** before and after suction, the use of gloves in ETS. However, about 40% of them did not wash their hands before and after suction and 63.3% of them did not wear sterile gloves during ETS. This may be due to that CCNs had no time to wash their hands because of workload and shortage of staff. In addition to, lack of sterile gloves. Nurses believed that wearing gloves can replace hand washing and it's enough to wash hands before and after each shift. Similarly to Kelleher et al 2007 reported that about one half of sample were not observed to wash their hand prior to the ETS procedure and also in line with Varghese 2016 found that only 42% of the participants washed hands before suctioning, and 28% post suctioning.

Despite **instillation of isotonic sodium chloride solution** is associated with many adverse effects (Sole 2002), the majority of the study sample instill normal saline in endotracheal tube during suction although they aware of its side effects. This may be due to the routine of its use in ICUs in addition to, nurses believing that saline instilation loose secretions. This is supported by Frota et al 2013 result that indicated poor

knowledge of participants, as only 44.5% correctly stated that it should not be applied routinely. This is against Kelleher et al 2008 and Jansson *et al* 2013 findings that 30%, 25% respectively of their participants instill normal saline in endotracheal tube during suction.

Negative pressure which used during ETS is another area of concern. High negative pressure leads to mucosal injury, which consequently increases the risk of the bronchial tree for infection (Wood 1998). Using high negative pressures does not mean aspiration of more secretions; hence, limiting pressures to between 80 and 150mmHg is recommended (Wood 1998, Thompson 2000, Day, et al., 2002). Our findings show that the majority of CCNs were aware of necessity of using appropriate negative pressure during ETS and already they apply suitable pressure during ETS. Kelleher et al 2008 results indicated that all studied sample used suction pressures outside of the recommend levels with suction pressures ranging from 230mmHg to 450mmHg. Day et al 2002 reported that nurses generally did not know the best ETS practice recommendations.

Frequency of suctioning, traditionally was performed every 1-2 hours, however, due to risks associated with "routine" suctioning; it is recommended that ETS should be performed only when needed (Pedersen et al., 2009). Result of the current study revealed that majority of CCNs had inadequate knowledge about frequency of ETS (if routinely (pre-established hours as prescribed or unit routine) or only when necessary, and at the same time they were not follow the recommendations in performing ETS suction. They are sometimes performing suction as needed; in another time especially at the beginning of each shift perform ETS for all critically ill patients who have endotracheal or tracheostomy tube. This is may be due to lack of policy, guidelines, lack of knowledge, and time related factors. On contrary to Frota et al 2013 that the knowledge of participants was viewed as very good as 92 6% correctly indicated that the ETA should be performed only when necessary.

Regarding to **suction catheter size**, result of this study indicates that the majority of CCNs had knowledge about appropriate suction catheter size but near one third of them did not select the proper suction size. Increased level of knowledge may be due to attendance of staff nurses to workshops related to patient's safety in ICU and accordingly some of them transfer their knowledge to novice nurses. Frota et al 2013 revealed that success rate was about 60% of sample, indicating poor knowledge.

Conclusion and recommendations: Based on the findings of the current study, it can be concluded that CCNs had inadequate knowledge and poor performance in relation to ETS and there was a gap between knowledge and practice of CCNs in relation to ETS.

In light of the current study findings, the following recommendations are suggested: in service educational programs should be conducted for critical care nurses regarding: ETS, its complications and how to prevent it. CCNs should be continuously assessed for their knowledge and practices regarding ETS and CCNs' performance in relation to ETS should be improved. Critical care nurse should adhere to evidence based practice recommendations of ETS.

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