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Effects of training on nurses' performance in terms of endotracheal suctioning of patients in intensive care units based on clinical indicators

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ABSTRACT

Introduction: Principled endotracheal suctioning (ETS) performed by nurses can reduce complications, duration of hospitalization and mortality in critically-ill patients in the intensive care unit (ICU). *Aim:* The present study was conducted to determine the effect of

training on nurses' performance in terms of the ETS of patients in the ICUs of Imam Khomeini Medical Educational Center in Ardabil, Iran based on clinical indicators. *Methods:* This single-blinded randomized clinical trial recruited 47 nurses working in the ICUs of Imam Khomeini Medical Educational Center in 2018-19. The participants were randomly assigned into an intervention group and a control group. Data collection tools included a standard performance checklist for nurses in the field of ETS. The data were analyzed in SPSS-22 using statistical tests. *Results:* The mean score of the nurses' performance in terms of ETS was 12.04±3.08 in the intervention group and 12.29±2.38 in the control group (P=0.75) before training, and 15.13±2.78 in the intervention group and 12.16±2.82 in the control group (P<0.001) after training. *Conclusion and implications:* The results showed that teaching ETS standards improves the performance of nurses in the ICU. Therefore, it is recommended to consider teaching ETS standards in health system planning and policy making.

Keywords: clinical indicators, ETS, ICU, performance, training

1. INTRODUCTION

Mechanically-ventilated patients in the ICU require an artificial airway of tracheal or tracheostomy tube types (Sole et al., 2015). Endotracheal intubation is performed to ensure airway openness, maintain adequate breathing and control the quality of respiration (Akgül and Akyolcu, 2002). Despite their advantages, artificial airways in the patient's airway weaken the cough reflex, cause cilia dysfunction, and ultimately lead to accumulation of secretions and disruption of secretions discharge from the airway (Alazmani Noodeh et al., 2016; Day et al., 2002; Vianna et al., 2017). These conditions make the respiratory system vulnerable to opportunistic infections through increasing the mucus production and reducing the secretion of pneumocytes and surfactants (Day et al., 2002). These patients are unable to discharge airway secretions, and require ETS (Akgül and Akyolcu, 2002; Vianna et al., 2017) as a common procedure in patients with artificial airways and a healthcare component of bronchial protection(AARC Clinical Practice Guideline, 2010), which is used to keep the airway open (Urden et al., 2014), clean the respiratory tract, improve oxygenation, prevent atelectasis (Jansson et al., 2013) and reduce work of breathing (Morrow et al., 2006). Despite the essential nature of this procedure, it can be associated with complications such as pain, discomfort, bleeding, infection, atelectasis, hypoxemia, cardiovascular instability, variability of arterial-blood gases, increased intracranial pressure, tracheal mucosal damage, bronchospasm, cardiac arrest and even death (AARC Clinical Practice Guideline, 2010; Chaseling et al., 2014; Dadkhah et al., 2017; Morrow et al., 2006; Pedersen et al., 2009). Given the differences in pathophysiological changes between patients requiring mechanical ventilation and the potential side effects of ETS, suctioning should be prescribed for each patient based on their individual condition (Chasheling et al., 2014).

Properly managing artificial airways can reduce complications such as ventilator-associated pneumonia (VAP), prolonged ICU hospitalization and mechanical ventilation as well as mortality (Chaseling et al., 2014; Jelic et al., 2008). Wood et al. (1998) showed that ETS performed by trained nurses based on clinical needs assessment results in better outcomes and fewer side effects compared to performing it regularly every two hours (Wood, 1998). Research suggests that ETS is routinely performed without evaluating patient needs, and that ICU nurses do not perform ETS according to the recommended guidelines. Despite the lack of compelling evidence, inappropriate ETS practices have been reported throughout the world in recent years (Day et al., 2002a; Jansson et al., 2013; Kelleher and Andrews, 2008).

According to Tina Day et al. (2002), most nurses are unable of providing satisfactory levels of competence regarding ETS, and some nurses perform unsafely (Day et al., 2002a). There is also a gap between the knowledge and practice of nurses in terms of ETS (Day et al., 2002a; Leddy et al., 2015). Given the hazards associated with the suctioning of tracheal and tracheostomy tubes, improving the suctioning quality in nurses as the most important factor can accelerate the improvement of mechanically-ventilated patients in ICUs (Golzari et al., 2014). Consistent training has been therefore identified as a means of responding to rapid changes in healthcare methods and improving nursing professional standards (Hadian Shirazi et al., 2010). Nursing education, especially clinical nursing education, should also be adapted to these changes, as nurses are a major care giving group in a direct contact with patients (Dorri and Hakimi, 2018).A quasi-experimental study by Seema Sachdeva et al. (2014) showed that teaching VAP prevention guidelines generally improves the outcomes associated with nurses and patients (Seema et al., 2017).

Given the emergence of irreparable complications associated with unsafe suctioning, the positive effect of standard airway suctioning on reducing respiratory infections, length of stay and mortality of patients and the importance of improving nurses' performance interms of correct caregiving and management of the airway, the present study was conducted to investigate the effect of training on nurses' performance in ETS based on clinical indicators.

Aims

- Determining the level of nurses' performance in ETS of patients in the ICUs of Imam Khomeini Medical Educational Center in Ardabil, Iran
- Determining the effect of training on nurses' performance in ETS based on clinical indicators

2. MATERIAL AND METHODS

The present single-blinded clinical trial was conducted on a population comprising all nurses working in the ICUs of Imam Khomeini Medical Educational Center from January to May 2019. Census method was used to select the subjects. Forty eight out of the 56 nurses in these wards included in the study directly took care of patients, and were willing to participate in the study, asfull-time employees with different employment statuses and at least a bachelor's degree and a minimum three months' work experience in the ICU.

After receiving the approval of the Ethics Committee of Ardabil University of Medical Sciences, the authors presented to the head office and the nursing office of Imam Khomeini Medical Educational Center, and received a letter of introduction to the ICUs. The participants were then briefed on the study objectives and ensured of the confidentiality of their information, and signed written informed consent forms.

The nurses were then divided into an intervention group and a control group using block randomization. The samples were randomly selected using two cards with different colors in a non-transparent box, which were taken out by the participants. After taking a card out and determining the type of group, the card was discarded. After the allocation and encoding the study subjects, the researcher repeatedly visited the ICU in different working shifts, i.e. morning, evening and night, to evaluate the nurses' performance in both groups in terms of the tracheal and tracheostomy tube suctioning of mechanically-ventilated patients. In case the subject decided to perform the procedure in the ICU, the researcher recorded the demographic information of the nurse, and completed the checklist of performance as the performance was observed. After completing the initial assessment, the nurses of the intervention group participated in a two-hour training session. Given the rotational shifts and workload of the nurses, this training program lasted about one week to allow all the nurses to participate. The content of the training package provided for the participants in the class by the canter's educational supervisor was adopted from the National Nursing Standards book, covered all items of the study checklist, and included lectures; group discussion, educational videos and educational pamphlets. No interventions were performed on the nurses in the control groups. The post-intervention evaluation was performed in all the participating nurses one month after the completion of the training program in the same way as the pre-intervention evaluation.

Data Collection

Data collection tools in this study comprised a checklist for evaluating the nurses' performance in ETS. To determine the content validity of this instrument and the training package, its contents, including the necessary standards for controlling infection, performance before, during and after ETS, the clinical indications required in ETS and all the items of the evaluation tool, were presented to ten faculty members of Ardabil School of Nursing and Midwifery. Necessary changes were made in the checklist and contents of the training package after performing the qualitative assessment and collecting the comments of the teachers.

The checklist of nurses' performance in ETS comprised two sections. The first part included information about age, gender, level of education, Graduate University Type, work experience in the ICU, type of working shift and previous training on ETS. The second part was the standard checklist of nurses' performance in tracheal and tracheostomy tubes suctioning adopted from a study by Golzari et al. (Golzari et al., 2014). This 25-item checklist consisted of three main sections, including 11 items on performance before suctioning, 7 on performance during and 7 on performance required after suctioning. Every item was scored either 1: Yes or 0: No, with the total score ranging from 0 to 25. Thescore of performance before suctioning was also 0-11, during suctioning 0-7 and after suctioning 0-7.The validity and reliability of this tool have been confirmed by Iranian (Golzari et al., 2014) and non-Iranian researchers (Kelleher and Andrews, 2008; Mckillop, 2004). A Cronbach's alpha of 0.73 also confirmed the reliability of this instrument in the present study.

Ethical Approval

The present study was approved by the Ethics Committee of Ardabil University of Medical Sciences (IR.ARUMS.REC.1397.144), and registered at the Iranian Registry of Clinical Trials (IRCT20181222042075N1). To observe ethical considerations, upon the completion of the final stage of the study, the control group was provided with the training package, and the correct principles of ETS were taught to this group.

Data Analysis

The data were analyzed in SPSS-22using descriptive statistics, i.e. mean, standard deviation and variance, and inferential statistics, i.e. the Chi-square and Fisher's exact tests, which were used for comparing the demographic characteristics of the subjects in the intervention and control groups. A statistician unaware of the type of groups compared the mean scores of the ETS performance of the nurses in the groups before and after the training using the Mann-Whitney and Wilcoxon tests.

3. RESULTS

A total of 47 nurses completed the present study, and the data of 23 subjects in the intervention group and 24 in the control group were analyzed (figure 1). All the subjects were female with a mean age of 33.08±4.43 years. The mean age of the intervention group was 32.69±4.84 and that of the controls 33.45±4.06. Table 1 presents the subjects' characteristics by group. Given the small sample size in both groups, i.e. below 30, the nonparametric tests of Mann-Whitney and Wilcoxon were used to compare the mean scores of the nurses' performance in suctioning in the intervention and control groups before and after the intervention. The pre-intervention performance score of the subjects was found to be 8-18 out of 25 and their post-intervention score 7-20. The main improvements were observed in eye protection, hand hygiene, hyper-oxygenation before suctioning and protection of the central venous catheter against secretions. Before the training, the mean score of performance in suctioning was 12.04±3.08 in the intervention group and 12.29±2.38 in the controls, suggesting a statistically-insignificant difference (P=0.75) (table 2).

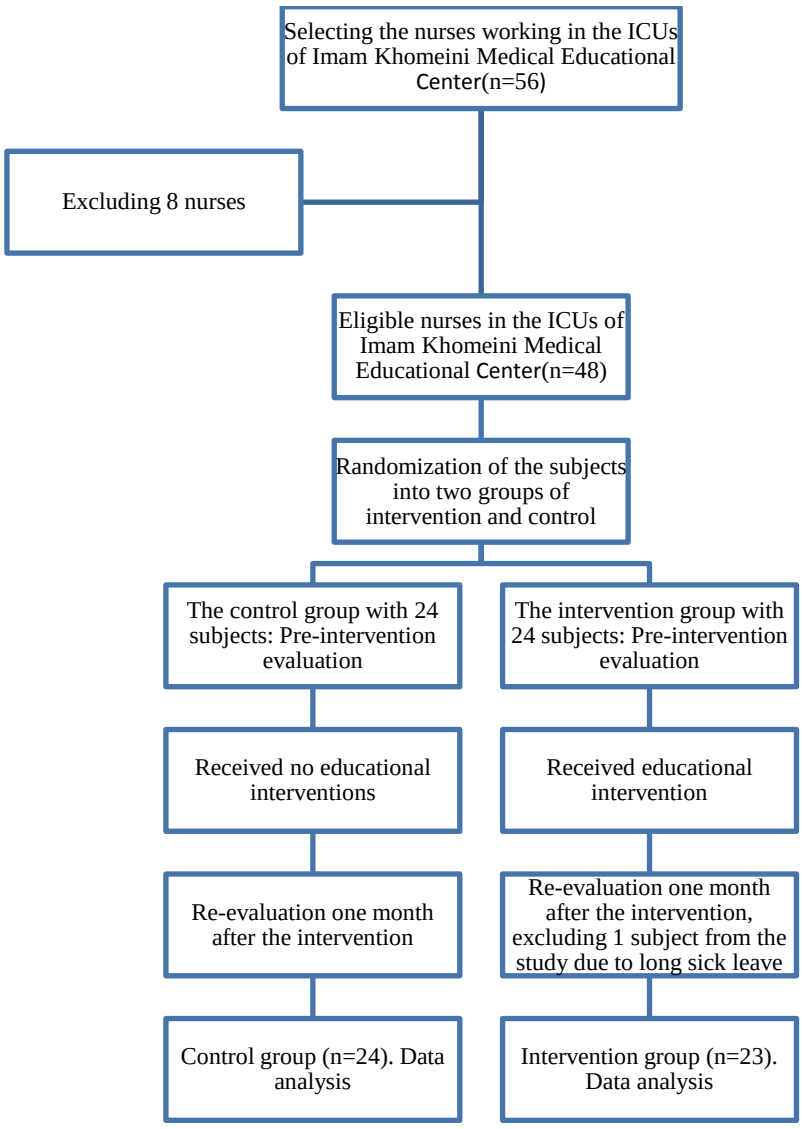

Figure 1 Diagram of participation in the study

Table 1 Demographic characteristics of the study subjects by group

Variable	Category	Intervention group	Control group	P
		Mean (SD)	Mean (SD)	
Age		32.69(4.84)	33.45(4.06)	0.57*
Work experience in the ICU		5.91(5.20)	5.54(3.86)	0.81*
		Number (percentage)	Number (percentage)	
Graduate University Type	State university	7 (30.4)	7 (29.2)	0.58**
	Islamic Azad University	16 (69.6)	17 (70.8)	
Type of working shift	Fixed	1 (4.3)	1 (4.2)	0.74***
	Rotational	22 (95.7)	23 (95.8)	

*Mann-Whitney; **Chi-square;***Fisher's Exact

Table 2 The mean score of performance in the intervention and control groups before and after the intervention

Group	Intervention	Control	P
Performance	Mean (SD)	Mean (SD)	
Before the intervention	12.04 (3.08)	12.29 (2.38)	0.75*
After the intervention	15.13 (2.78)	12.16 (2.82)	<0.001*
P	<0.001**	0.62**	

*Mann-Whitney; **Wilcoxon

One month after the training, the mean score of performance in suctioning was 15.13±2.78 in the intervention group and 12.16±2.82 in the controls, suggesting a statistically-significant difference (P<0.001) (table 2). The mean score of performance before suctioning was 2.65±1.77 in the intervention and 2.91±1.34 in the control group, suggesting a statistically-insignificant difference (P=0.46) (table 3). After the intervention, these values respectively increased to 4.52±1.87 and 3.25±1.67, which showed a statistically-significantly difference (P=0.013) (table 4). The two groups were not significantly different in terms of the mean scores of performance during suctioning before (P=0.96) and after the intervention (P=0.23) (tables 3 and 4).

The two groups were not significantly different in terms of the mean score of performance after suctioning before the intervention (P=0.90) (table 3), while after the intervention, the statistical association between the intervention and control groups was significant (P<0.001) (table 4).

Table 3 The mean score of performance before, during and after suctioning in the intervention and control group before the intervention

Group	Intervention	Control	P
Performance	Mean (SD)	Mean (SD)	
Before suctioning	2.65 (1.77)	2.91 (1.34)	0.46*
During suctioning	6.04 (0.63)	6.04 (0.75)	0.96*
After suctioning	3.34 (1.26)	3.33 (1.04)	0.90*

* Mann-Whitney

Table 4 The mean score of performance before, during and after suctioning in the intervention and control groups after the intervention

Group	Intervention	Control	P
Performance	Mean (SD)	Mean (SD)	
Before suctioning	4.52 (1.87)	3.25 (1.67)	0.013*
During suctioning	6.17 (0.49)	5.83 (0.96)	0.23*
After suctioning	3.43 (0.89)	3.08 (0.82)	<0.001*

* Mann-Whitney

4. DISCUSSION

The present findings confirmed the effectiveness of training on ETS standards in the ETS performance of nurses working in ICUs. The educational intervention could improve the performance level of nurses before and after ETS, although the performance during suctioning did not significantly increase after the intervention in the intervention compared to control group potentially due to the desirability of the performance level in both groups before the intervention. A study by Tina Day et al. (2009) entitled "Effect of performance feedback on tracheal suctioning knowledge and skills: randomized controlled trial" conducted on 95nurses and physiotherapists in the UK showed that the scores of knowledge and performance after the conventional training were moderate in the participants, suggesting no significant differences between the intervention and control groups. However, individually providing feedback on performance caused the statistical association between the two groups to become significant in terms of the mean score of knowledge and performance in both simulation and clinical settings (Day et al., 2009). Despite the differences in the expertise of subjects, type of intervention, which was providing feedback on performance, and the study design in simulated and actual settings, the results of this study are consistent with those obtained in the present research and a previous study by Day (2001). In addition, the main improvement in performance was associated with applying a proper suction pressure, which increased from 12% at the baseline to 48% after receiving feedback. In contrast, the present findings suggest that the main improvements are associated with eye protection and hand hygiene. A quasi-experimental study by Seema Sachdeva et al. (2014) entitled "Effectiveness of Suction Protocol on Nurse's and Patient's Outcome in ICU" and conducted on 60 nurses an intervention group and a control group evaluated the knowledge and performance of nurses and the consequences of bleeding from the trachea and VAP in the patients before and one month after the structured training program, and showed an increase in adherence to the protocol from 0.52 to 0.77 in the intervention group, and a significant decrease in the rate of suction complications after the intervention in the intervention group. Moreover, a significant relationship was observed between the incidence of complications in the patients and increasing the suction duration and frequency in both groups. This study suggested post-intervention improvements in all the three stages of before, during and after suctioning, whereas the present study showed significant improvements only before and after suctioning (Seema et al., 2017). Despite the differences in the content of the tools used and paying attention to the outcomes of the patients as a performance indicator in nurses, the results of this study are generally consistent with those obtained in the present research and in (Chau et al., 2007; Day et al., 2009, 2001). In an experimental study by Janita Chau et al. (2007) entitled "An evaluation of the implementation of a best practice guideline on tracheal suctioning in intensive care units", the best guideline was developed by systematically reviewing the evidence, and presented to all nurses in the ICU during 45-minute training sessions. The pre test and post test results six months after implementing the best guideline confirmed the positive effect of the intervention on nurses' suctioning performance. Prior to the intervention, adherence to the suction guidelines during suctioning, i.e. selecting an appropriate catheter size, using a sterile suctioning technique and not using normal saline, was acceptable, which is completely consistent with the present study. After the intervention, improvements were achieved in all dimensions, except for the suctioning duration, observation of a maximum number of two for consecutive suctions, consider at least 10 minutes interval between suctioning and activities increasing the intracranial pressure in patients with head traumas, allowing for the oxygen percentage to go high enough before suctioning and physiological supports. Despite the general consistency in the outcomes between this study and the present research, the discrepancy of results can be explained by differences in the content of the tools used, the study setting and the type of study patients (Chau et al., 2007). An experimental study by Hadiyan Shirazi et al. (2006) examined the knowledge and performance of nurses in the ETS of neonates, and the findings suggested improvements in the knowledge and performance of the subjects after the training, although these improvements declined over the course of time, suggesting the requirement for performing consistent training in this regard (Hadian Shirazi et al., 2010). A quasi-experimental study by Mohammadi et al. (2012) with an unequal number of subjects in the control group entitled "Effect of endotracheal suctioning education for nurses on patients' hemodynamic parameters" showed that the blood pressure status of the patients becomes unstable after ETS, and that retraining programs reduce the instability duration (Mohammadi et al., 2012). The practical skills results of a quasi-experimental study entitled "The Effect of Mastery learning model for suction and oxygen therapy skills in nursing students" and conducted by Hakimi et al. (2013) on two groups of nursing students at the fifth semester in Isfahan showed that the mean changes in the scores of the practical evaluation checklist at the beginning and end of internship were statistically significant in the control and intervention groups (Dorri and Hakimi, 2018). A study by Seyedjavadi et al. (Seyedjavadi et al., 2012) proposing an educational intervention on clinical supervisors and applying the clinical coaching role by them confirmed the present results despite being different in terms of the subjects' expertise. The results of all the studies cited confirm the positive effect of educational interventions using different training methods on nurses' suctioning performance.

The findings obtained from a randomized clinical trial entitled "Does educating nurses with ventilator-associated pneumonia prevention guidelines improve their compliance?" and conducted by Sami M Aloush et al. (2016) on 120 nurses working in the ICUs

of five hospitals in Jordan showed that, despite the effective factors in each group, including the number of beds in each ward and the ratio of nurses to patients, whose reduction increased the compliance score, the mean score of compliance after the educational intervention was not statistically and significantly different between the intervention and control groups (Aloush, 2017), which is inconsistent with the findings of the present study. This discrepancy of results can be explained by many factors such as differences in the time and conditions of the intervention, the type of the tools used, which was an observational 9 items checklist for preventing VAP and the environmental differences.

5. CONCLUSION

Overall, the results showed that teaching ETS standards improves the ETS performance of nurses working in ICUs. Given the positive effect of standard airway suctioning on reducing respiratory infections, length of stay and mortality of patients, the health system planners and policymakers are recommended to take measures to include these standards in the training of nurses so as to improve their healthcare and airway management performance. The present study limitations comprised the lack of necessary resources for changing the enabling factors required for controlling infections. Future studies are recommended to focus on discussing and communicating with the authorities and having access to infection control facilities to enable them to change behavior. There was no conflict of interest in this study. The financial base of this study is Ardebil University of Medical Sciences.

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Implications for clinical practice

Improving nurses' performance in terms of the ETS of patients in the ICUs
Reducing complications of endotracheal suction in patients
Reducing duration of hospitalization and mortality in critically-ill patients in the ICUs

Abbreviations

ICU = Intensive Care Unit
ETS = Endotracheal suctioning
VAP = Ventilator-associated pneumonia

Conflicts of interest

None

Financial resources

None.

REFERENCE

1. AARC Clinical Practice Guideline. Endotracheal suctioning of mechanically ventilated patients with artificial airways 2010. Respiratory Care. 2010;55:758-64.
2. Akgül S, Akyolcu N. Effects of normal saline on endotracheal suctioning. Journal of clinical nursing. 2002;11:826-30.
3. Al-azmani F, Ramezani Badr F, Shiri Geidari P, Naghibi Mahmodabadi T. Investigating the Effect of Artificial Airway Artificial Suction on the basis of comprehensive criteria for the need for suction on hemodynamic status of patients admitted to intensive care units. Journal of Preventive Care in Nursing and Midwifery. 2016;2:1-12.
4. Aloush SM. Does educating nurses with ventilator-associated pneumonia prevention guidelines improve their compliance? American journal of infection control. 2017;45:969-73.
5. Chaseling W, Bayliss S-L, Rose K, Armstrong L, Boyle MS, Caldwell J, et al. Suctioning an Adult ICU Patient with an Artificial Airway: A Clinical Practice Guideline. Agency for Clinical Innovation NSW Government Version 2 Chats wood, NSW, Australia. 2014.
6. Chau, J, Thompson, D, Chan, D, Chung, L, Au, W.-L, Tam, S, Fung, G., Lo, S, Chow, V. An evaluation of the implementation of a best practice guideline on tracheal

suctioning in intensive care units. International Journal of Evidence-Based Healthcare. 2007;5:354-9.
7. Dadkhah B, Faramarzi AS, Amri P, Mohammadi MA. Comparison of Changes in Arterial Blood Oxygen Saturation and Occurrence of Cardiac Dysrhythmia in Patients with Head Trauma undergoing Open and Closed Suction. Journal of Research in Medical Dental Science. 2017;5:89-94.
8. Day T, Farnell S, Haynes S, Wainwright S, Wilson-Barnett J. Tracheal suctioning: an exploration of nurses' knowledge and competence in acute and high dependency ward areas. Journal of advanced nursing. 2002;39:35-45.
9. Day T, Farnell S, Wilson-Barnett J. Suctioning: a review of current research recommendations. Intensive and Critical Care Nursing. 2002;18:79-89.
10. Day T, Iles N, Griffiths P. Effect of performance feedback on tracheal suctioning knowledge and skills: randomized controlled trial. Journal of advanced nursing. 2009;65:1423-31.
11. Day T, Wainwright SP, Wilson-Barnett J. An evaluation of a teaching intervention to improve the practice of endotracheal suctioning in intensive care units. Journal of clinical nursing. 2001;10:682-96.
12. Dorri S, Hakimi H. The Effect of Mastery learning model for suction and oxygen therapy skills in nursing students. Research in Medical Education. 2018;9:10-9.
13. Golzari, Z., Rezaee, H.H., Sabzevari, S., Sharafkhani, R.Study of nurses performance on standardized endotracheal and tracheostomy tube suctioning in inttensive care unit in Kerman hospitals 2013-2014. Journal of Iranian Society of Anesthetics and Intensive Care. 2015;2:11-9.
14. Hadian Shirazi Z, Kargar M, Edraki M, Ghaem H, Pishva N. The impact of teaching principles of Endotracheal Tube Suctioning on Knowledge and Performance of Nursing Staff Working in Neonatal Intensive Care Units. Iranian Journal of Medical Education. 2010;9:365-71.
15. Jansson M, Ala-Kokko T, Ylipalosaari P, Kyngäs H. Evaluation of endotracheal-suctioning practices of critical-care nurses-An observational correlation study. Journal of Nursing Education and Practice. 2013;3:99-105.
16. Jelic S, Cunningham JA, Factor P. Clinical review: airway hygiene in the intensive care unit. Critical Care 2008;12:209.
17. Kelleher S, Andrews T. An observational study on the open-system endotracheal suctioning practices of critical care nurses. Journal of clinical nursing. 2008;17:360-9.
18. Leddy R, Wilkinson JM. Endotracheal suctioning practices of nurses and respiratory therapists: how well do they align with clinical practice guidelines? Canadian journal of respiratory therapy. 2015;51:60-4.
19. McKillop A. Evaluation of the implementation of a best practice information sheet: tracheal suctioning of adults with an artificial airway. JBI reports. 2004;2:293-308.
20. Mohammadi N, Parviz S, Peyravi H, Hosseini AF. Effect of endotracheal suctioning education for nurses on patients' hemodynamic parameters. Journal of hayat. 2012;18:38-46.
21. Morrow B, Futter M, Argent A. Effect of endotracheal suction on lung dynamics in mechanically-ventilated paediatric patients. Australian journal of physiotherapy. 2006;52:121-6.
22. Pedersen CM, Rosendahl-Nielsen M, Hjermind J, Egerod I. Endotracheal suctioning of the adult intubated patient—what is the evidence? Intensive Critical Care Nursing. 2009;25:21-30.
23. Seema S, Pity K, Kiran B. Effectiveness of suction protocol on nurse's and patient's outcome in ICU. Asian Journal of Nursing Education and Research. 2017;7:589-95.
24. Seyedjavadi, M., Alaee, V., Mohammadi, R., Aslani, M., Hashemi-biria, B. The effect of clinical supervisors education to quality of nursing care of patients under mechanical ventilation in critical care units. Journal of Health and Care. 2012;14:34-40.
25. Sole ML, Bennett M, Ashworth S. Clinical indicators for endotracheal suctioning in adult patients receiving mechanical ventilation. American Journal of Critical Care. 2015;24:318-24.
26. Urden L, Stacy K, Lough M. Critical Care Nursing: Diagnosis and Management. Canada: Elsevier; 2014.
27. Vianna, J.R. d. F., Pires Di Lorenzo, V.A., Simoes, M.M.L. d. S., Jamami, M. Comparing the Effects of Two Different Levels of Hyperoxygenation on Gas Exchange during Open Endotracheal Suctioning: A Randomized Crossover Study. Respiratory care. 2017;62:92-101.
28. Wood CJ. Can nurses safely assess the need for endotracheal suction in short-term ventilated patients, instead of using routine techniques? Intensive & critical care nursing. 1998;14:170-8.