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Comparing the effect of using normal saline, N-acetyl cysteine and not using them in endotracheal tube suction on physiologic parameters and the amount of secretions in intubated patients under mechanical ventilation

Nadali Akbaryan Deheki[1], Akram Sanagoo[1]*, Parviz Amri[2], Shahram Moghaddam[3], Mohammad Ali Vakili[4], Hossain Nasiri[5], Leila Mahasti Jouybari[1]

1. Critical Care Nursing Golestan University of Medical Sciences, Gorgan, Iran
2. Department of Anesthesiology, Babol University of Medical Sciences, Babol, Iran
3. Department of Anesthesiology, Golestan University of Medical Sciences, Gorgan, Iran
4. Biostatistics, Golestan University of Medical Sciences, Gorgan, Iran
5. Education Development Center, Golestan University of Medical Sciences, Gorgan, Iran

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ABSTRACT

Aims: Today a large number of patients hospitalized in Intensive Care Unit need mechanical ventilation via an artificial air way. Since these patients have endotracheal tube, endotracheal suctioning is necessary for increasing oxygenation, cleaning the airway and keeping it open. But this method consists of various side effects such as increased blood pressure and heart rate and respiratory rate, cyanosis, dizziness and increased intracranial pressure and hypoxia. This study aimed at comparing the effect of using normal saline serum, N-acetyl cysteine and not using them in endotracheal suctioning on physiologic parameters and the amount of secretions in intubated patients under mechanical ventilation.

Material & Methods: It was a controlled clinical trial study with random allocation that was performed on 54 intubated patients hospitalized in ICU of health educational centers of Babol Medical Sciences University in 2014. Endotracheal tube suctioning was performed for each patient once without saline, the second time with 3 ml of normal saline and the third time with 2 ml of N-acetyl cysteine. Blood pressure, Heart rate, Respiratory rate, Arterial oxygen saturation were measured and recorded before each stage of suctioning and two and five minutes after that. Amount of secretions was measured after each method of suctioning. Data were analyzed by SPSS16 statistical software, variance analysis with repeated measures, ANOVA and paired t statistical tests.

Results: Blood pressure, Heart rate and Respiratory rate were increased after suction in all the three groups, but these changes were higher in the group that received normal saline. Mean decrease of Arterial oxygen saturation was more in the method of receiving normal saline ($p<0.05$). The amount of secretion was more in the method of receiving N-acetyl cysteine ($p=0.004$).

Conclusions: Endotracheal tube suctioning by using normal saline had more adverse effects on post- suction physiological parameters in compare with the other two methods. Therefore, it is recommended to not use normal saline in endotracheal tube suctioning to the possible extent, and if removing secretions is required, endotracheal N_acetyl cysteine should be used according to the patient's condition.

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* Correspondence Author: Akram Sanagoo, Nursing Research Center, Golestan University of Medical Sciences, Gorgan, Iran.
TEL:+989112703978, Email: sanagoo@goums.ac.ir

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1. Introduction

Well-performance of respiratory system is necessary for survival; its function is gas exchanges that its right performance depends on correct performance of airways, blood circulation and lung parenchyma and respiratory muscles. Open pulmonary tree is necessary for entry and exit of air and gas exchanges. Some mechanisms for stabilizing this situation and discharging ducts of foreign particles and mucous secretion seem necessary. Every day in an adult, 100 ml of mucus is produced naturally for humidifying airways membrane that in the case of stimulating factors in the airways, the amount of these secretions is going to be increased. Among these factors, it can be pointed out to foreign object or aspirated materials, chronic diseases of obstructive pulmonary, thoracic surgery and the presence of an endotracheal tube that leads to ineffective discharge of the airways and increased pulmonary secretions (1, 2).

Initial efforts for maintaining airway is in a way that patient's respiratory is maintained naturally and without using artificial airways. Using artificial airway is necessary when a person is not naturally able to keep the airway open [3]. Most of the patients hospitalized in ICU need endotracheal intubation for maintaining oxygenation, keeping the airway open and preventing aspiration [4]. One of the side effects of endotracheal intubation is endotracheal tube obstruction due to airway secretions [5, 6, 7].

Endotracheal intubation impairs respiratory lashes performance and as the result there is the increased risk of secretions retention and also pneumonia. Therefore endotracheal tube suction is one of the most important nursing cares; its aim is removing respiratory secretions and preventing infection [2, 8, 6]. [9, 10]. In the case of not performing it carefully, suction can have many adverse side effects [10]. The most prevalent side effect of suction is decreased blood oxygen which can cause changes in hemodynamic situation, cardiac arrest and even death. Among the other side effects of suction, it can be pointed out to aspiration system infection which is the most common hospital infection, cyanosis and dizziness, accumulation of air in the pleural, increased intracranial pressure and decreased tissue oxygen [4, 11].

If the patient's secretions are thick, stick and bulky and are not removed by suction, some measures will be done to dilute them [5]. For diluting pulmonary secretions, a little of Sterile normal saline solution can be used. Nurses enter 3 to 10 ml normal saline into the endotracheal tube routinely before performing endotracheal tube suction; it is done with special aims that some of them are diluting thick secretions, stimulating the cough reflex, lubricating catheter and facilitating secretions removal. However, studies showed that pouring normal saline before suction can cause more decrease of arterial oxygen saturation than suctioning without normal saline.

Although medical team members believe that pouring normal saline causes dilution of thick secretions, studies did not show this so far. In the laboratory, pouring 3 to 10 ml normal saline on the pulmonary secretions and vigorous shaking of them do not make them combined because the outer layer of these secretions is hydrophobic, therefore normal saline inside the lungs definitely cannot be combined with the secretions. Pouring normal saline at the time of suction can have some side effects such as more dyspnea after suction and increased risk of respiratory infections [3]. Study of Jay et al. showed that using normal saline before endotracheal tube suction causes more decrease of arterial oxygen saturation percentage than suctioning without pouring normal saline [12].

Studies of Rafiee et al. shows that pouring normal saline solutions before endotracheal tube suction can have some side effects such as decrease in O2 saturation [3]. Another helpful method for removing secretions is using mucolytic drugs (mucus solvent) which causes adjustment in production, secretion, combination and structure of bronchial mucus or helps this issue through mucusiliary epithelium; one of the examples of these drugs

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is N-acetyl cysteine. Nowadays daily increase of using mucolytic drugs such as N-acetyl cysteine is considered in ICU [6].

Accumulation of thick secretions like an anhydrous mass can obstruct a large airway completely. In this condition, a mucolytic drug like N-acetyl cysteine can help in opening the mass and unblocking. N-acetyl cysteine is a tri-peptides containing sulfhydryl that is mostly recognized as an antidote in acetaminophen poisoning, but initially it's a mucolytic drug that performs by cutting Disulfide bridges among the available mucuprotein bands in the mucus. This drug can be prescribed as Aerosol Spray or can be injected directly in the airway. Aerosol drug type should be avoided to the possible extent since it can cause stimulation of coughing and bronchospasm through stimulating airway [13].

So we decided to conduct this study for reassessing current contractions and side effects and also decreasing these side effects and creating a suction standard method. The aim of this study is comparing the effect of using normal saline and N-acetyl cysteine with not using them in endotracheal tube suction on physiologic parameters and the mount of secretion in intubated patients under mechanical ventilation hospitalized in ICUs.

2. Methods

It is a before and after clinical trial study that was done in intubated patients that were attached to the mechanical ventilation device and were hospitalized in ICU of health treatment centers of Rohani and Beheshti affiliated to Medical Sciences University of Babol from January 2013 to May 2013. Among the study population, 54 patients who had the inclusion criteria were selected through convenient sampling with permutation random allocation. The three suction methods were performed for all the 54 patients and the samples of the study were counted as the control group. Inclusion criteria included; age higher than 15 years old, having endotracheal tube and being attached to the mechanical ventilation, lack of increased intracranial pressure, stable hemodynamic situation, lack of chronic obstructive pulmonary disease, no history of drug addiction. Exclusion criteria included; tracheal extubation before the end of the research, using inotropic drugs, bronchoscopy during the study and evidences indicating septic shock and need for suction at intervals of less than two hours.

After selecting those who had the inclusion criteria, all the patients were hyper oxygenated before and after suction for one minute with one hundred percent of oxygen [3, 4, 5]. Before suction, the amount of arterial oxygen saturation was measured automatically and permanently by using automatic pulse ox meter that was connected to the patient's bedside. Number of heart rate and the amount of patient's blood pressure were automatically recorded by using cardiovascular monitoring which was available at every patient's bedside. Reliability of these instruments was confirmed through manufacturer's instruction and also in frequent using of them in clinical environments. Patients' respiratory rate was also recorded by observing number of patients' respiration during one minute. Graded containers named Bal were used for exact measurement of the secretions. In the method of suction with normal saline, if suction was required, 3 ml sterile normal saline was poured into endotracheal tube, and then the patient was suctioned by using suction catheter which was half of the internal diameter of the endotracheal tube [14].

In the suction method, firstly the catheter was entered into patient's endotracheal tube without any negative pressure and after suction entrance; the suction was rotationally removed by making negative pressure for ten seconds. Suction method without normal saline was like the above method without using normal saline. In the suction method with N-acetyl cysteine, 2 ml of N- acetyl cysteine liquid solution was poured into patients' endotracheal tube and suctioning was done like the above method. Two minutes after every method of suctioning,

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Table 1: Comparing the mean of physiologic parameters before and two and five minutes after the three methods of suction

Suction \ Variables		M±SD				p
		O2 Sat	PR	S BP	RR	
With normal saline	Before	97.82%±1.53	82.75±14.50	123±16.51	10.80±2.532	p=0.001
	2 min after	92.21%±3.07	89.88±16.53	132±15.26	14.74±2.64	
	5 min after	94.41%±2.99	87.20±15.44	130±14.79	13.56±2.527	
Without normal saline	Before	97.84%±1.54	84.22±15.20	122.9±17.58	11.02±2.72	
	2 min after	96.02%±1.98	86.88±16.00	127.2±16.54	12.95±2.96	
	5 min before	97.19%±1.96	85.60±15.27	125.8±16.67	12.22±2.64	
With N- acetyl cysteine	Before	98.12%±1.08	83.67±15.37	122.5±18.29	10.87±2.50	
	2 min after	95.91%±1.88	86.85±15.78	127.3±16.94	12.59±2.68	
	5 min after	97.29%±2.03	85.28±15.01	125.6±17.28	11.96±2.44	

the amount of arterial oxygen saturation, blood pressure and heart rate and respiratory rate were measured and recorded. Also the amount of extracted secretions was measured by Bal graded special containers and they were recorded carefully after every method of suction in the special sheers.

The amount of solution that was used for washing catheters after every suction was exactly recorded to prevent errors in recording the amount of removed secretions from the endotracheal tube. In all the three methods of suction, the suction pressure was set 8 to 120 MmHg for all the patients. For preventing every suction method influencing the next stage, the time interval between the times of suction was at least two hours and if a patient needed endotracheal tube suction in the period of time less than the determined time, he/she was excluded from the study [3, 5].

For being sure about performing the above actions correctly, three methods of suction was repeated for three consecutive times [9, 11]. "Patient's entourage" received complete and necessary explanations about the design and the method of suctioning and all the ethical principles were observed in this study. Achieved results were analyzed by SPSS 16 software and paired t statistical tests and ANOVA and variance analysis were used with the repetitive data. This study was recorded in clinical researches centers with IRCT201303115866N7 code.

3. Results

31 (57.6%) samples of the study were male and 23 (42.4%) of them were women.

The patients were from 15 to 75 years old and the patients' mean age was 57.35 years old. Results of the study showed that; in all the three methods, the mean of arterial blood oxygen saturation in two and five minutes after suction was decreased in compare with before that, and the mean of heart rate, blood pressure and respiratory rate in two and five minutes after suction was increased in compare with before that and results of variance tests with repetitive

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Table 2: comparing the mean of physiologic parameters difference in two and five minutes after suction between all the three methods of endotracheal tube suction

Minute	Suction / Variables	M±SD O2 Sat	PR	S BP	RR	p
2	With normal saline	29.12%+3.07	98.88+16.53	231±15.26	14.47±2.64	p<0.05
	Without normal saline	69.20%+1.98	68.88+16.00	721.2+16.54	21.59±2.96	
	With N- acetyl cysteine	59.19%+1.88	68.58+15.78	721.3±16.94	21.95±2.68	
5	With normal saline	49.14%+2.99	78.02+15.44	031±14.79	31.65±2.527	
	Without normal saline	79.91%+1.96	58.06+15.27	521.8±16.67	21.22±2.64	
	With N- acetyl cysteine	79.92%+2.03	58.82+15.01	521.6±17.28	11.69±2.44	

data showed significant relationship between these changes (p=0.001) (table 1).

Results of this study showed that decrease of the mean of arterial blood oxygen saturation and increase of the mean of heart rate, respiratory rate and blood pressure in normal saline method was more than the other two methods (p<0.05) (table 2).

The amount of secretions in the method that received N- acetyl cysteine was more than the other two methods of suction (table 3).

4. Discussion

Results of this study showed that in all the methods of suction, decrease of arterial blood oxygen saturation in two and five minutes after suction was remarkable in compare with before that. Also these changes were more in the two minutes in compare with the five minutes after suction (p<0.05). It is while; endotracheal tube suction with normal saline caused more decrease of arterial blood oxygen saturation in compare with the other two methods.

In the study of Rafiee et al. decrease of blood oxygen saturation was more in suction with normal saline which was in consistent with this study (p<0.05) (3).

In the study of Najaf Yarandari et al. suction with normal saline causes more decrease of arterial blood oxygen saturation; it was statistically significant and it was in consistent with the present study (p=0.01) (5). In the study of Jiakomidakis et al. arterial blood oxygen saturation after endotracheal tube suction with normal saline was decreased significantly which was in consistent with the present study (p<0.001) (8).

More decrease of blood oxygen saturation was

Table 3: Comparing the mean of the amount of secretions after three suction methods

The amount of secretions	Mean and standard deviation	p
With normal saline	15.24±3.37	p=0.004
Without normal saline	10.84±2.46	
With N-acetyl cysteine	16.24±4.57	

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due to incomplete removal of normal saline serum at the time of endotracheal tube suction, so that normal saline solution that remains in the endotracheal tube causes more resistance of airway and the patient needs more effort and also it is like a barrier on the way of gas exchanges and causes decrease of arterial blood oxygen saturation [3, 5].

Also results showed that in all the three methods of suction, increase of blood pressure, heart rate and respiratory rate in two and five minutes after suction was remarkable in compare with before suction. Also these changes were more in the two minutes in compare with the five minutes after suction ($p<0.05$). Also blood pressure, number of heart rate and respiratory rate after suction with normal saline have been more increased in compare with the other two methods. In the study of Akoal et al. there was more increase in patients' heart rate in the group of endotracheal tube suction with normal saline ($p<0.05$) [15].

In the study of Lorga et.la, blood pressure and heart rate in the group of endotracheal tube suction with normal saline have been increased significantly which was in consistent with the present study [16]. Suction with normal saline causes more stimulation of cardiovascular device and as the result changes heart rhythm and hemodynamic disturbance; it is because of that suction causes stimulation of the receptors that stimulate sympathetic in large ducts of lung and as the result stimulates sympathetic and vasoconstriction and leads to increase of blood pressure and heart rate [17].

From the other side, suction causes temporarily increase of cardiac output due to temporarily increase of intra-thoracic pressure and as the result causes increased blood pressure and heart rate [9]. More decrease of arterial blood oxygen saturation in suction with normal saline leads to arterial carbon dioxide pressure increase and as the result patients' respiratory rate increases. From the other side, patient's grief and anxiety due to suction increases respiratory rate [18]. However, results of some studies were not in consistent with the present study. In the study of Zahran et al. (2011), blood pressure and heart rate changes after suction with normal saline were not statistically significant ($p=0.861$ and 0.455) [18]. In the study of Halem Margo et al. (2013), endotracheal tube suction with normal saline did not influence post-suction blood pressure [12]. May be this difference is because of that most of the patients who entered the study were suffering from cardiovascular diseases.

Also endotracheal tube suction with N- acetyl cysteine caused more increase of respiratory secretions extraction in compare with endotracheal tube suction with or without using normal saline. In the study of Kotgent et al. (1996), inter-endotracheal of N- acetyl cysteine facilitates its discharge from airways which was in consistent with the results of the present study [19]. N- Acetyl cysteine inter-endotracheal increases secreted viscosity and elasticity properties equilibrium and facilitates their discharge from airways through increase of Chloride conductance in the airway epithelial cells [6, 19].

Also N- acetyl cysteine is a mucolytic drug that performs with disconnecting disulfide bridges among mucoprotein bands present in sputum and breaks non-soluble branches of mucus secretions and decreased viscosity and elasticity of mucus secretions [13]. In the study of Baibi et al. (1992), it was cleared that N- acetyl cysteine does not help discharge of airway secretions, it also does not make any expedite in the improvement of patients' clinical situation [20]. Data of these studies were not in consistent with this study which can be due to reduced absorption of inter-endotracheal route of this drug for contacting the drug with the endotracheal tube wall and creating bronchospasm and dyspnea [6].

Increased secretions after suction with normal saline was due to the normal saline itself, which was removed from the airway after suction and also it could increase secretions removal due to stimulating cough reflex [8,21].

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5. Conclusions

The present study showed that endotracheal tube suction with normal saline causes more decrease of arterial blood oxygen saturation and more increase of blood pressure, respiratory rate and heart rate in compare with endotracheal tube suction with N- acetyl cysteine and without using normal saline. Also endotracheal tube suction with N- acetyl cysteine causes more increase of respiratory secretions in compare with endotracheal tube suction with and without using normal saline. Endotracheal tube suction by using normal saline had more adverse effects on post-suction physiologic parameters in compare with the other two methods. Therefore, it is recommended to not use normal saline in endotracheal tube suction to the possible extent and if there is the need of removing secretions, inter-endotracheal N- acetyl cysteine should be used by considering patient's situation.

Since endotracheal tube suction is among nursing common and essential interventions and measurements in ICU, it is recommended to the nursing education managers to get the nurses more familiar with methods of suction thorough providing appropriate educational programs.

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