



ANALYSIS OF DIFFERENCES IN PATIENTS' HEMODYNAMIC STATUS WITH PRE AND POST SUCTION HYPEROXYGENATION MEASURES IN PNEUMONIA PATIENTS ON VENTILATORS

Dwi Santoso^a ; Nurul Hidayah^{b*}

^a Soerojo Hospital; Ahmad Yani Street No.169; North Kramat; North Magelang; Magelang and 56115; Indonesia

^b Nursing Professional Study Program; Faculty of Health Sciences; Universitas Muhammadiyah Magelang; Mayjend Bambang Soegeng Street No.Km 5; Glagak; Sumberrejo; Mertoyudan; Magelang and 56172; Indonesia

Abstract

Pneumonia remains a major health problem in developing countries. Pneumonia can be fatal if not promptly diagnosed and treated appropriately. If a pneumonia patient experiences a worsening or declines in condition resulting in respiratory failure, the patient will require intensive care. Management of patients with respiratory failure is to use a ventilator. One procedure that can be performed on patients on a ventilator to reduce the buildup of secretions is suction (suctioning out mucus). Suctioning can also trigger several complications, so hemodynamic monitoring is necessary. This study used quantitative research with consecutive sampling data collection techniques. The sample was determined by sample calculation, which in this study was conducted in June-July 2025 for 5 patients and 71 observations. The data collection tools used in this study were patient hemodynamic status observation sheets and a Dräger Vista 120 bed site monitor. The data collection method in this study was carried out using primary data obtained directly by observing the patient's hemodynamic status. This study used descriptive statistics and a paired sample t-test. The pre-post suction hemodynamic status was as follows: blood pressure difference $t = 0.977$, MAP difference $t = 0.598$, heart rate difference $t = 0.061$, respiratory rate difference $t = 0.198$, body temperature difference $t = 0.505$, and oxygen saturation difference $t = 0.828$. There was no difference in hemodynamic status between pre and post suction action in pneumonia patients on ventilators, because the p value was > 0.05 .

Keywords: *Hemodynamic Status ; Pre Post Suction ; Hyperoxygenation ; Pneumonia ; Ventilator*

1. Introduction

Pneumonia remains a major health problem in developing countries. Pneumonia is an acute inflammatory disease of the lung parenchyma resulting from an acute lower respiratory tract infection, characterized by coughing and shortness of breath (Choridah et al., 2023). It is caused by infectious agents such as bacteria, viruses, mycoplasma, and foreign substances. It presents as pneumonia accompanied by exudation and consolidation. Pneumonia is a contagious disease with a high mortality rate, affecting both the elderly and children (Abdjul & Herlina, 2020).

According to the 2013 and 2018 Basic Health Research, the prevalence of pneumonia sufferers

*) Corresponding Author (Nurul Hidayah)

E-mail: nurulhidayah@ummgl.ac.id

based on data from health worker diagnoses in Indonesia in 2013 reached 1.6%, while in 2018 it

increased to 2.0%. Therefore, between 2013 and 2018, pneumonia experienced a 0.4% increase, as explained in the data above. Furthermore, pneumonia is one of the top 10 inpatient diseases in hospitals, with a proportion of cases being 53.95% male and 46.05% female. Based on the 2018 Basic Health Research data, the prevalence of pneumonia in the elderly reached 15.5% (Kementrian Kesehatan Republik Indonesia, 2018).

Based on a review of pneumonia cases in Central Java Province, 80-90% of all deaths from Acute Respiratory Infections were caused by pneumonia. The prevalence of pneumonia sufferers in Central Java in 2019 reached 26.76% (Fatin & Pasha, 2021). The number of patients treated in the Intensive Care Unit (ICU) of Soerojo Hospital Magelang during the last year (January 2024 - December 2024) was 111, of which 60 patients (54.05%) were on ventilators. Pneumonia can be dangerous and can be fatal for sufferers. Pneumonia is considered a major health problem because it can increase morbidity and mortality.

The impact of pneumonia if not given appropriate treatment includes persistent fever or possible relapses, superinfection (subsequent infection by other bacteria, which occurs during antibiotic therapy), pleural effusion, or pneumonia caused by unusual organisms such as pneumocystis carinni, even in severe pneumonia often causing death (Nyoman & Bagus, 2017).

Pneumonia can cause death if not diagnosed immediately and given appropriate treatment. Most cases of pneumonia occur in children, especially those under 5 years of age, because their immune systems are not yet fully developed. If a patient with severe pneumonia experiences worsening or deterioration, resulting in respiratory failure, the patient requires intensive care in the ICU and ventilatory support. Respiratory failure is an imbalance between the exchange of oxygen and carbon dioxide within the body's cells. As a result, the oxygen pressure in the arteries is less than 50 mmHg and the carbon dioxide pressure is greater than 45 mmHg (Firmansyah, Amin, Loho, & Shatri, 2015).

Patients who have experienced respiratory failure will need assistance through a mechanical ventilation machine. Management of patients with respiratory failure involves the use of a ventilator (Adriansyah, Setianto, Lestari, Ayu, & Arindis, 2021). The installation of a ventilator will reduce the cough reflex and normal muco-ciliary function will be disrupted, so that there will be an increase in the production of secretions from the airways and the ability to reduce secretions will be reduced (Isabella, Cintami, & Pujiastuti, 2022).

One procedure that can be performed on patients on a ventilator to reduce secretion buildup is suctioning. Suctioning is a method used to remove substances from the trachea, pharynx, mouth, and nose. Suctioning can also trigger several complications. After suctioning secretions in patients on a ventilator without hyperoxygenation, oxygen levels decrease by 4-10%, which also impacts hemodynamic status, requiring hemodynamic monitoring (Isabella, Cintami, & Pujiastuti, 2022).

Hemodynamics is the circulatory system within the body, through both the major and pulmonary circulations. The examination includes blood circulation, heart function, and the physiological characteristics of the peripheral vasculature (Mohammed, 2025). The basis of hemodynamic monitoring is adequate tissue perfusion, such as the balance of oxygen supply with body needs, body temperature, and electrochemical balance so that early signs of hemodynamic disorders that if not treated appropriately and quickly will result in multiple organ failure. Parameters used to assess hemodynamic status are blood pressure, Mean Arterial Pressure, heart rate, respiratory rate, and oxygen saturation (Ulya, Nurhidayah, & Jufrizal, 2024).

One measure that can minimize the negative effects of suction is to administer hyperoxygenation before suctioning, which is used to help maintain the patient's hemodynamic stability (Jahromi, Mahdood, Shaafi, & Ramezanli, 2022). Hyperoxygenation is the act of administering additional oxygen to patients using ventilators, which can be done using a manual resuscitation bag or through a ventilator by increasing the oxygen flow to 100% (Oktarisa, 2019).

Efficient hyperoxygenation and preventing hypoxia is given 30 seconds pre-suction, suction is performed for 10 seconds, then post-suction is given hyperoxygenation for 30 seconds. The purpose of this hyperoxygenation is to prevent oxygen dissaturation that may occur due to suctioning, which results in temporary obstruction of airflow to the lungs (Oktarisa, 2019).

2. Method

This study used quantitative research with consecutive sampling data collection techniques. The sample was determined by sample calculation, which in this study was conducted in June-July 2025 for 5 patients and 71 observations. The inclusion criteria for respondents in this study included: patients treated in the ICU of Soerojo Hospital, Magelang, medically diagnosed with pneumonia, on a ventilator, adults aged 18-70 years, and receiving suction treatment. The data collection tools used in this study were patient hemodynamic status observation sheets and Dräger Vista 120 bed site monitor.

Researchers in collecting data require assistance from research assistants (ICU nurses), so before collecting data, researchers need to align perceptions between researchers and research assistants regarding the description of the patient's hemodynamic status. Data analysis was conducted using SPSS version 25. Researchers used univariate and bivariate data analysis. Univariate analysis aims to describe the characteristics of each research variable.

This study used respondent characteristics based on age and gender. The variables described in this study were the hemodynamic status of ventilated pneumonia patients before and after pre-suction hyperoxygenation, including blood pressure, Mean Arterial Pressure (MAP), heart rate, respiratory rate, body temperature, and oxygen saturation (SpO₂).

Researchers also used bivariate data analysis to determine differences in hemodynamic status between pre and post suction hyperoxygenation in ventilated pneumonia patients. The statistical test used in this study was the paired sample t-test. The paired sample t-test is used to compare the difference between two means from two paired samples, assuming the data are normally distributed. Paired samples come from the same subject, with each variable being taken under different circumstances.

3. Result and Discussion

The results of this study were made from filling out hemodynamic observation sheets on 5 respondents with a total frequency (f) of 71 observations.

a. Respondents' age and gender characteristics

Characteristics	Category	Respondent (n)	Percentage (%)
Age	18-30 years	0	0
	31-40 years	0	0
	41-50 years	1	20
	51-60 years	2	40
	61-70 years	2	40
Gender	Male	2	40
	Female	3	60

Table 1. showed that it is known that most of the pneumonia patients who were installed on ventilators were aged between 51-60 years and 61-70 years, as many as 2 respondents (40%) and female as many as 3 respondents (60%).

b. Hemodynamic status of patients with pre post suction hyperoxygenation procedures in patients on ventilators

Table 2. showed that the majority of respondents observed experienced adverse changes in blood pressure during pre-suction procedures, occurring in 55 observations (77.5%). Most of the observation results showed changes in blood pressure, namely not good during post-suction procedures, namely 55 observations (77.5%). Most of the observation results experienced changes in MAP, namely experiencing poor MAP, namely 43 observations (60.6%), while 28 observations (39.4%) experienced a decrease in MAP during pre-suction. Most of the observation results experienced unfavorable changes in MAP, namely 43 observations (60.6%), while 28 observations (39.4%) experienced a decrease in MAP during pre-suction.

Most of the respondents' observation results showed a positive change in heart rate frequency, namely 41 observations (57.7%). Most of the observation results showed a positive change in heart rate frequency, namely 39 observations (54.9%). Most of the observation results showed that there were changes in respiratory frequency that were not good, namely 61 observations (85.9%). Most of the observation results showed that there were changes in respiratory frequency that were not good, namely 63 observations (88.8%). Most of the observation results showed that respondents did not experience changes in body temperature during the pre-suction procedure or their temperature was good, namely 50 observations (70.4%). Most of the observation results showed that there was no change in body temperature during post-suction procedures or the temperature was good, namely 50 observations (70.4%). Most of the observation results showed no change in oxygen saturation during pre-suction (good oxygen saturation), namely 67 observations (94.3%). Most of the observation results showed no change in oxygen saturation during post-suction procedures (good oxygen saturation), namely 66 observations (92.9%).

Table 2. Pre-Post Suction Hyperoxygenation Procedures in Patients on Ventilators (f=71)

Hemodynamic Status	Frequency (f)	Percentage (%)
Pre suction blood pressure		
Good (100/70 mmHg - 120/80 mmHg)	16	22.5
Not good (< 100/70 mmHg atau > 120/80 mmHg)	55	77.5
Post suction blood pressure		
Good (100/70 mmHg - 120/80 mmHg)	16	22.5
Not good (< 100/70 mmHg atau > 120/80 mmHg)	55	77.5
Pre suction Mean Atrial Pressure		
Good (70-100 mmHg)	28	39.4
Not good (< 70 atau > 100 mmHg)	43	60.6
Post suction Mean Atrial Pressure		
Good (70-100 mmHg)	28	39.4
Not good (< 70 mmHg atau > 100 mmHg)	43	60.6
Pre suction heart rate		
Good (60-100x/menit)	41	57.7
Not good (< 60x/menit atau > 100x/menit)	30	42.3
Post suction heart rate		
Good (60-100x/menit)	39	54.9
Not good (< 60x/menit atau > 100x/menit)	32	45.1
Pre suction respiratory rate		
Good (16-20x/menit)	10	14.1
Not good (> 20x/menit)	61	85.9
Post suction respiratory rate		
Good (16-20x/menit)	8	11.2
Not good (> 20x/menit)	63	88.8
Pre suction body temperature		
Good (36.5°C - 37.5°C)	50	70.4
Not good (< 36.5°C atau > 37.5°C)	21	29.6
Post suction body temperature		
Good (36.5°C - 37.5°C)	50	70.4
Not good (< 36.5°C atau > 37.5°C)	21	29.6
Pre suction oxygen saturation		
Good (> 95%)	67	94.3
Not good (< 95%)	4	5.7
Post suction oxygen saturation		
Good (> 95%)	66	92.9
Not good (< 95%)	5	7.1

c. Differences In Patients' Hemodynamic Status with Pre and Post Suction Hyperoxygenation

Table 3. showed that all measured hemodynamic parameters (systolic and diastolic blood pressure, MAP, heart rate, respiratory rate, body temperature, oxygen saturation) did not show

significant changes after the intervention, because the p-value was greater than 0.05 for all parameters indicating that statistically, the intervention did not significantly affect the patient's hemodynamic condition.

Table 3. Patients' Hemodynamic Status with Pre and Post Suction Hyperoxygenation (f=71)

Hemodynamic Status	Mean Pre	Mean Post	t	p (Value)
Blood pressure				
Systole	131	133	-0.977	0.332
Diastole	80	81	-0.598	0.552
Mean Atrial Pressure	110	111	-0.198	0.844
Heart rate	99	99	-0.061	0.951
Respiratory rate	27	27	-1.082	0.283
Body temperature	37.3	37.3	0.505	0.615
Oxygen saturation	97.6	97.8	-0.828	0.411

Respondents in the study were mostly aged between 51 and 70 years or the adult age group. According to Siebenmann & Lundby (2015) in adulthood, especially approaching old age, the respiratory system begins to experience physiological changes that can affect lung function. The elasticity of the lung tissue and chest wall decreases, the inspiratory and expiratory reserve volumes decrease, and the cilia in the airways are less effective in clearing foreign particles. As a result, adults become more susceptible to respiratory infections such as pneumonia, bronchitis, or Chronic Obstructive Pulmonary Disease (COPD). According to Alvis & Hughes (2016) in addition, long-term exposure to risk factors such as smoking, air pollution, and exposure to chemicals in the workplace can worsen lung function at this age.

In this study, the respondents were mostly women with a total of 3 respondents (60%). According to Barbagelata, Cilloniz, Dominedo, Torres, Nocolini, & Solidoro (2020), female gender has a significant relationship with respiratory health problems, including pneumonia, due to physiological, hormonal, and immune system differences compared to men. In general, women have smaller lungs and airways, which results in slightly lower lung capacities such as tidal volume and vital capacity. This can affect the efficiency of gas exchange and tolerance to respiratory tract infections, especially during inflammation. In addition, estrogen, one of the main hormones in women, is known to play a role in modulating the immune system, both as a protective factor and as a factor that triggers an excessive inflammatory response, which can worsen pneumonia.

According to Abid et al. (2017), epidemiologically, several studies have shown that women can experience more severe symptoms when exposed to respiratory infections, especially if there are comorbidities such as asthma, obesity, or autoimmune disorders. Estrogen and progesterone can also affect the sensitivity of respiratory receptors and the function of respiratory muscles, especially during pregnancy, menopause, or the menstrual cycle. In addition, women who smoke have a higher risk of developing chronic lung disorders that can worsen pneumonia. These differences indicate the need for a gender-sensitive clinical approach in the evaluation and management of respiratory problems in female patients.

The results of the study showed that most of the observations experienced adverse changes in blood pressure during pre-suction, amounting to 58 observations (81.7%). According to Eggen & Bronstad (2020), the hemodynamic picture of patients on ventilators due to pneumonia during pre-suction can be influenced by compromised lung conditions, physiological stress due to infection, and stimulation from the suction procedure itself. Pre-suction can cause changes in hemodynamics, especially blood pressure. According to Perl et.al, (2016), when pre-suction is performed, blood pressure tends to rise. It tends to rise temporarily (mild hypertension) due to sympathetic stimulation during pre-suction. However, in patients who are already weak or in septic shock, blood pressure can actually drop due to the inability of the cardiovascular system to compensate.

Analysis of observational items showed changes in blood pressure in 71 observations, with 38 (53.5%) experiencing increased blood pressure. According to LeWine (2024), increased blood pressure can occur through the mechanism of mild hypoxia as initial compensation. Another mechanism for increased blood pressure is sympathetic activation in response to stress or pain, resulting in increased adrenaline and increased blood pressure.

In this observation, a decrease in blood pressure was also found, namely 32 observations (45.1%) of the observation results showed a decrease in blood pressure. According to Hidayati, Akbar, & Rosyid (2018), the vagal reflex mechanism stimulates the trachea or larynx and experiences bradycardia. The mechanism of severe hypoxia can also cause a decrease in blood pressure through vasodilation of blood vessels and decreased cardiac output. In addition, it can also be due to the sedative effect caused by the vasodilatory effect of drugs. The mechanism of the decrease in intrathoracic pressure during pre-suction can also reduce preload so that cardiac output decreases.

Blood pressure changes occurred in systolic pressure between pre and post suction, with an average difference of 2.21, while in diastolic pressure between pre and post suction, a difference of 0.77 was found. Tracheal suction can trigger vagal stimulation, which causes sudden bradycardia or hypotension. Conversely, procedural stress can trigger a sympathetic response, increasing blood pressure and heart rate, a common manifestation during endotracheal suction (Aris, Arafat, & Rachmawaty, 2025).

According to Maggiore et al (2013) in the decreasing the adverse effects of endotracheal suctioning guide, blood pressure can increase to systolic >200 mmHg (severe hypertension) or decrease <80 mmHg (severe hypotension) during suction. Meanwhile, according to the results of research, suction can significantly increase systolic blood pressure, although diastolic changes are sometimes not statistically significant. This is evident in the Significant Systolic Change (SCC) in the ICU. Salsabila, Windiarti, & Arwani (2025) informed that factors influencing changes in blood pressure before and after suctioning include suction technique, preoxygenation, suction duration, medications, and the patient's heart and lung status.

The results of the study showed that most of the observations experienced changes in MAP, namely experiencing poor MAP, namely 47 observations (66.2%), while 32 observations (40.8%) experienced a decrease in MAP during pre-suction. According to Hafifah & Hakim (2021) hemodynamic changes, especially MAP (Mean Arterial Pressure) during pre-suction in patients on ventilators, occur due to temporary disturbances in circulation and ventilation as well as reflex responses of the autonomic nervous system.

Analysis of MAP observation items before and after pre-suction found a majority increase, with 38 observations (53.5%). This occurs through the sympathetic stress mechanism, which occurs due to increased catecholamines, resulting in an increase in MAP. Several observations showed a decrease in MAP with 29 observations (40.8%). According to Atchley, Tesoro, Meyer, Bauer, Pulver, & Benken (2022) this can occur due to the vagal reflex mechanism causing bradycardia and vasodilation, resulting in a decrease in MAP. Furthermore, decreased intrathoracic pressure causes decreased cardiac output, resulting in a decrease in MAP. A decrease in MAP can also be caused by the effects of sedative drugs due to vasodilation and cardiac depression.

The results of the study showed a difference in MAP values between pre and post suction, namely the difference in MAP changes before and after pre suction was 0.267. According to Blackwood, Burns, Cardwell, & O'Halloran (2014), suction can cause significant changes in MAP, heart rate, and oxygen saturation. When the suction catheter enters the airway, stimulation of the vagus nerve occurs, causing bradycardia and vasodilation, so that MAP can decrease. In some patients, the sympathetic response actually increases, causing tachycardia and vasoconstriction so that MAP can increase temporarily (Blakeman, Scott, Yoder, Capellari, & Strickland, 2022). According to Urden, Stacy, & Lough (2022), factors that influence the resistance to changes in MAP during suction are influenced by hypoxemia, vagal stimulation, and pain or anxiety.

The results of the study showed that most observations showed positive heart rate changes, namely 40 observations (56.3%). According to Siebenmann & Lundby (2015), pre-suction can cause changes in heart rate toward tachycardia. Generally, this increase (tachycardia) is due to stimulation of the vagus nerve and a stress response. However, in some patients, especially those with severe hypoxia or sensitivity to stimulation, vagal bradycardia can occur.

The difference in heart rate between pre-post suction is indicated by the difference in heart rate before and after the pre-suction procedure, with an average change of 0.070. During suction, the suction catheter touches the tracheal or bronchial mucosa, stimulating the vagus nerve. This triggers bradycardia (decreased heart rate), and can even cause arrhythmia if excessive Blakeman, Scott, Yoder, Capellari, & Strickland (2022). According to Urden, Stacy, & Lough (2022), this change in heart rate can occur due to the effects of hypoxemia and anxiety. Suction removes air along with secretions, resulting in a temporary decrease in oxygenation ($\text{SpO}_2/\text{PaO}_2$). This causes hypoxemia, which triggers activation of the sympathetic system, thereby increasing heart rate (tachycardia). If hypoxemia is severe and prolonged, it causes decreased cardiac contractility, resulting in bradycardia. Another factor that can cause changes in heart rate is anxiety.

The results of this study indicate that most observations showed adverse changes in respiratory rate, with 63 observations (88.7%). According to Misirlioglu, Horoz, Yildizdas, Ekinci, Yontem, Menemencioglu, & Salva (2021), pre-suction in ventilated pneumonia patients will increase respiratory rate. According to Dee, Natalia, & Suwardianto (2025) this increase in respiratory rate (tachypnea) is due to respiratory distress and a response to discomfort. However, if the patient is sedated or in severe respiratory failure, the respiratory rate may remain constant or decrease. Pinsky et al., (2022) stated that hemodynamic changes, particularly in respiration during pre-suction, occur due to a combination of physiological reflexes, airway obstruction, and the patient's emotional response.

Analysis of each item of information based on the trend of changes in respiratory frequency between before the pre-suction procedure showed that 41 observations (57.7%) showed an increase in respiratory frequency. According to Mauri et al., (2021), the mechanism of respiratory changes during pre-suction can be caused by a cough reflex or spasm due to tracheal and bronchial stimulation, causing irregular breathing and even stopping for a moment. In addition, changes in respiratory frequency can occur due to a temporary disruption of oxygen flow that causes compensatory tachypnea and underlying diseases (pneumonia and sepsis) that compensate for hypoxia or acidosis so that breathing becomes rapid and shallow. Analysis of each observation item also found that there were 19 observations (26.8%) that actually experienced a decrease in respiratory frequency or bradypnea. Spear (2022) this decrease in respiratory frequency can be caused by a vagal mechanism that activates the vagus due to ETT stimulation so that breathing slows down or can even stop temporarily.

The difference in respiratory rate between pre-suction and post-suction was 0.591. This occurs because suctioning removes air and secretions, resulting in a temporary decrease in $\text{PaO}_2/\text{SpO}_2$, potentially leading to hypoxemia. This hypoxemia stimulates peripheral chemoreceptors (in the aorta and carotid) and increases respiratory drive, resulting in increased respiratory rate (tachypnea) (Blakeman, Scott, Yoder, Capellari, & Strickland, 2022).

Several other factors can influence increased respiratory rate, including stress, anxiety, and pain. Suctioning often causes discomfort, increasing sympathetic activation. This can trigger hyperventilation, increasing respiratory rate. Factors influencing changes in respiratory rate include duration, negative suction pressure, suction technique, suction frequency, and the patient's clinical condition (Urden, Stacy, & Lough, 2022).

The results of the study showed that most of the observations showed no change in body temperature during the pre-suction procedure or the temperature was good, namely 45 observations (63.4%). There were 71.8% of observations that did not show any change in body temperature. Urden, Stacy, & Lough (2022) stated that changes in body temperature during or after pre-suction procedures in patients using ventilators are not a direct and rapid response like heart rate or blood pressure. However, changes in body temperature can occur due to sympathetic activation mechanisms, increased work of breathing, nosocomial infections, advanced sepsis, and a cold ICU environment.

Analysis of each observation item, from 71 observation results showed 11 observations (15.5%) showed an increase in body temperature between before and after pre-suction. Rass et al, (2020) the mechanism of changes in body temperature during and after pre-suction occurs due to the mechanism of sympathetic activity which increases metabolism due to stress so that body temperature tends to rise. In addition, body temperature can increase through increased work of breathing so that heat production from the respiratory muscles' increases. However, there were 9 observations (12.7%) that experienced a decrease in temperature. This can occur due to the mechanism of the cold ICU environment which disrupts thermoregulation.

The difference in body temperature between before and after suctioning is 0.007. Suction can trigger hypoxemia, airway trauma, and increase the risk of infection associated with changes in vital signs, including temperature (Blakeman, Scott, Yoder, Capellari, & Strickland, 2022). Suction can cause a temporary decrease in oxygen saturation (SpO_2), resulting in hypoxia. Hypoxia increases lactate production and anaerobic metabolism, which accelerates basal body metabolism, potentially increasing body temperature (Akbarpour, Jafarpour, Shamsalinia, Fotokian, & Hamidi, 2023).

Meanwhile, Kollef et al. (2021) stated that ventilator patients who are frequently suctioned are at high risk of VAP, and one of the main clinical signs is fever. Wu, Wu, Zhang, & Zhong (2019) informed that in patients with pneumonia on ventilators, repeated suctioning has the potential to introduce microorganisms into the airway (Ventilator Associated Pneumonia or VAP), an infection that can cause persistent fever. Factors that influence changes in body temperature during suctioning include suction technique, duration and frequency of suctioning, sterility of the procedure, the patient's clinical condition, and individual response.

The results of the study showed that most of the observations did not experience changes in oxygen saturation during pre-suction (good oxygen saturation), namely 60 observations (84.5%). The results of the analysis of the observation results showed that 18 observations (25.4%) experienced a decrease in oxygen saturation. According to Faraji, Khatony, Moradi, Abdi, & Rezaei (2015) hemodynamic changes, especially oxygen saturation (SpO_2) during pre-suction in patients using ventilators, are a common physiological reaction. A decrease in oxygen saturation during pre-suction can occur through a mechanism of disrupted oxygen flow because the ventilator is removed or $F_{I}O_2$ has not been increased so that SpO_2 decreases. The cough reflex/bronchial spasm mechanism can also decrease SpO_2 due to airway obstruction and impaired gas exchange. A decrease in SpO_2 can also occur due to atelectasis due to alveolar collapse after suction.

From the analysis of observational items, an increase in oxygen saturation was found in 21 observations (29.6%), and there were 32 observations (45.1%) where SpO_2 remained or did not change. According to Choudhary et al., (2025), oxygen saturation should not decrease and must be maintained stable during pre-suction procedures in ventilator pneumonia patients, referring to the preference for using a closed suction system (CSS) over open suction (OSS). Closed suction does not cause a decrease in oxygen saturation or lung volume in patients with severe respiratory distress, while open suction is often associated with desaturation and a decrease in lung volume after suctioning. Research by Choudhary et al., (2025) shows that the use of CSS allows saturation to remain stable during and after suctioning, especially when accompanied by optimal hyperoxygenation and in a short procedure time (<10 seconds).

The results of the overall expected observations before and during the pre-suction procedure are stable, meaning there are no hemodynamic changes. From the analysis of the observation items, 1 observation (1.4%) did not experience changes in blood pressure, 4 observations (5.6%) showed a constant MAP (no decrease or increase in MAP), 3 observations (4.2%) showed a constant heart rate, 11 observations (15.5%) showed a constant respiratory rate, and even 32 observations (45.1%) showed a constant SpO_2 .

The results of observations that are stable or do not experience a decrease or increase in hemodynamics before and after the pre-suction procedure in pneumonia patients who are attached to a ventilator indicate that pre-suction has been carried out with the correct technique, the patient is in a stable hemodynamic condition, the level of consciousness or sedation is adequate, the ventilator is not removed during pre-suction, pneumonia has not gradually disrupted lung function, hemodynamic support drugs.

The difference in oxygen saturation between before and after suctioning was 0.211. According to Blakeman, Scott, Yoder, Capellari, & Strickland (2022), suctioning can cause hypoxemia, atelectasis, and changes in oxygen saturation if not performed with proper technique. Suction can temporarily reduce PEEP, causing partial atelectasis, and atelectasis reduces the surface area of gas exchange, resulting in a decrease in SpO_2 . Another factor that influences this is that suctioning not only removes secretions but also some of the gas already filled in the alveoli.

This results in transient hypoxemia due to reduced alveolar oxygen. Decreased oxygen saturation in ventilator patients during suctioning is caused by loss of PEEP, hypoventilation, and the removal of alveolar oxygen with secretions (Urden, Stacy, & Lough, 2022). Other factors that can influence the

magnitude of changes in oxygen saturation before and after suctioning are suction technique, suction duration, pre-oxygenation, patient condition, and suction frequency.

4. Conclusion and Suggestion

The hemodynamic status before and after pre-post suctioning in ventilated pneumonia patients from 5 respondents and 71 observations showed varying changes, with those experiencing insignificant hemodynamic changes. Real-time monitoring is necessary, noting even the slightest changes that could indicate systemic instability. Standard protocols should be implemented that include hyperoxygenation, selection of closed suction, and routine training for nurses to recognize the body's response to this invasive procedure to minimize the risk of complications and maintain optimal patient stability.

5. Acknowledgments

The authors express their deepest gratitude to all individuals and institutions who contributed to the completion of this study.

6. References

- Abdjul, R. & Herlina. (2020). Asuhan Keperawatan Pada Pasien Dewasa Dengan Pneumonia. *Study Kasus*, 102-107.
- Abid, S., Xie, S., Bose, M., Shaul, P.W., Terada, L.S., Brody, S.L., Thomas, P.J., Katzenellenbogen, J.A., Kim, S.H., Greenberg, D.E., Jain, R. (2017). 17 β -Estradiol Dysregulates Innate Immune Responses to *Pseudomonas aeruginosa* Respiratory Infection and Is Modulated by Estrogen Receptor Antagonism. *Infect Immun*, 85(10): e00422-17. doi: 10.1128/IAI.00422-17. PMID: 28784925; PMCID: PMC5607430.
- Akbarpour, R.M.B., Jafarpour, H., Shamsalinia, A., Fotokian, Z., Hamidi S.H. (2023). Effects of a forced-air warming system and warmed intravenous fluids on hemodynamic parameters, shivering, and time to awakening in elderly patients undergoing open cardiac surgery. *Ann Card Anaesth*, 26(4):386-392. doi: 10.4103/aca.aca_20_23. PMID: 37861571; PMCID: PMC10691583.
- Alvis, B.D. & Hughes, C.G. (2016). 'Physiology considerations in the geriatric patients', *Anesthesiology Clinics*, vol 33(3):447-56.
- Adriansyah, A. A., Setianto, B., Lestari, I., Ayu, P., & Arindis, M. (2021). *Jurnal Riset Kesehatan Patient Satisfaction Analysis Based on Service Quality*. 10(2), 105-113. <https://doi.org/10.31983/jrk.v10i2.7529>
- Aris, R.J., Arafat, R., & Rachmawaty, R. (2025). The Effect of Endotracheal Suction on Hemodynamics of Neurological Patients: A Literature Review. *International Journal of Nursing and Health Services (IJNHS)*, 8(4): 243-250. DOI: 10.35654/ijnhs.v8i4.844.
- Atchley, E., Tesoro, E., Meyer, R., Bauer, A., Pulver, M., Benken, S. (2022). Hemodynamic Effects of Ketamine Compared with Propofol or Dexmedetomidine as Continuous ICU Sedation. *Ann Pharmacother*, 56(7):764-772. doi: 10.1177/10600280211051028.
- Barbagelata, E., Cilloniz, C., Dominedo, C., Torres, A., Nocolini, A., Solidoro, P. (2020). Gender Differences in Community-acquired pneumonia. *Minerva Medica* April; 111 (2):153-165.
- Blackwood, B., Burns, K.E.A., Cardwell, C.R., & O'Halloran, P. (2014). Protocolized versus non-protocolized weaning for reducing the duration of mechanical ventilation in critically ill adult patients. *Cochrane Database of Systematic Reviews* 2014, Issue 11. Art. No.: CD006904. DOI: 10.1002/14651858.CD006904.pub3.
- Blakeman, T.C., Scott, J.B., Yoder, M.A., Capellari, E., & Strickland, S.L. (2022). AARC Clinical Practice Guidelines: Artificial Airway Suctioning. *Respir Care*, 67(2):258-271. doi: 10.4187/respcare.09548. PMID: 35078900.
- Choridah, L., Ekowati, A., Setyawan, N. H., Setyawati, B. A., Afifah, N. H., & Rengganis, A. A. (2023). The Concordance of Brixia and Rale Scores in Evaluation of Covid-19 Pneumonia Patient Using Radiography in Indonesia Referral Hospital. *Jurnal Riset Kesehatan*, 12(1), 16 - 21. <https://doi.org/10.31983/jrk.v12i1.9333>.

- Choudhary, M.K., Holmström, K., Bouquin, H., Saarinen, T.P., Koskela, J.K., Pietilä, E., Suojanen, L., Mustonen, J.T., Nevalainen, P.I., Pörsti, I.H. (2025). Impact of aging on cardiovascular dynamics and heart rate variability during passive head-up tilt. *Physiol Rep*, 13(14):e70477. doi: 10.14814/phy2.70477. PMID: 40685803; PMCID: PMC12277527.
- Dee, T. S., Natalia, D., & Suwardianto, H. (2025). *The Effect of Suction Towards Oxygen Saturation to Patients in Intensive Care Unit: Literature Review*. 0 - 7. <https://doi.org/10.20944/preprints202504.1206.v1>.
- Eggen, I. B. & Brønstad, G. (2020). Short-term Effects of Endotracheal Suctioning in Post-Cardiac Arrest Patients. Graduate thesis in Medicine, Programme of Professional Study. Norwegian University of Science and Technology.
- Faraji, A., Khatony, A., Moradi, G., Abdi, A., & Rezaei, M. (2015). Open and Closed Endotracheal Suctioning and Arterial Blood Gas Values: A Single-Blind Crossover Randomized Clinical Trial. *Crit Care Res Pract*. 2015;2015:470842. doi: 10.1155/2015/470842. Epub 2015 Sep 3. PMID: 26425366; PMCID: PMC4573878.
- Fatin, M. N. A., & Pasha, E. Y. M. (2021). Potensi Interaksi Obat Dengan Obat Pada Pasien Dewasa Dengan Pneumonia. *Journal of Pharmacopolium*, 4(2), 98-104.
- Firmansyah, M.A., Amin, Z., Loho, T., dan Shatri, H., 2015. Faktor-Faktor Prediktor Mortalitas Community-Acquired Pneumonia dalam Perawatan Inap di Rumah Sakit Cipto Mangunkusumo, Jakarta. *Indonesia Journal of CHEST Critical and Emergency Medicine*, 2: 45-53.
- Hafifah, I.R.F.R. & Hakim, L. (2021). Studi kasus: evaluasi status hemodinamik pasien dengan ventilator mekanik pasca mobilisasi harian (supinasi-lateral) di ruang ICU RSUD Ulin Banjarmasin. *Faletehan Health Journal*, 8(01), 51-57.
- Hidayati, A.F., Akbar, M.I.D., & Rosyid, A.N. (2018). *Gawat Darurat Medis dan Bedah*. Surabaya: Airlangga University Press.
- Jahromi, F.F., Mahdood, B., Shaaafi, M.S., & Ramezanli, H. (2022). Investigating The Effect of The Duration of Hyperoxygenation before Endotracheal Tube Suction on Heart and Arterial Blood Oxygen Saturation of Patients Hospitalized in The Intensive Care Unit. *Int J Med Invest*, 11(3), 89-96.
- Kementerian Kesehatan Republik Indonesia. (2018). Hasil Riset Kesehatan Dasar (Riskesdas) 2018. Jakarta: Badan Penelitian dan Pengembangan Kesehatan Kementerian Republik Indonesia.
- Kollef, M. H., et al. (2021). The epidemiology of ventilator-associated pneumonia and the role of multi-drug-resistant pathogens. *Current Infectious Disease Reports*, 23(2), 15-25.
- LeWine, H.E. (2024). Memahami respon stress, aktivitas kronis mekanisme bertahan hidup ini mengganggu kesehatan. Harvard Health Publishing.
- Maggiore, S.M., Lellouche, F., Pignataro, C., Girou, E., Maitre, B., Richard, J.C., Lemaire, F., Brun-Buisson, C., & Brochard, L. (2013). Decreasing the adverse effects of endotracheal suctioning during mechanical ventilation by changing practice. *Respir Care*, 58(10):1588-97. doi: 10.4187/respcare.02265.
- Mauri, T., Spinelli, E., Pavlovsky, B., Grieco, D.L., Ottaviani, I., Basile, M.C., Dalla, F.D., Corte., Pintaudi, G., Garofalo, E., Rundo, A., Volta, C.A., Pesenti, A., & Spadaro, S. (2021). Respiratory Drive in Patients with Sepsis and Septic Shock: Modulation by High-flow Nasal Cannula. *Anesthesiology*; 135:1066-75.
- Misirlioglu, M., Horoz, O.O., Yildizdas, D., Ekinci, F., Yontem, A., Menemencioglu, A., & Salva, G. (2021). The Effects of Endotracheal Suctioning on Hemodynamic Parameters and Tissue Oxygenation in Pediatric Intensive Care Unit. *J Pediatr Intensive Care*, 11(4):349-354. doi: 10.1055/s-0040-1721725. PMID: 36388067; PMCID: PMC9649295.
- Mohammed, H.M. (2025). Effects of Hyperoxygenation Techniques on Arterial Blood Gases and Hemodynamic Status after Endotracheal Suctioning. *Rawal Medical Journal*, 50(2), 605-609.
- Nyoman, P. & Bagus, S. (2017). Pneumonia Atipikal. *Sari Pediatri*, 9(2), 138-144.
- Oktarisa, A. (2019) Penerapan Hiperoksigenasi sebagai Evidence Based Nursing Untuk Meningkatkan Saturasi Oksigen Pada Pasien Yang Terpasang Endotracheal Tube, *Riset Media Keperawatan*, 2(2), 10-14.
- Perl, S., Niederl, E., Kos, C., Mrak, P., Ederer, H., Rakovac, I., Beck, P., Kraler, E., Stoff, I., Klima, G., Pieske, B.M., Pieber, T.R., Zweiker, R. (2016). Randomized Evaluation of the Effectiveness of

- a Structured Educational Program for Patients with Essential Hypertension. *Am J Hypertens*, 29(7):866-72. doi: 10.1093/ajh/hpv186. PMID: 26643687.
- Pinsky, M. R., Cecconi, M., Chew, M. S., Backer, D. De, Douglas, I., Edwards, M., Hamzaoui, O., Hernandez, G., Martin, G., Monnet, X., Saugel, B., Scheeren, T. W. L., Teboul, J. L., & Vincent, J. L. (2022). Effective hemodynamic monitoring. *Critical Care*, 1 - 10. <https://doi.org/10.1186/s13054-022-04173-z>.
- Rass, V., Ianosi, B.A., Lindner, A., Kofler, M., Schiefecker, A.J., Pfausler, B., Beer, R., Schmutzhard, E., & Helbok, R. (2020). Hemodynamic response during endotracheal suctioning predicts awakening and functional outcome in subarachnoid hemorrhage patients. *Crit Care*, 24(1):432. doi: 10.1186/s13054-020-03089-w. PMID: 32665009; PMCID: PMC7362501.
- Salsabila, A., Windiarti, S. E., & Arwani, A. (2025). Toonatric on Reducing Systolic Blood Pressure in Elderly Hypertension Patients. *Jurnal Riset Kesehatan*, 14(1), 61 - 66. <https://doi.org/10.31983/jrk.v14i1.12392>.
- Siebenmann, C. & Lundby, C. (2015). Regulation of cardiac output in hypoxia. *Scand J Med Sci Sports. Suppl* 4:53-9. doi: 10.1111/sms.12619. PMID: 26589118.
- Spear, L. (2022). Neonatal/Pediatric Endotracheal Suctioning, Endotracheal suctioning is one of the most commonly performed NICU/PICU interventions but the practice requires special care for neonatal and pediatric airways. *Clinical, ICU & Ventilation, Neonatal, Pediatric Care, Therapy Devices*.
- Ulya, S.R., Nurhidayah, I., & Jufrizal. (2024). Asuhan Keperawatan Acute Respiratory Failure Et Causa Pneumonia di Intensive Care Unit: Studi Kasus. *Jurnal Gawat Darurat*, 6(1), 21-38.
- Urden, L.D., Stacy, K.M., & Lough, M.E. (2022). *Critical Care Nursing Diagnosis and Management* (9th ed.). St. Louis: Elsevier.
- Wu, D., Wu, C., Zhang, S., & Zhong, Y. (2019). Risk Factors of Ventilator-Associated Pneumonia in Critically Ill Patients. *Frontiers in Pharmacology*, 10(May), 1 - 7. <https://doi.org/10.3389/fphar.2019.00482>