International Journal of Allied Medical Sciences and Clinical Research (IJAMSCR)

ISSN:2347-6567

IJAMSCR |Volume 8 | Issue 2 | Apr - Jun - 2020
www.ijamscr.com

Research article *Medical research*

Comparison the effectiveness of the head of bed to 45 and 30 degrees with hyperoxigenation against oxygen saturation during the open suction in patients that installed mechanical ventilation in ICU room

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ABSTRACT

Background

Complications of suction are hypoxemia or hypoxia that occurs during the suction process. HOB 45 degrees with hyperoxygenation can reduce diaphragm pressure, increase alveolar expansion and increase lung volume thereby reducing oxygen desaturation during open suction.

Objective

Proving HOB 45 degrees with hyperoxygenation is more effective than HOB 30 degrees for oxygen saturation during the suction process in patients who are fitted with mechanical ventilation.

Method

True experiments with randomized control group design pre-post test design. The sample consisted of 32 people who were divided into intervention and control groups with simple random sampling technique. Interventions of HOB 45 and 30 degrees with hyperoxygenation of oxygen saturation during open suction. Data analysis uses repeated measure ANOVA and Independent t test.

Results

HOB 45 degrees for 30 minutes with hyperoxygenation for 2 minutes is more effective in reducing oxygen desaturation during the suction process which is characterized by an average oxygen saturation value immediately after suction of 98.63% in the intervention group while HOB 30 degrees for 30 minutes with hyperoxygenation for 2 minutes, the value the average oxygen saturation immediately after suction was 95.75% in the control group.

Conclusion

HOB 45 degrees with hyperoxygenation effectively increases oxygen saturation after open suction

Keywords: HOB, Semi-fowler, Hyperoxygenation, Open suction, Oxygen saturation.

INTRODUCTION

Hypoxemia / hypoxia is a complication of suction. This is due to the process of suctioning not only the mucus that is inhaled but the oxygen supply that enters the respiratory tract is also inhaled so that it allows hypoxemia which is marked by a decrease in oxygen saturation, loss of lung volume and ending with respiratory failure to the point of life threatening and may even lead to life dead. [1, 2]

Respiratory failure reaches 20-75 cases in 100,000 populations each year with mortality

reaching 30-50%, [3] globally, acute respiratory failure is still one of the 20 major diseases causing high mortality in the Intensive Care Unit (ICU). In the United States, the incidence of respiratory failure in adults is 306 cases in 100,000 populations per year at the age of 75-84 years. In 2016, out of 50 countries in Asia, there were 10.4% of the total ICU hospitalized patients with acute respiratory failure. [4, 5]

The prevalence of respiratory failure in Indonesia is not clearly recorded. The incidence of respiratory failure ranked second cause of death in the hospital that is equal to 20.98% in 2010 based on data ranked ten non-communicable diseases (PTM) in 2012. [6] The number of sufferers who installed mechanical ventilation due to respiratory failure in 2019 in Wilasa Citarum Panti Hospital as many as 198 people (19.8%), the data of death sufferers who were installed mechanical ventilation as many as 96 people.[7]

Actions taken in reducing oxygen desaturation during the suction process are as comfortable as possible, setting the suction pressure variant, suction duration for 10-15 seconds each suction, suction no more than 3 times a day, pre oxygenation before, during and after the process suction but oxygen saturation <95% is still found [2, 8-11].

Head of Bed (HOB) is a reclining position with the head of the bed elevated to various heights of the position of the bed without using a pillow or other support, does not maneuver the neck area, lower extremity and straight body position without flexi, extension and rotation. [12]

HOB 30 degrees affects venous drainage and Cerebral perfusion Pressure (CPP). Brain blood flow depends on CPP. If the elevation is higher than 30 degrees, Cerebral perfusion pressure (CPP) and cerebral oxygen saturation will decrease in patients with neurological disorders. CPP is the difference between Mean Arterial Pressure (MAP) and Intracranial Pressure (ICP) [13, 14].

Age will cause a decrease in physiological function of the body where there is a decrease of 1 mmHg decrease in PaO2 every year age increases, respiratory muscle strength decreases, chest wall motility decreases, alveoli elasticity decreases so that affects systemic oxygenation including the brain. [1, 15]

Hyperventilation during the process of respiration can occur due to decreased physiological function of the body and degenerative diseases such as non-pulmonary disease and pulmonary disease, especially in critical patients in increasing the capacity of the lungs and when the patient is not attached to a breathing apparatus. [1, 16] Hyperventilation will cause acute respiratory alkalosis and is an effective action in handling the crisis of increasing ICT but will cause cerebral ischemia. [17-19]

Not all the air that enters the airway reaches the alveoli, the place where the gas exchange takes place. The portion of tidal volume that is not involved in gas exchange will affect the volume of anatomic loss and the volume of physiological loss space. Anatomical loss space depends on body posture and disease status. [1]

HOB 45º by using gravity will pull the diaphragm down so as to maximize the development of the lower front of the chest to allow alveolar expansion and Cardiorespiratory homeostasis, this will physiologically reduce the occurrence of hyperventilation during the inspiration process and tidal lung volume increases especially in degenerative diseases so that SpO2 increases and PCO2 decreases in patients with mechanical ventilation. [1, 16, 20, 21]

The results of several previous studies stated that the physiological effects of body position on the respiratory work system with Head of Bed (HOB 30 and 45 degrees) and oxygenation can increase oxygen saturation in critical patients with mechanical ventilation characterized by SpO2, PaO2 increasing and PCO2 decreasing. [22-25]

Findings on the effects of HOB 45 and 30 degrees body position are still being applied to different clinical conditions including suction. The lack of clarity about the effects of HOB 45 and 30 degrees during the suction procedure on oxygen saturation is a problem that inhibits the provision of effective treatment for sufferers who do open suction.

OBJECTIVE

Proving the effectiveness of HOB 45 degrees with hyperoxygenation is more effective than HOB 30 degrees on oxygen saturation during the suction process in patients with mechanical ventilation.

METHODS

This research is a true experimental study, using a simple random sampling technique with a pretest-

posttest randomized control group design. The total population of the study was 37 subjects then identified the research subjects based on inclusion and exclusion criteria, then excluded 5 study subjects and obtained as many as 32 patients. The division of the group was done by simple random sampling with a total of 16 study subjects. The first group with HOB 45 degrees with hyperoxygenation is called the intervention group and the second group with HOB 30 degrees with hyperoxygenation is called the control group. Each group was measured oxygen saturation 3 times.

RESULT AND DISCUSSION

Data analysis

Univariate analysis in this study is a description of the characteristics of respondents in the form of categorical data, namely gender, age, type of disease (non-pulmonary and pulmonary disease), hemodynamic status, HB levels, body temperature levels. Categorical data are presented in the form of proportions while numeric data in the frequency distribution table. Bivariate analysis was performed to determine the differences in the effectiveness of HOB 45 and 30 degrees with hyperoxygenation by parametric test with repeated measure anova test followed by pairwise comparisons test and analysis of effectiveness of HOB 45 and 30 degrees with non-pulmonary and pulmonary disease to oxygen saturation with independent t test.

Confounding Analysis

Table 1 Frequency distribution based on the characteristics of the subjects in the group intervention and control group (n = 32)

Characteristics	Intervention	Control	*P.*
	F%	F%	
Age (Mean ± SD)	55.75 ± 9,277	54.94 ± 8,652	0.360
Gender			
Male	8 50	5 31.2	0.128
Girl	8 50	11 68.8	
Types of diseases	F%	F%	1,000
Pulmonary	8 50	8 50	
Non-pulmonary	8 50	8 50	
Frequency (HR)	90.38 ± 9,535	94.94 ± 5.767	0.084
Hemoglobin levels	11,713 ± 1.2027	11,394 ± 0.9066	0.142
Body temperature level	37,038 ± 0.5252	37,413 ± 0.4455	0.590

*) Descriptive statistics test * Levene homogeneity Test: sig> 0.05

The table above shows the mean age of the respondent, sex, type of disease, hemodynamic frequency (HR), HB level and degree of body temperature there were no significant differences in the intervention group and the control group (p> 0.05), meaning that the characteristics of the respondent's data were homogeneous and could be controlled.

Oxygen saturation

Data normality test

Saturation data normality test results on SpO2 Pre intervention up to SpO2 post 2 in both groups are listed in the table below.

Table 2 Test normality of oxygen saturation data before and after treatment in the intervention group and control group

Variable	Group	
	Intervention	**Control**
SpO2 Pre	0.146	0.145
SpO2 Post 1	0.610	0.168
SpO2 Post 2	0.060	0.100
Pre - post 1	0.157	0.061
Pre - post 2	0.073	0.100
Post 1 - post 2	0.061	0.166

*) Shapiro-wilk, sig> 0.05

The above table shows data on oxygen saturation that are normally distributed against SpO2 in the intervention and control groups with a significant value of P> 0.05. So that statistical analysis (parametric test) can be carried out, namely repeated measure ANOVA test because more than 2 times the measurement is followed by pairwise comparisons.

Analysis of oxygen saturation differences between intervention groups and control groups

Table 3 Analysis of Differences in Oxygen Saturation between Groups intervention and control group (n=32)

Group	Type III sum of Squares	*Df*	Mean Square	F	*P.*
Between groups	18,375	1	18,375	6,060	0.020

*) Anova Repeated Measure

The table above shows that the F value for the time factor of measurement between groups there is a difference in oxygen saturation after being given HOB 45 and 30 degrees with hyperoxygenation with an F value of 6,060, p = 0.020 (p <0.05).

Analysis of differences in oxygen saturation in the intervention group and control group Table 4 Analysis of differences in oxygen saturation in the intervention and control groups

Group	Pre	Post 1	Post 2	Difference	F	*P.*
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**pre-post 2**		
HOB 45^0	95.44 ± 1.548	97.50 ± 1,366	98.63 ± 1,258	-3,188	41,046	0,000
HOB 30^0	96.38 ± 1,088	97.81 ± 1,223	95.75 ± 1,390	-0.375	38.95	0,000
Difference	0.063	-0.313	2,875	-2,812		
P-value	0896	0.501	0,000	0,000		

*) Anova Repeated Measure Test

The table above showed differences in oxygen saturation in the intervention group and the control group with a value of p = 0,000 (p <0.05). Oxygen saturation in both groups in the pre- intervention showed a value of p> 0.05), there was no difference in saturation between the intervention group and the control group (homogeneous data). The results of the oxygen saturation statistical test in the two groups in the pre- intervention showed a value of p> 0.05), there was no difference in saturation between the intervention group and the control group (homogeneous data). Analysis to find out the meaningful measurement, post-hoc paired wise comparison.

Table 5 Analysis of Differences in Oxygen Saturation before and after Treatment in both groups

Group	Pre> <Post 1	Pre> <Post 2	Post 1> <Post 2
HOB 45^0	2,063	3,188	1,125
P- value HOB 30^0	0,000	0,000	0.003
p-value	2,438	0.375	-2,063
	0,000	0.347	0,000

*) posc hoc pairwise comparisons

The above table shows that in the HOB 45 degrees results p value <0.05, this result means that differences were obtained in all measurements while in the HOB 30 degrees group p > 0.05 in pre >< post 2 measurements, so it can be concluded that the HOB 45 degrees group is more effective in each measurement time compared to the HOB 30 degrees group with a P value = 0.000, a difference of 3,188 in the intervention group and 0.375 in the control group.

Analysis of the effectiveness of HOB 45 and 30 degrees with non-pulmonary disease and pulmonary disease on oxygen saturation between the intervention and control groups

Table 4.5 Analysis of the effectiveness of HOB 45 and 30 degrees with non-pulmonary and Pulmonary disease against Oxygen Saturation between Groups (n = 32)

Variable	Intervention Mean ± SD	Control Mean ± SD	Delta*P-value*
Non-Pulmonary Disease Pulmonary	98.75 ± 1,165	95.88 ± 1,642	2,8750.001
Disease	98.50 ± 1,414	95.63 ± 1,188	2,8750.001
Non-Pulmonary,and Pulmonary Disease	98.63 ± 1,258	95.75 ± 1,390	2,8750,000

*) Independent t test

The above table shows that HOB 450 and 30 degrees with non-pulmonary disease and pulmonary disease to oxygen saturation during the suction process effectively reduce oxygen desaturation by controlling HR between 60-100 times/minute, HB levels ≥10 gr%, degrees of body temperature between ≥36^0C - <38^0C with a p value <0.05.

DISCUSSION

The average age of respondents in this study was 55.75 years in the intervention group and 54.94 years for the control group, which ranged in age from 46 to 65 years as the elderly and 70 years or older at high risk, where this age would result in a decrease physiological function of the body [1, 26].

The sex of the respondents indicated that in the intervention group the same number of respondents were male and female while the control group was mostly female. Liu, Jin, Ma & BO Qu (2015) stated that there was no statistical difference in changes in gas exchange due to age- related suction between the groups installed in pressure-controlled and volume controlled ventilator modes [27]. The theory of sex is associated with the condition of blood vessels due to a history of previous behavioral patterns and the type of disease that accompanies degenerative age which is a risk factor for reduced oxygen supply.[21] Both sexes have the same potential to experience respiratory failure due to decreased physiological function of the body and accompanying diseases.

This type of disease does not statistically affect oxygen saturation during the suction process P = 0.000, this is due to the condition of the cardiovascular system is very closely related to the respiratory system [28]. The criteria for these two types of diseases with normal HB and HR levels and body temperature are not high so that the process of diffusion, oxygenation and systemic transport is adequate. Factors that influence oxygen saturation values are HB, hemodynamics: HR and body temperature. [21]

Zukhri (2018) reported that the type of respondent's disease diagnosis statistically did not affect changes in peripheral oxygen saturation before and after suction, p> 0.05 [29]. Jacquiline (2017), regulating HOB 40 degrees for 20 seconds in each respondent with respiratory, cardiovascular, neurological, surgical and shock disease patients

did not decrease oxygen saturation <95% immediately after suction.[25] These results are not in accordance with Tety H et al (2019), giving hyperoxygenation before suction in patients with most respondents with HB values less than 10 g / dl can increase oxygen saturation before and after hyperoxygenation. [30]

HB in this study ≥10 gr%, which is sufficient in the process of oxyhemoglobin. After diffusion and ventilation the respiratory process involves the transportation of respiratory gas to deliver oxygen throughout the body. Every gram of HB can bind to a maximum of 1.34 million liters of oxygen.[20] The lower the HB, the less gram levels of HB bind to oxygen.

HR frequency has no effect on saturation during the open suction process, P> 0.05. Ching Ching (2017) states no significant differences were found in heart frequency before and after suction. [31] An increase in heart rate occurs during hypoxia during suction and after suction with hyperoxygenation, the pulse frequency returns to the initial normal value before suction.[1, 2] Body temperature is not feverish and hyperoxygenation will maintain a balance between supply and the need for metabolic substances so that there is no increase in cerebral or systemic metabolism. [17]

Analysis of the differences in the effectiveness of HOB 45 and 30 degrees

The results showed that there was a significant difference in oxygen saturation in the intervention and control groups after HOB 45 degrees for 30 seconds with hyperoxygenation for 2 minutes 3 times suction in 24 hours with oxygen saturation 98.63%, P = 0.000, 95% confidence interval, effect size 2.1. The difference in difference before and after treatment in the intervention group was -3,188 while the control group was -0.375.

A decrease in oxygen saturation <95% in the control group was found by 4 respondents (25%) and oxygen saturation in the intervention group of all respondents in the normal category (> 95%). Research conducted by Manggiore (2013), oxygen desaturation occurred in 46.8% of respondents, as many as 6.5% was caused by open suction with a decrease in oxygen saturation above 5%, P <0.05.[32] This is associated with high suction pressure resulting in severe loss of lung volume.[33]

Research conducted by Fernandez et al (2004) in patients with mild and moderate pulmonary disease with exclusion criteria of HOB 45 degrees, states that hyperoxygenation before suction reaches 99-100%, after termination of the ventilator saturation circuit drops to 95% and lung air loss is 1,281+ 656 ml and oxygen saturation after suction to 93%, p <0.05. [34] The application of high suction pressure (150 mmHg) with hyperoxygenation without HOB 45 degrees is less maximal in ventilation and developing lungs.

The respiratory mechanism consists of inspiration and expiration through the role of lung compliance and airway resistance, most of the work of the breath is carried out by the respiratory muscles to develop the lungs. Factors that influence changes in oxygen saturation include: PaO2, HB, age, pulmonary capacity. [1]

Age will result in decreased physiological function of the body. The higher the HOB will help respiratory function in the development of the lungs at degerative age due to decreased respiratory muscle function, decreased alveoli elasticity, and decreased PaO2 1 mmHg every year as you age, resulting in decreased systemic oxygen saturation including the brain. [1, 35]

Hyperventilation during the process of respiration can occur due to decreased physiological function of the body and degenerative diseases such as non-pulmonary disease and pulmonary disease, especially in critical patients in increasing the capacity of the lungs and when the patient is not attached to a breathing apparatus. [1, 16]

Hyperventilation will cause acute respiratory alkalosis, and changes in pH around the blood vessels, this will cause vasoconstriction and will certainly reduce Cerebral Blood Vascular (CBV) so that it will reduce Intra cranial Pressure (ICT). Hyperventilation is an effective action in handling the crisis of increasing intracranial pressure but will cause cerebral ischemia. [17-19]

HOB 45 degrees by using gravity will pull the diaphragm down so as to maximize the development of the lower front of the chest to allow alveolar expansion, this will physiologically reduce the occurrence of hyperventilation during the inspiration process and tidal lung volume increases especially in degenerative diseases. [1, 16, 20] HOB 45 degrees reduces anatomical and physiological loss in patients with non-pulmonary and pulmonary disease. [1]

The results of this study are in accordance with Jacquiline (2017), HOB 40 degrees for 20 seconds

suction pressure 150 mmHg 5 times insertion in one episode of mucus evacuation, application of 100% FiO2 before 95.0 intervention immediately post suction 98.0, p = 0.001, 95% CI This proves that HOB higher than 30 degrees with hyperoxygenation is more effective against oxygen saturation during the suction process. [25] The difference in difference between the results of oxygen saturation in the current study and that of Jacquiline was 0.63%.

At the time of inspiration, the respiratory center sends impulses along the phrenic nerve so that the diaphragm contracts. When the abdominal organs move downward and forwards, so that the length of the chest increases to enter air into the lungs. The diaphragm moves about 1 cm and the ribs are pulled up from the midline of the body around 1.2-2.5cm with inhalation of 500cc of air, so it can be concluded that the higher the HOB the more the development of the lower front of the chest and the increasing volume of lung residue in degenerative age sufferers with non-pulmonary and pulmonary diseases. [1, 20]

Oxygen saturation in this study immediately after the last 10 seconds of suction was 98.63%, this result proves that after effective airway suction is released, the process of inspiration is adequate, this will imply that blood perfusion to important organs is still adequate such as the brain, heart, lungs which is marked by peripheral oxygen saturation within normal limits, and hypoxia does not occur during suction. Implications of HOB 45 degrees with types of non-pulmonary disease and pulmonary disease by controlling the frequency of hemodynamics: regular HR between 60-100 times / minute, HB≥10gr% level and body temperature level between $\geq 36^0$C - $<38^0$C effective against oxygen saturation during open suction in patients with mechanical ventilation attached.

The results of this study were reinforced by Deye (2013) that the physiological effects of body position on the respiratory work system in patients with weaning difficulties with the results of the semi-Fowler 45 degrees position were effective in maintaining oxygen saturation of 97%. [22] The difference in difference between the results of oxygen saturation in the current study and that of Deye was 1.63%.

The results of this study were also supported by Shah DS et al (2012) who stated that the semi-Fowler 45 degrees found better in increasing oxygenation in mechanical ventilation in ARDS patients, this positioncan increase tidal volume up to 440 ml and oxygen saturation by 97.75% in patients with mechanical ventilation. [36] This result is clinically significant but not statistically significant (p> 0.05).

Preoxygenation of 100% for the process of respiration aims to reduce the work of breathing and myocardium, increase vital capacity and avoid hypoxemia. [21] The results of this study are in line with Hossein T (2015) which states that Pre oxygenation is 100% for 2 minutes, causing less interference with arterial oxygen saturation during the suction process with an average oxygen saturation value immediately after suction 95.61%, p <0.05. [37]

The results of the current study are different from those reported by Prato et al (2015) which states the position of bed heights 0, 30,45 and 90 degrees and Asmaa (2017) who examined HOB 30 and 45 degrees, an increase in oxygen saturation after HOB intervention with a significance value p <0.05, but more effective at position 30 degrees. [14, 24]

High suction pressure can maximize the evacuation of mucus. Suction pressure in this study was 140 mmHg for 10 seconds each one time suction as much as 3 times suction in 24 hours that had been used previously by Muhaji (2017) with the result an increase in oxygen saturation after open suction 98.07%, P = 0.004,[38] whereas in this study an increase in oxygen saturation of 98.63%, p = 0.000. The magnitude of the difference in current research with research conducted by Muhaji by 0.56%.

HOB 45 degrees with hyperoxygenation can increase the ability of the lung to inflate or expand the lower front of the lung in response to increasing intraalveolar pressure, effective ventilation with maximum inhalation through hyperoxygenation 100% thereby reducing hyperventilation, oxygen consumption during the inspiration process and can reduce oxygen desaturation during open suction process with a pressure of 140 mmHg which is characterized by oxygen saturation reaching 98.63% immediately after the last 10 seconds ofsuction.

CONCLUSION

HOB 45 degrees with hyperoxygenation is more effective than HOB 30 degrees with 100% hyperoxygenation of oxygen saturation in patients

with mechanical ventilation in the ICU with non-pulmonary and pulmonary diseases.

Acknowledgments

Thank you researchers for their help and guidance from various parties in completing this research

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How to cite this article: Saudurma Sirait, Suharyo Hadisaputro, Mardiyono, Sri Endang Pujiastuti. Comparison the effectiveness of the head of bed to 45 and 30 degrees with hyperoxigenation against oxygen saturation during the open suction in patients that installed mechanical ventilation in ICU room. Int J of Allied Med Sci and Clin Res 2020; 8(2): 359-367.
Source of Support: Nil. **Conflict of Interest:** None declared.