Original Article

Best-Practice Interventions: How Can You Prevent Endotracheal Suctioning Associated Complications?

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Abstract

This study was carried out to determine the effect of the duration of hyperoxygenation before endotracheal suctioning is the heart rate and oxygen saturation of the patients admitted to the intensive care unit. In this experimental intervention, 42 eligible patients admitted to intensive care units, which were mechanically ventilated, were divided into two groups. In the first group, pre-oxygenation was performed for 1 minute and in the second group was performed 2 minutes before internal suction, and then both groups were subjected to tracheal suctioning. Data were analyzed using various analysis tests with repeated measurements and independent T-tests. The results indicated that the one-minute pre-oxygenation increased the mean oxygen saturation, compared to 5 minutes before suction and during suction, and immediately after suction, there was a significant difference in this increase ($p = 0.000$). Also, the two-minute pre-oxygenation increased the mean oxygen saturation, which is statistically significant ($p = 0.000$) compared to other suctioning stages. The result of the ANOVA test showed no significant difference in mean heart rate changes at different stages of suction in the two groups. The results of this study showed that not only does oxygen injection of 100% to the patient one minute and two minutes before and one minute after intestinal suction prevent the loss of arterial oxygen saturation after suction, but it also increases it compared to before suctioning.

Keywords: Hyperoxygenation, Endotracheal suctioning, Heart rate, Arterial blood oxygen saturation, Intensive care unit

Introduction

One of the early signs of acute illness is the deterioration of respiratory function in patients. The respiratory disorder is one of the major causes of critical illness and is considered one of the main reasons for admission to intensive care units [1]. The impairment of the respiratory system and the inability of the patient to perform spontaneous respiration is the most important challenge in the intensive care unit. Therefore, the use of mechanical ventilation and the application of an intubation tube is an integral part of these sections [2]. Since patients with an artificial airway, such as the tracheal tube and intracranial hemorrhage, are unable to cough and remove pulmonary secretions, the accumulation of secretions in patients with a critical condition that has an endotracheal tube and a weak cough, causes airway obstruction in the gas exchange [3]. Consequently, it will result in a decrease in arterial oxygen pressure, acidosis, cyanosis, drowsiness, disturbance of consciousness, and cardiac dysrhythmia [4]. Therefore, to clean the airway and to maintain the airway open, tracheal suction is used in abundance in special sectors, especially the ICU [5, 6]. The tracheal suction is one of the most important and necessary interventions in nursing, which removes the secretions from the respiratory tract and prevents the accumulation of secretions, and increased respiratory function, atelectasis, and respiratory infection [7]. However, in addition to the benefits and necessities of doing it, suctioning is accompanied by some complications such as airway damage, bronchial spasm, hypoxemia, cardiac rhythm disorders, ventilator-dependent pancreas, emphysema, pneumothorax, rupture of chip and mild to severe bleeding, increased intracranial pressure and cardiac arrest and death [2, 3, 8]. The main goal of suctioning the inside of the trachea is to remove secretions from the airways. If the secretions of a patient who is not able to cough due to the presence of the tube are not removed, then air sacs are created. Of course, doing this is not divorced from risk

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and complication, the accumulation of air in the adjacent layer, pneumonia, bacteremia, necrosis of the chest, and changes in blood flow are all the complications that threaten patients requiring suction. As the suction tube passes into the trachea, the movement of mucus covering membranes of the trachea is reduced and destroyed; following the destruction of the tinnitus and trachea stimulation, the mucus production is markedly increased, and as a result, the need for suction is increased [9]. The most common complication of airway suction is hypoxemia, which can cause changes in heart rate, heart rhythm disorders, and imbalance in hemodynamics by stimulating the adrenergic system which is a compensatory mechanism in response to the reduction in the amount of oxygen in the blood [4]. On the other hand, suction may result in loss of arterial oxygen saturation, followed by side effects such as heart rate abnormalities, cardiovascular collapse, and even sudden death [7]. Also, hypoxemia can cause cell death, and in milder cases, it can weaken brain activity, coma, and decrease muscle function [10]. Therefore, taking into account the effects of suction, especially the complication of hypoxemia and its effects on various organs of the body, the prevention of this complication is very important. Therefore, researchers have proposed a method called hyperoxygenation that can significantly reduce the hypoxemia associated with endotracheal suctioning [2, 6, 11, 12]. John Jordan and colleagues (2012) state that the development of cardiac arrhythmias during endotracheal suctioning is due to hypoxemia. By performing hyperoxygenation before and after the suctioning process, hypoxemia, and as a result, cardiac arrhythmia can be prevented [13]. Although various studies have shown that hyperoxygenation has a positive effect on the amount of oxygen saturation during suction, the results are different in these studies. For example, in the study of Oh and Seo that was done to clarify the effect of interventions that have a preventive role in the development of hypoxemia pao2, sao2, pao2 / fio2, svo2 were investigated as measurement indices of hypoxemia. The results showed that the most common method for the prevention of hypoxemia is hyperoxygenation where oxygen is 100% and the volume is equal to one hundred and fifty percent of the vital volume during three to six respiration [14]. On the other hand, hyperfluidation with a volume of 150% of flowing air volume can increase intracranial pressure in patients with a head injury.

A study was carried out by Orand *et al*. to provide a guide to improve the clinical performance of the members of the health care team during the suctioning of patients under mechanical ventilation. To collect information, articles from MEDLINE, CINAHL, EMBASE, and resources from the Cochrane Library from 1998 to 2007 were used. The results of studies showed that hyperoxygenation during tracheal suctioning in patients undergoing mechanical ventilation has been recommended since 2001 on the majority of resources as an intervention to maintain blood oxygen levels and a preventive method for the loss of arterial oxygen saturation in patients with trauma and patients with chronic obstructive pulmonary and heart diseases [15]. This study also referred to the necessity of conducting studies with a larger sample size to evaluate the suction indication, the duration of hyperoxygenation, the clearance of the airway with minimal complications, and the examination of suction in non-intubated patients (due to limited information).

Regarding the limitations of previous studies on the duration of hyperoxygenation concerning the effects of duration of hyperoxygenation on hemodynamic parameters, the researchers aimed to compare the effect of hyperoxygenation 1 minute and 2 minutes before the tracheal suctioning on the number heart rate and arterial oxygen saturation in ICU patients. The general aim of this study was to determine the effect of hyperoxygenation duration before tracheal suctioning on heart rate and arterial oxygen saturation in patients admitted to intensive care units.

Materials and Methods

This study was a randomized controlled trial. The statistical population of this study included patients admitted to the ICUs of Peymanieh Hospital in Jahrom, who were admitted to the hospital during the research. Sampling was done among patients who met inclusion criteria and after giving explanations about the research and obtaining informed consent from patients' guardians they entered the study. The conditions for entering the study included: patients with trauma admitted to intensive care units with tracheal intubation under mechanical ventilation and had been admitted at least 48 hours earlier, aged between 18 and 65 years, no lung injury according to radiologic studies and expert opinion, stable hemodynamic status (SBP> 100mmHg, output = 30cc / hr, HR = 60-100) and the lack of cardiac arrhythmias, the absence of a history of chronic pulmonary disease and acute respiratory infections, the absence of symptoms indicating an increase in ICP and the need for three episodes to clear the airway in each episode of suctioning the trachea. Patients with hemodynamic imbalance during the intervention and median arterial blood pressure of less than 60mmhg were excluded. Patients were randomly assigned to one of the two groups of one-minute and two-minute hyperoxygenation. Then, tracheal suctioning was done by the researcher according to the patient's needs. The procedure of tracheal suctioning was done on each patient once. The researcher prescribed 100% oxygen to the patient before tracheal suctioning, which was 1 minute for one group and 2 minutes for the other group. The suction process was carried out at a negative pressure of a maximum of 120mmhg [16]. The number of entrances of the suction tube into the trachea and the application of suction for each suction period was 3 times, which took approximately 15 seconds. Between episodes 1, 2, and 3, the patient was reconnected to the ventilator for forty-five seconds and received oxygen at 100%. After completing the third episode of suction, 100% oxygen was given to patients in both groups for 1 minute. If a patient needed fewer or more episodes of catheter insertion and suctioning during any suction period, that suction period was removed and re-measured in the next period. The data gathering tool in this study included a form that included information such as hospitalization code, age, sex, hospitalization date, and parameters under study (heart rate and arterial oxygen saturation). It should be noted that the parameters were recorded in the data recording tables at five minutes and thirty seconds before the start of suction, during suction, immediately after the completion of suction, five minutes after the completion of suction, and twenty minutes after the completion of suction. To monitor the hemodynamic variables, the S1800-ER monitoring device belonged to Pouyandegan Rahe Saadat company. Electrodes on the patient's chest were connected to the patient to monitor heart rate and a finger probe was connected to monitor the amount of arterial oxygen saturation. The reliability of the monitoring device was evaluated by the manufacturer's instructions.

After collecting data and checking the necessary data and encoding them, the data were entered into the SPSS version 16 software. Initially, the comparison of the two groups was done in terms of equalizing the underlying and confusing variables and the data compliance with a normal distribution. Data were analyzed by descriptive statistics of independent t-test for quantitative variables and the Chi-square test for qualitative variables. Repeated Measure ANOVA and post-test were used to compare changes in each group. The level of 0.05 was considered significant for the results.

Results and Discussion

The findings of the study on 42 patients under a ventilator showed that the mean age of the patients under study was 41 years with a dispersion of 33-50 years. Based on the results of ANOVA, there was no significant difference between the two intervention groups in terms of quantitative variables (P = 0.923). The majority of patients, 76.2%, in the two interventional groups were male. In this study, the comparison of the mean oxygen saturation in the two groups was compared **(Table 1)**.

Table 1. Comparison of mean changes in arterial oxygen saturation in the studied groups at different suction times

P	F	Degrees of freedom	Two minutes	one minute	Review steps
			Mean and standard deviation	Mean and standard deviation	
0.55	0.60	2	96.28 ± 1.87	95.90 ±5.39	5 minutes before suctioning
0.046	3.25	2	99.33 ±10.01	97.05 ±5.56	Pre-Oxygenation
0.001	7.32	2	95.90 ±3.41	92.48 ±7.40	During suctioning
0.002	6.73	2	95.61 ±2.99	92.57 ±7.50	Immediately after suction
0.000	10.46	2	98.04 ±1.80	96.90 ±4.80	5 minutes after suctioning
0.000	10.69	2	97.57 ±1.77	97 ±3.72	20 minutes after suctioning

The result of the ANOVA test showed a significant difference in different stages of suction in the two groups. The results of the LSD post-test indicated that: there was no significant difference between the two groups in the mean O2 sat at 5 minutes before suctioning. There was no significant difference between the mean O2 sat in any of the suctioning stages in the two groups of pre-oxygenation for one minute and two minutes.

Also, in this study, the mean heart rate changes were compared in the two groups of patients at different suction times **(Table 2)**.

Table 2. Comparison of mean heart rate changes in the two studied groups at different suction times

P	F	Degrees of freedom	Two minutes	one minute	Review steps
			Mean and standard deviation	Mean and standard deviation	
0.172	2.74	2	**83** ±9.27	82.19 ±13.15	5 minutes before suctioning
0.123	2.169	2	83.38 ±10.07	81.33 ±13.67	Pre-Oxygenation
0.648	0.437	2	91 ±12.41	86.80 ±19.97	During suctioning
0.840	0.174	2	90.61 ±12.26	87.85 ±19.31	Immediately after suctioning
0.987	0.013	2	83.47 ±11.49	84.14 ±19.91	5 minutes after suctioning
0.778	0.252	2	85.47 ±19.02	83.42 ±17.40	20 minutes after suctioning

The result of the ANOVA test showed that there was a statistically significant difference in different stages of suction in mean changes in heart rate in the two groups.

In general, the results of this study showed the effects of the duration of hyperoxygenation before endotracheal suctioning on heart rate and arterial oxygen saturation in patients undergoing mechanical ventilation in intensive care units at the Peymanian Hospital of Jahrom.

The results showed that there was no significant difference between the two groups in the mean o_2 sat for 5 minutes before suctioning. Also, the result of the ANOVA test showed that there was no significant difference in the heart rate of patients before the suctioning in the two groups. Therefore, the patients were the same in terms of the variables before the intervention.

Based on the results, the majority of patients were male in two groups.

According to the results of the study, most changes in heart rate were in the form of an increase and changes in the saturation of arterial oxygen were in the form of a decrease during the suctioning phase compared to before the suction, which is consistent with the study by Etemadi Farr *et al*., Oh and his Seo [14, 15].

The results of this study showed that there was no significant difference between the mean heart rate of patients during suctioning and immediately after 5 minutes and twenty minutes after suction in the two groups. The result of the ANOVA test showed that there was no statistically significant difference in the different stages of suction in the two groups. Researchers have found that, although pre-oxygenation is possible enough, separating the patient from a mechanical ventilation device and open endotracheal suctioning can lead to increased heart rate during and after suction. In a systematic study by Favretto (2012), it was concluded that pre-oxygenation of pre-endotracheal suctioning and suctioning without separating the patient from mechanical ventilation can prevent heart rate increase during suctioning [16].

In a study by Jongerden *et al*. (2012) to examine changes in heart rate, mean arterial pressure, and arterial oxygen saturation, the results showed a significant increase in heart rate in patients after 10 minutes after suctioning [13].

In this study, hyperoxygenation for one minute and two minutes before endotracheal suctioning showed no significant difference in heart rate during different stages of suction in the two groups.

The results of this study showed that there was no significant difference between the mean increase in heart rate of patients during suctioning and immediately after 5 minutes and twenty minutes after suction in the two groups. The results of a study by Bourgault *et al*. Showed that heart rate increased significantly after 10 minutes after suctioning [17].

During the conducted studies and comparisons in this study, there was no significant difference in the mean arterial oxygen saturation in any of the suctioning stages in two groups of pre-oxygenations for one minute and pre-oxygenation. Evidence suggests that changes in arterial blood pressure and heart rate and arterial oxygen saturation can be controlled by performing sufficient oxygenation and the least duration of suction as an invasive procedure [16].

Researchers have concluded that performing oxygen therapy for one minute before endotracheal suctioning is sufficient and can greatly reduce the complications of suction.

Concerning arterial oxygen saturation in the two groups of hyperoxygenation for one minute and hyperoxygenation for two minutes that is due to an increase in arterial oxygen pressure after hyperoxygenation, it is noteworthy that if the pressure of arterial oxygen is greater than 100 mm Hg, it does not affect the amount of arterial oxygen saturation and the oxygen saturation curve is placed in the flat part [18]. Thus, by giving 100% oxygen, possibly, in both groups, pao_2 was placed in the upper limit and arterial oxygen pressure in the two groups of hyperoxygenation for one minute and hyperoxygenation for two minutes after suction was more than 100 mmHg, there was no statistically significant difference in arterial oxygen saturation.

Gayton (2012) states that when arterial oxygen pressure reaches more than 95 mmHg, the arterial oxygen saturation reaches 100%, and since then arterial oxygen saturation does not change [19].

In a study conducted by Overend *et al*. In Austria under the title "Investigating the effect of intracranial suction on oxygenation, circulation and pulmonary mechanics in neonates", the results showed that during the suctioning stage and immediately after the suctioning, the heart rate increased by 20 times per minute, and oxygenation of the arterial blood decreased [20]. In the fifth minute and twenty minutes after suction, in the two groups, during the suctioning and immediately after the suctioning, the heart rate reduction and the increase in arterial oxygenation were evident, which was significant in the pre-oxygenation group for one minute and two minutes. The results of this study showed that oxygen injection of 100% to the patient for one minute, two minutes before, and one minute after intestinal suction not only prevents reducing the saturation of arterial oxygen after suction but also increases it compared to before the suctioning.

It seems that this invasive procedure, although standardized during and immediately after the suction, has a high physiological response to the body, resulting in the most changes in the increase of heart rate and reduction of arterial blood oxygenation in these stages. Therefore, the time and frequency of suction in these stages should be less and hyperoxygenation be performed with more continuity, and the patient is placed in a more comfortable position for respiration.

In the study of Maggiore *et al*., It has been pointed out that performing endotracheal suctioning more than six times a day increases the incidence of endotracheal suctioning, in particular the reduction of arterial oxygen demand, followed by a decrease in arterial oxygen saturation and severe changes in heart rate, and blood secretion [5].

Conclusion

Since this research is a practical one and is of special importance in nursing, its results can be used in all sections, especially in intensive care units, so by applying the provided method along with the tracheal suctioning, dropping arterial oxygen demand, thereby reducing oxygen saturation, and abrupt increase in heart rate and increased arterial pressure in patients with arterial carbon dioxide will be avoided. The results of this research can be used in other nursing research and other similar studies can be done on more extensive and varied samples.

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