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The Effect of the Combination of Endotracheal Tube (ETT) Suction and Semi-Fowler Position on Oxygen Saturation (SPO2) Levels in Patients with Respiratory Failure on Ventilators in the ICU

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Abstract: Patients on mechanical ventilators are at risk of decreased oxygen saturation due to accumulation of secretions in the airway. Endotracheal Tube (ETT) Suction and semi-Fowler positioning are nursing interventions aimed at maintaining and improving patient oxygenation. This study aims to determine the effect of ETT suction and semi-Fowler position on oxygen saturation levels in ventilator-treated patients in the Intensive Care Unit (ICU) . This study used a pre-post design with a sample of 48 ventilator-treated patients in the ICU. Oxygen saturation measurements were performed before and after ETT suction and semi-Fowler positioning. Data were analyzed using the Wilcoxon test . The results showed an increase in oxygen saturation levels after the intervention. The mode value before the intervention was in the mild hypoxemia category, while after the intervention it was in the normal category. The Wilcoxon test results obtained a p value = 0.001 ($p < 0.05$) which indicated a significant difference between oxygen saturation before and after the intervention . ETT suction and semi-Fowler position have a significant effect on increasing oxygen saturation levels in patients on ventilators in the ICU (p value <0.05).

Keywords : ETT suction; ICU; Oxygen Saturation; Semi-Fowler Position; Ventilator.

1. BACKGROUND

Respiratory failure is a serious clinical condition in which the respiratory system is unable to meet the body's oxygen needs or adequately remove carbon dioxide. This condition leads to hypoxemia and hypercapnia, which can impair vital organ function. Respiratory failure can also disrupt the exchange of oxygen and carbon dioxide, risking a decrease in the patient's level of consciousness. This decreased level of consciousness often leads to complications such as sputum accumulation due to a decreased cough reflex (Afrianus et al., 2024) .

Patients with respiratory disorders are one of the groups most frequently treated in the *Intensive Care Unit* (ICU). Respiratory failure remains a major cause of high morbidity and mortality in critically ill patients in intensive care. *Acute Respiratory Distress Syndrome* (ARDS) is one of the causes of acute respiratory failure, especially in patients with severe lung disorders or systemic infections. Based on reports from 50 countries, the prevalence of ARDS in 2017 was recorded at 10.4% of all ICU patients, and approximately 75% of ARDS cases are characterized by lung tissue injury due to inflammation, increased blood vessel permeability, and decreased pulmonary aeration (Prayoga, 2024). Furthermore, the WHO reported that respiratory failure was a significant leading cause of death in the age group over 40 years in 2018 with a mortality rate of approximately 922,000 cases per year (Suci Mas'a et al., 2024) .

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One intervention to maintain airway patency in patients on mechanical ventilators is suction . *Suction* is a nursing procedure to remove mucus that has accumulated in the respiratory tract, either through the natural airway (mouth and nose) or an artificial airway such as *a tracheostomy* or *endotracheal tube (ETT)* . Suction techniques can be performed using two methods: *the Closed Suction System* (CSS) and *the Open Suction System* (OSS). However, *suctioning* in patients on mechanical ventilators has the potential to reduce tidal volume and affect oxygen saturation. In addition, *suction* can cause changes in oxygen saturation levels and respiratory rate. Oxygen saturation is the percentage of hemoglobin bound to oxygen in arterial blood. An SaO_2 value of less than 90% indicates hypoxemia (Wiryansyah & Hidayati, 2024).

Oxygen saturation monitoring needs to be carried out strictly because it can

provides an overview of tissue oxygenation and perfusion status. An oxygen saturation level <90% can indicate respiratory distress, while <85% indicates tissue oxygen deprivation. In fact, a value <70% can be very dangerous for the patient. Efforts can be made to increase oxygen saturation levels by adjusting the patient's body position. *The semi-Fowler's position* is known to help increase lung capacity, facilitate oxygen distribution, and improve breathing patterns, making them more effective. Research shows that the average oxygen saturation value increases after patients are placed in *the semi-Fowler's position* compared to before the positioning is performed (Nugraha & Hadyantari, 2024) .

The semi-Fowler's position is one in which the patient's head and body are elevated at an angle of approximately 15° to 45° (Kozier and Erb's, 2020). This position is generally applied at an angle of approximately 30° and can help improve lung expansion, thereby reducing shortness of breath (Suhatridjas & Isnayati, 2020). Furthermore, the *semi-Fowler's position* can also affect hemodynamics because changes in body position affect blood pressure, heart rate, and oxygen saturation (Nugraha & Hadyantari, 2024).

Oxygen saturation values are influenced by several factors, such as hemoglobin levels, blood circulation, patient activity, pH, and body temperature. Furthermore, suctioning *and* positioning, such as 30° head-up or 45° *semi-Fowler's,* can also affect oxygen saturation values. Oxygen saturation measurements after suctioning *should* be taken after a few seconds because the lungs need time to return to optimal gas exchange. Generally, the test is performed approximately 10–15 seconds after suctioning to allow the body time to adjust to the oxygen distribution process throughout the tissues (Setiyawan et al., 2020) .

Previous research has shown that the average oxygen saturation level of patients increases after suctioning . Furthermore, *the semi-Fowler's position* can also improve the stability of the patient's respiratory rate, thus contributing to improved oxygenation (Brunner & Suddarth, 2016). The results of research by Maria et al. (2019) proved that *the semi-Fowler's position* is effective in stabilizing breathing in asthma patients with a p value <0.05 (Dewi Silfiah et al., 2020) . Based on this background, this study aims to determine the effect of the combination of ETT suction and semi-Fowler's position on oxygen saturation levels in patients with respiratory failure who are on ventilators in the ICU.

2. THEORETICAL STUDY

2.1 Respiratory Failure

Respiratory failure is a condition where the respiratory system is unable to maintain adequate gas exchange, characterized by PaO_2 < 60 mmHg or $PaCO_2$ > 50 mmHg. One cause is sputum retention, which can be overcome by suctioning *to* increase oxygen saturation levels (Tani et al., 2023) . One cause of respiratory failure is sputum retention. An independent nursing action that can be carried out is *suctioning* . Providing *suction* to patients with respiratory failure can reduce sputum production and increase oxygen saturation levels. (Afrianus et al., 2024)

Classification of respiratory failure according to R. Dewi & Made Kariasa (2022) consists of: hypoxic respiratory failure and hypercapnic respiratory failure. Hypoxemic respiratory failure has a low PaO_2 but normal $PaCO_2$. This $PaCO_2$ differentiates it from hypercapnic respiratory failure, the main problem of which is alveolar hypoventilation. Patients with hypercapnic respiratory failure have abnormally high $PaCO_2$ levels. Because CO_2

increases in the alveolar space, O_2 is displaced in the alveoli and PaO_2 decreases. Severe chronic obstructive pulmonary disease often results in hypercapnic respiratory failure.

2.2 Mechanical Ventilation

Mechanical ventilation is a life-support device designed to replace or support normal respiratory function. Critically ill patients with decreased consciousness who are on mechanical ventilation may experience impaired cough and swallow reflexes because the respiratory tract is one of the body's defense mechanisms (Marleza Oktavia et al., 2024) .

2.3 Suction

Suction is the action or process of sucking the respiratory tract.

in patients with excessive sputum production where the patient is unable to do so independently. *Suction* is often performed in critically ill patients treated in intensive care, especially in patients with an endotracheal *tube (ETT)* inserted into the bronchial tree of the airway. (Mawarti & Budi Setyawan, 2020)

Indications for *ETT suctioning* in patients are if there is gurgling (noisy breathing sounds like gargling), anxiety, difficulty/lack of sleep, snoring, decreased level of consciousness, changes in skin color, decreased oxygen saturation levels, decreased *pulse rate* , irregular pulse rhythm, decreased respiration rate and impaired airway patency (Tani et al., 2023)

2.4 Semi Fowler Position

A semi-Fowler's position involves the client lying down at a 30-45 degree angle. Placing the client in *a semi-Fowler's position* will slow the increase in cardiac return. Slower return reduces the amount of fluid entering the lungs, allowing the air in the alveoli to absorb oxygen. (Ani & Muzaki, 2020)

Position assignment is a nursing action aimed at reducing oxygen consumption and increasing maximum lung expansion, as well as addressing gas damage associated with changes in the alveolar membrane, thereby reducing shortness of breath. A stable breathing pattern is characterized by a normal respiratory rate, the absence of oxygen deficiency (*hypoxia*), changes in breathing patterns, and the absence of airway obstruction (Putri Sinta et al., 2023).

2.5 Theoretical Basis and Implied Hypothesis

Based on the theories of respiratory failure, mechanical ventilation, suction, and the semi-Fowler position that have been explained, and supported by previous research, it is implied that the combination of suction and the semi-Fowler position can increase oxygen saturation levels. Therefore, the underlying hypothesis is that there is an effect of the combination of suction actions . *Endotracheal Tube (ETT)* and *semi-Fowler position* on oxygen saturation levels ($SpO2$) in patients with respiratory failure who are on a ventilator in the ICU.

3. RESEARCH METHODS

This study used *a one-group pretest-posttest design* without a control group. The number of samples in this study involved 48 respiratory failure patients using mechanical ventilators in the ICU room of Sari Asih Hospital Karawaci. Sample selection was carried out using a *purposive sampling technique* by considering the predetermined inclusion and exclusion criteria. The study was conducted from October to December 2025. The intervention provided was a combination of *Endotracheal Tube (ETT) suction and semi*-Fowler positioning . Measurement of oxygen saturation levels (SpO_2) was carried out before and after the intervention using a *pulse oximetry device* . Data collection was carried out through observation sheets and data analysis using the *Wilcoxon test* using the SPSS program .

4. RESULTS AND DISCUSSION

4.1. Results

4.1.1. Data Collection Process

Data collection was carried out using an observation sheet containing the respondent's general identity at the top of the sheet. The research results were listed at the bottom. *pretest & posttest* against the action of sucking mucus *(suction)* was performed. The implementation of *suction and semi-Fowler* position in this study used SOP, a note sheet to write down the results of observations on the patients being performed. *endotracheal tube suctioning* procedure . Once all the results are collected, the data will be processed using a computer. Observations will be made. on the patient 5 minutes before action *suction* on day First. Observation done for 10 minutes for 3 consecutive days, on the next day, after 5 minutes have been done action *suction* , will done evaluation of the patient. Suction is performed for 10-15 seconds and does not exceed a total time of 3 minutes. Then, the blood glucose level is measured. oxygen saturation in patients by observing on patient with give tool in the form of oximetry to know Oxygen saturation levels, with normal oxygen saturation levels at 95%-100. *Oximetry* devices have a high level of validity and reliability for measuring oxygen saturation levels (SPO_2) in patients (Salamah et al., 2020)

4.1.2. Research Time Range and Location

The study was conducted from October to December 2025 , taking place in the ICU of Sari Asih Hospital, Karawaci, as the primary location. The location was selected purposively, *considering* that the hospital had a population size suitable for the research needs

4.1.3. Data Analysis Results

This study successfully collected data from 48 respondents obtained through observation sheets. The data obtained included respondent characteristics and oxygen saturation measurement results before and after the combined intervention of *Endotracheal Tube (ETT) suction and semi-Fowler's* position . The results of the study are presented in the form of a frequency distribution table and analyzed to determine changes in oxygen saturation levels after the intervention was carried out :

Table 1. Frequency Distribution of Respondents' Frequency Characteristics (n = 48)

Characteristics	Frequency	Percentage (%)
Gender		
Man	19	39.6
Woman	29	60.4
Age		
Young adults (18-44 years)	11	22.9
Middle adulthood (45-59 years)	19	39.6
Elderly (60-74 years)	13	27.1
Elderly people aged 75-90 years)	5	10.4
FiO_2		
Low :<40%	11	22.9
Medium: 41-60%	27	56.3
Height: >60%	10	20.8
PaO2		
Normal: 80-100	3	6.3
Light-moderate 60-79	4	8.3
Hyperoxia >100	41	85.4
PCO_2		
Normal 35-45	22	45.8
Mild hypercapnia 46-60	17	35.4
Severe Hypercapnia >60	5	10.4
Hypocapnia <35	4	8.3
Tidal Volume		

Characteristics	Frequency	Percentage (%)
200 – 299	6	12.5
300 – 399	13	27.1
400 -500	29	60.4

Source: Primary research data (2025)

The results showed that the majority of patients were female, 29 respondents (60.4%). The largest age group was middle-aged adults (45–59 years), namely 19 respondents (39.6%). Based on FiO ₂ requirements , the majority of respondents were in the moderate category (41–60%) with 27 respondents (56.3%). In the PaO ₂ parameter , most respondents were in a hyperoxia condition (>100 mmHg) with 41 respondents (85.4%). Based on the PCO ₂ parameter , the majority of respondents were in the normal category (35–45 mmHg) with 22 respondents (45.8%). Meanwhile, the most commonly used tidal volume was 400–500 mL in 29 respondents (60.4%).

Table 2. SpO2 Frequency Distribution Before Intervention (n = 48)

Variables	Frequency	Percentage (%)
SpO2		
Normal: 95-100%	9	18.8
Mild hypoxemia: 90-94%	24	50.0
Severe hypoxemia: <90%	15	31.3
Total	**48**	**100**

Source: Primary research data (2025)

Table 2 shows that before the intervention, the majority of respondents were in the mild hypoxemia category with an oxygen saturation value (SpO ₂) of 90 – 94%, amounting to 24 respondents (50.0%), which indicates that most patients experienced mild oxygenation disorders.

Table 3. SpO2 Frequency Distribution After Intervention (n = 48)

Variables	Frequency	Percentage (%)
SpO2		
Normal: 95-100%	42	87.5
Mild hypoxemia: 90-94%	1	2.1
Severe hypoxemia: <90%	5	10.4
Total	**48**	**100**

Source: Primary research data (2025)

Table 3 shows that after the intervention, the majority of respondents were in the normal category with an oxygen saturation value (SpO ₂) of 95 – 100%, as many as 42 respondents (87.5%), which indicates an improvement in the patient's oxygenation status after administering a combination of Endotracheal Tube (ETT) suction and semi-Fowler's position.

Table 4. Distribution of Research Variables (n = 48)

Variables	Before Intervention (Mode)	After Intervention (Mode)	n	p-value
SpO2 Before and after *suction* and *semi-Fowler position*	Mild hypoxemia	Normal	48	0.001

Source: Primary research data (2025)

Table 4 shows that before the intervention, the oxygen saturation mode value (SpO 2) was in the mild hypoxemia category, while after the intervention, the mode value was in the normal category. The Wilcoxon test showed a p value = 0.001 ($p < 0.05$), which means there was a significant difference in the oxygen saturation value (SpO 2) before and after the administration of a combination of Endotracheal Tube (ETT) suction and semi-Fowler's position.

4.2. Discussion

4.2.1. Respondent characteristics

Based on age, the largest group of respondents was in the middle adult category (45–59 years old), with 19 respondents (39.6%). This finding aligns with Ma et al.'s (2022) findings. which states that patients undergoing treatment in the ICU with mechanical ventilators are generally dominated by adults to the elderly. With increasing age, there is a decline in organ function, including the respiratory and cardiovascular systems, so that this age group is more susceptible to respiratory disorders that require mechanical ventilation assistance. This finding is also supported by research by Stretti et al., (2024) , which states that middle-aged to elderly patients more often experience critical conditions that require ventilators during hospitalization .

Based on age, the largest group of respondents was in the middle-adult category (45–59 years old), namely 19 people (39.6%). This is supported by the opinion of Ma et al., (2022) , who stated that patients undergoing treatment in the ICU with mechanical ventilators are generally dominated by adults to elderly groups. With increasing age, there is a decline in organ function, including the respiratory and cardiovascular systems, so that this age group is more susceptible to respiratory disorders that require mechanical ventilation. This finding is also supported by research by Safitri et al., (2023) who stated that middle-adult to elderly patients more often experience critical conditions that require ventilators during hospitalization.

FiO_2 requirement variable , the majority of respondents are in the category

moderate (41–60%), namely 27 people (56.3%). These results are consistent with research by Roozeman et al., (2020) which stated that the SpO_2/FiO_2 ratio is an important indicator in assessing the oxygenation status of patients using invasive mechanical ventilation in the ICU. In addition, Ma et al., (2022) also assessed the patient's oxygenation condition using the PaO_2 /FiO_2 ratio as the main parameter to describe the balance between arterial oxygen pressure and inspired oxygen fraction in patients using ventilators.

Regarding the PaO_2 parameter , the majority of respondents were hyperoxia (>100 mmHg), namely 41 people (85.4%). This finding is consistent with research by Jentzer et al., (2023) , which stated that critically ill patients often experience excessive oxygen exposure due to intensive oxygen therapy, resulting in PaO_2 values that can increase beyond normal physiological limits. Research by Sartini Sartini et al., (2021) also stated that PaO_2 values that are too low or too high are associated with an increased risk of poor outcomes in critically ill patients.

Based on the results of the study on the $PaCO_2$ variable , the majority of respondents were in the normal category (35-45 mmHg), namely 22 people (45.8%). The dominance of normal $PaCO_2$ values in patients is thought to indicate adequate ventilation and support relatively stable tissue perfusion and oxygenation conditions. This finding is in line with research (Zhou et al., 2024) which states that $PaCO_2$ values play a role in influencing organ perfusion in patients with respiratory disorders. In addition, Zhang et al., (2023) also explained that $PaCO_2$ values in ventilator patients can be in the normal or abnormal category, depending on the clinical condition and the effectiveness of the mechanical ventilation provided. Normal $PaCO_2$ values indicate adequate ventilation, while hypercapnia or hypocapnia values can indicate ventilation imbalance .

Based on tidal volume settings, most respondents were in the 400–500 mL range, amounting to 29 people (60.4%). The determination of tidal volume categories in this study was based on the range of values. However, clinically, tidal volume settings need to be adjusted to the patient's condition, especially in patients with ARDS, because inappropriate tidal volume can increase the risk of lung injury due to mechanical

ventilation. This is in accordance with the opinion of Muldiiarov & Buesing (2025) who stated that a low tidal volume ventilation strategy is very important to minimize the risk of ventilator-induced lung injury. Research by Jiang et al., (2024) also confirmed that tidal volume settings significantly influence the physiological condition of the lungs and the patient's clinical outcome. Appropriate tidal volume can help prevent complications of mechanical ventilation and support patient respiratory stability.

4.2.2. Oxygen saturation levels in patients with an *endotracheal tube (ETT)* before *suctioning* and *semi-Fowler position*

The results of the study showed that before the combined intervention *of suction and semi-Fowler's* position , the majority of respondents were in the mild hypoxemia category (SpO_2 90–94 %), amounting to 24 people (50.0%). This finding indicates that the majority of patients experienced mild oxygenation disorders before the procedure was performed. This finding is in line with the study of Juswan & Azizah (2024) who reported that before endotracheal tube suction, most patients had oxygen saturation values below 95%, so only a small proportion were in the normal range.

Furthermore, research by Hammad et al. (2020) also found changes in oxygen saturation levels in adult patients who underwent *endotracheal tube suctioning* in the ICU. Another study by Yuliastuti et al. (2025) Studies have shown that *a semi-Fowler's* position with a 30° head of bed elevation can significantly increase oxygen saturation in patients with non-hemorrhagic stroke. This suggests that body positioning plays a role in improving patient oxygenation.

4.2.3. Oxygen saturation levels in patients with an *endotracheal tube (ETT)* after *suctioning* and *semi-Fowler position*

After suctioning *and* semi *-Fowler positioning* , the results showed that the majority of respondents were in the normal category (SpO_2 95–100 %) , amounting to 42 people (87.5%). This indicates an increase in oxygen saturation levels in most patients after the intervention. These results are in line with research by Anggreani et al. (2023) which stated that *endotracheal tube suction* in ICU patients can increase oxygen saturation levels after the procedure. Other studies also show that the combination of *suctioning* and *semi-Fowler* positioning can improve the oxygenation status of mechanical ventilator patients. The *semi-Fowler position* with head elevation of approximately 30° can support more optimal lung expansion so that alveolar ventilation increases and oxygen saturation levels improve after suctioning (Ainun 2023).

4.2.4. Differences in oxygen saturation levels before and after *suction* and *semi-Fowler position*

The results of the study showed an increase in oxygen saturation values in patients with an *Endotracheal Tube (ETT)* after a combination of suction and semi-Fowler's position. This increase can occur because suction helps clear secretions in the airway, making the airway more patent and lung ventilation more effective. In addition, *the semi-Fowler's position* can increase lung expansion, thereby facilitating ventilation and improving gas exchange. This finding is in line with the research of Maria et al. (2019) which stated that the semi-Fowler's position is effective in improving patient respiratory stability, and is supported by Dewi Silfiah et al., (2020) , which stated that providing a semi-Fowler's position after suction can help improve patient oxygenation. Based on the results of the Wilcoxon test, a p value of 0.001 ($p < 0.05$) was obtained, indicating a significant difference between oxygen saturation before and after the intervention. Thus, it can be concluded that the combination of *Endotracheal Tube (ETT) suction and semi-Fowler* position has a significant effect on increasing oxygen saturation levels in patients with respiratory failure who use ventilators in the ICU.

Research Implications

According to the results of this study, there was a significant difference in oxygen saturation values (SpO_2) before and after the combination of *endotracheal suction and semi-Fowler's* position , so it can be used as a basis for nurses in implementing evidence-based nursing practices. This finding emphasizes the importance of the role of nurses in performing *suction and semi-Fowler's* position in accordance with standard operating

procedures, accompanied by SpO_2 monitoring before and after the procedure to assess the patient's response and prevent oxygenation disorders. In addition, the results of this study can be used as material for evaluating and developing nursing care for patients with airway disorders, especially in improving the quality and safety of nursing actions in the intensive care unit.

5. CONCLUSION AND SUGGESTIONS

Based on the research results, it can be concluded that there is an increase in oxygen saturation levels in patients with an *Endotracheal Tube (ETT)* after a combination of *suction* and *semi-Fowler's position* . Thus, the combination of *ETT suction* and *semi-Fowler's position* has been proven to have an effect on increasing patient oxygen saturation. This study has limitations in measuring oxygen saturation (SpO_2) in a relatively short time, namely before and after *endotracheal tube suction and semi-Fowler's* position . Therefore, this study cannot describe the long-term effects of this combination of actions on the patient's oxygen saturation category. In addition, this study uses secondary data in the form of medical records, which causes the results of the study to be highly dependent on the completeness and accuracy of data recording. The presence of incomplete data or variations in recording methods has the potential to affect the results of the analysis.

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