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COMPARISON OF THE EFFECTIVENESS OF TWO LEVELS OF SUCTION PRESSURE ON OXYGEN SATURATION IN ARDS PATIENTS

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ABSTRACT

Patients in the Intensive Care Unit (ICU) often require mechanical ventilators, necessitating close monitoring and care, including regular evaluations of oxygen saturation levels. Suction procedures are conducted in the ICU to maintain airway patency, reduce sputum retention, and prevent pulmonary infections. The effectiveness of suction procedures can vary based on the suction pressure applied, which may impact patient outcomes differently. The purpose of this study was to determine the effectiveness of suction action with pressures of 130 mmHg and 140 mmHg on increasing oxygen saturation in ARDS patients with mechanical ventilation in the ICU. The research employed a quantitative approach using a quasi-experimental pre-post design with a control group. A sample of 30 ICU patients was divided into two groups: one group of 15 patients received suctioning at a pressure of 130 mmHg, while the other group of 15 received suctioning at 140 mmHg. Oxygen saturation levels were measured using pulse oximetry before and after the suction intervention. The procedures were conducted in accordance with the hospital's Standard Operating Procedure (SOP). Data were analyzed univariate and bivariate using the T-test. There was a significant increase in oxygen saturation after suctioning with both pressures. For the 130 mmHg group, the average increase in oxygen saturation was 5.933 with a P-value of 0.000. For the 140 mmHg group, the average increase was 6.400 with a P-value of 0.000. However, there was no statistically significant difference between the two suction pressures in terms of the overall increase in oxygen saturation, with a P-value of 0.567. Both 130 mmHg and 140 mmHg suction pressures were effective in improving oxygen saturation in ARDS patients on mechanical ventilation in the ICU. Hospitals should ensure structured and consistent monitoring of suction procedures in accordance with hospital SOPs to optimize patient outcomes.

Keywords: ARDS; mechanical ventilator; oxygen saturation; suctioning

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INTRODUCTION

Acute Respiratory Distress Syndrome (ARDS) is a non-cardiogenic pulmonary edema caused by several risk factors and is an emergency case (Masikome et al., 2021). ARDS is a manifestation of acute lung injury, usually due to sepsis, trauma, and severe lung infection. Clinically, it is characterized by dyspnea, hypoxemia, decreased lung function which can lead to respiratory acidosis resulting in impaired gas exchange, and bilateral diffuse infiltrates on chest radiographs or excessive secretion build-up resulting in ineffective airway clearance (Chiumello & Brioni, 2016). Acute respiratory failure is often caused by lung infection, the most common infection being pneumonia.. *World Health Organization* (2019) suggests that pneumonia is the biggest cause of death in the world with around 922,000 deaths per year. *Centers for Disease Control and Prevention* (CDC) states mortality data in the United States during 2019 showed that there were 56,979 deaths associated with pneumonia and 149,205 cases of deaths caused by lower respiratory tract diseases. (Nicholson et al., 2020).

ARDS can occur at any age, but is more common in adult and female patients. In the United States, the incidence of ARDS in pediatric patients is recorded as 9.5 cases per 100,000 population per year, 16 cases per 100,000 population per year at the age of 15-19 years and 306 cases per 100,000 population per year at the age of 75-84 years. Based on data from The American-European Consensus if respiratory failure cases amounted to 12.6-28.0 cases per 100,000 population/year and the mortality rate due to respiratory failure was reported to be around 40% (Marlisa et al., 2016). The prevalence of respiratory failure in other countries such as Brazil found 843 people (49%) were hospitalized in the ICU room due to acute respiratory failure and 141 people experienced respiratory failure after being treated in the ICU and 475 people died after being discharged from the ICU (Deli et al., 2017). This is in line with research conducted in Germany and Sweden on respiratory failure, namely the incidence of respiratory failure that occurs in adults is around 86.8 cases per year. Whereas in Germany, the incidence of acute respiratory failure is 77.6-88.6 cases per 100,000 population per year with a mortality rate of 40% (Akoumianaki et al., 2016). Based on data on the most fatal causes of death based on the Case Fatality Rate (CFR) in hospital inpatients in 2017, the incidence of respiratory failure ranked second at 20.98%. Epidemiology of ARDS in Indonesia is 10.4% of the total ICU patients (Kemenkes RI, 2019).

Data obtained from the ICU patient registration book of Duren Sawit Hospital 2022 total patients admitted to the ICU were 462 patients and experienced respiratory failure as many as 323 patients (69.9%). Whereas in 2023 the total number of patients admitted to the ICU was 668 patients and experienced respiratory failure as many as 415 patients (62.1%). There was an increase in the number of patients with respiratory failure although not significantly (Rekam Medik RSKUD Duren Sawit, 2024). Factors that can cause respiratory failure are ineffective airway clearance. The treatment for ineffective airway clearance due to accumulated secretions is to perform*suctioning* by inserting a *suction* catheter through the nose/mouth/ *Endotracheal Tube* (ET). *Suctioning* is a method to release excessive secretions in the airway. *Suctioning* can be applied to oral, nasopharyngeal, *tracheal*, and endotracheal or *tracheostomy tubes*. The aim is to free the airway, reduce sputum retention and prevent pulmonary infection. In general, patients with an ETT have a poor body response to remove foreign bodies, so*suction* is necessary (Potter & Perry, 2015).

There are two methods of *suction* : open and closed *suction*, both of which are safe and can be used, although closed *suction* is more recommended (Özden & Görgülü, 2015). Based on the literature, there are variations in the use of negative pressure in *suctioning.* The recommended negative pressure used for adult patients is 100-150 mmHg with a duration of 7-15 seconds and a *suction* catheter size of 12 Fr and 14 Fr. 4-8 and some mention 200 mmHg (Yousefi et al., 2014). A pressure of 100 mmHg is the minimum recommended negative pressure for *suction* but *suction* pressure is set based on the amount of secretions in the airway, if 100 mmHg pressure cannot mobilize secretions then the pressure can be increased to a maximum of 150 mmHg. Pressures exceeding 150 mmHg can cause airway trauma and hypoxia (Potter & Perry, 2015).

Higher pressure can maximize secretion and increase oxygen saturation, but on the one hand, high pressure can reduce oxygen saturation, trauma, hypoxemia, bronchospasm and anxiety (Lesmana, 2019). Inappropriately applied pressure can affect changes in arterial oxygen saturation (SaO_2). Sub-ideal ETT *cuff* expansion will lead to sub-optimal SaO_2 due to oxygen leakage through the ETT which will cause a reduction in tidal volume (Butterworth et al., 2018). Inappropriately applied pressure can affect changes in arterial oxygen saturation (SaO2). Sub-ideal ETT *cuff* expansion will lead to sub-optimal $_{SaO2}$ due to oxygen leakage through the ETT which will cause a reduction in tidal volume (Butterworth et al., 2018). This condition can be fatal including decreased oxygen saturation, cardiac dysrhythmias, hypotension, and even cause increased intracranial pressure (Hudak & Gallo, 2014). Regulating the use of *suction* pressure and providing hyperoxygenation before *suctioning* can minimize the side effects that occur. There is a paucity of literature or research that examines *suction* pressures that are effective in maintaining adequate oxygen saturation for patients admitted to the intensive care unit. From some literature and research, the negative pressure that is widely recommended in *suction* is 100 mmHg, 120 mmHg and a maximum of 150 mmHg, so research is needed to find out the most effective pressure to improve oxygen saturation (Lesmana, 2019).

Appropriate suction can minimize complications. Various studies related to the effect of suctioning have previously discussed the type of negative pressure varying from 100, 120, 150, 200 mmHg and the length of suction 10-15 seconds with different viewpoints. Another study conducted by Subhan (2019) involving 28 patients attached to the ventilator showed a difference in SPO_2 given a pressure of 120 mmHg and 150 mmHg with a significance level of p = 0.000. The suction pressure that proved more effective was 150 mmHg pressure compared to 120 mmHg pressure. The higher the *suction* pressure, the higher the *suction* power of secretions in the airway. This is because a clean airway will increase oxygen saturation (Muhaji et al., 2017). Suparti's research shows that negative pressure of 25 kPa or 180 mmHg is more effective in removing secretions in the airway and allows an increase in oxygen saturation after *suction* in patients with ventilators compared to pressure of 20 kPa or 150 mmHg (Suparti, 2019).

Given the importance of the implementation of mucus suctioning measures so that cases of respiratory failure in patients with mechanical ventilators that can cause death can be prevented, it is very necessary to monitor$_{O2}$ saturation levels appropriately. In this study, the authors used pressures of 130 mmHg and 140 mmHg during *suctioning*. The reason for using these pressure values is that the author wants to know the effectiveness at pressures of 130 mmHg and 140 mmHg where these values are in accordance with the settings commonly used in the room, and based on standard operating procedures (SPO) that apply in the ICU at Duren Sawit Hospital. This study aims to determine the effectiveness of *suction* action with pressures of 130 mmHg and 140 mmHg on increasing oxygen saturation in ARDS patients with mechanical ventilation in the ICU at Duren Sawit Hospital Jakarta.

METHOD

The study was conducted in the ICU of Duren Sawit Hospital in December 2023-January 2024. Quasi experiment research using two group pretest- posttest design. The study sample was ICU patients who met the inclusion and exclusion criteria. Inclusion criteria are adult patients> 18 years, patients admitted to the ICU room who are installed endotrecheal tube size number 7.0 mm, diagnosed with ARDS, patients who do not use opium analgesic drugs (morphine) or opium sedation (morphine). Exclusion criteria in this study were patients who did not get consent from the family, patients who were being performed cardiopulmonary resuscitation (CPR), using CPAP ventilators and patients with unstable hemodynamic status. The sample was 15 patients with suction pressure of 120 mmHg and 15 patients with suction pressure of 130 mmHg. Data collection through primary data through measurement of oxygen saturation using Fingertrip Pulse Oximeter. Data analysis was carried out univariate and bivariate with a two-group mean difference test. The researcher guarantees that the study is conducted in accordance with ethical principles by ensuring the confidentiality of respondent data and using the data obtained only for this study. Data were analyzed univariate and bivariate using the T-test. Before bivariate analysis, descriptive and analytical data normality tests were carried out using the Kolmogrov Smirnov test, and the results of the normality assumption test were met. Dependent t test to determine the difference in oxygen saturation before and after in each group. An independent t-test was conducted to compare the mean difference in changes in oxygen saturation between the intervention pressure 130 mmHg and pressure 140 mmHg. This study has received ethical clearance from the ethics committee of RSKD Duren Sawit with ethics permit number 007-LE/KEPK/RSKDDS/2024.

RESULT

The results showed that of the 30 respondents, the majority were late elderly (56-65 years old), namely 9 (30%) respondents, male 21 (70%) respondents, with a length of stay <7 days, namely 29 (96.7%) respondents (Table 1).

Table 1.
Frequency Distribution of Patient Characteristics in ICU (n=30)

Respondent Characteristics	f	%
Age		
Early Adult (26-35 Years)	3	10.0
Late Adult (36-45 Years)	2	6.7
Early Elderly (46-55 Years)	8	26.7
Late Elderly (56-65 Years)	9	30.0
Elderly (> 65 Years)	8	26.7
Gender		
Male	21	70.0
Female	9	30.0
Length of Stay		
1-7 days	29	96.7
>7 days	1	3.3

In the 130 mmHg pressure suction intervention group, the average O_2 saturation before intervention was 91.8% with a median of 91 and a standard deviation of 2.305. The lowest O_2 saturation value was 88% and the highest was 96%. After the intervention, the mean O_2 saturation was 97.73% with a median of 98 and a standard deviation of 1.554. The lowest O_2 saturation value was 95% and the highest was 100%. While the 140 mmHg pressure suction intervention group obtained an average O_2 saturation before intervention of 91.87% with a median of 92 and a standard deviation of 2.973. The lowest O_2 saturation value was 84% and the highest was 97%. After the intervention, the mean O_2 saturation was 97.87% with a median of 98 and a standard deviation of 2.668. The lowest O_2 saturation value was 94% and the highest was 100% (Table 2).

Table 2.
Overview of Oxygen Saturation Before and After Intervention in ICU (n=30)

Group		Mean	Median	Standard Deviasi	Min-Max
Pressure 130 mmHg	Before	91.80	91.00	2.305	88-96
	After	97.73	98.00	1.554	95-100
Pressure 140 mmHg	Before	91.87	92.00	2.973	84-97
	After	98.27	98.00	1.668	94-100

The average O_2 saturation in the intervention group giving 130 mmHg pressure suction before was 91.80 and after was 97.73 with an average increase of 5.933. The results of the

Dependent T test obtained P value (0.000) < (0.05) andtcount (14.983) > ttable (2.131) then Ho is rejected meaning there is a difference in O_2 saturation before and after 130 mmHg pressure suction intervention. While the average O_2 saturation in the intervention group giving 140 mmHg pressure suction before was 91.87 and after was 97.80 with an average increase of 6.933. The results of the Dependent T test obtained P value (0.000) < (0.05) andtcount (9.112) > ttable (2.131) then Ho is rejected, meaning that there is a difference inO2 saturation before and after the 140 mmHg pressure suction intervention (Table 3).

Table 3.
Effectiveness of Suction on Oxygen Saturation in ARDS patients in ICU (n=30)

Group		Mean	Average Decrease	T -Test	P *Value*
Pressure 130 mmHg	Before	91.80	5.933	14.983	0,000
	After	97.73			
Pressure 140 mmHg	Before	91.87	6.400	9.112	0,000
	After	98.27			

The average increase in oxygen saturation at 130 mmHg pressure suction is 5.933 with a standard deviation of 1.533 while the increase in oxygen saturation at 140 mmHg pressure is 6.400 with a standard deviation of 2.720. The results of statistical analysis with the Independent T test showed a p value = 0.567 (>alpha 5%), then Ho is accepted which means there is no difference in the average increase in O_2 saturation in the 130 mmHg pressure suction intervention with 140 mmHg pressure (Table 4).

Table 4
Differences in the increase in saturation in ICU patients at Duren Sawit Hospital after receiving interventions Suction 130 mmHg and 140 mmHg

Group	T Test- Independen				
	n	Mean Decrease	Standard Deviasi	T Test	P Value
Pressure 130 mmHg	15	5.933	1.533	0.579	0,567
Pressure 140 mmHg	15	6.400	2,720		

DISCUSSION

The results of the analysis found that the average O_2 saturation in the intervention group giving suction pressure 130 mmHg increased significantly. In line with other research conducted by Subhan involving 28 patients attached to the ventilator showed a difference in SPO_2 which was given a pressure of 120 mmHg with a significance level of p = 0.000 (Subhan, 2019). Gunawan's research with the average results of oxygen saturation in patients with respiratory failure before suction action with a pressure of 100-150 mmHg was 90.91 and after was 97.48 with Pvalue = 0.002 which means there is a difference in saturation before and after suction action 100-150 mmHg (Gunawan, 2019).

Negative pressure regulation of effective suction is needed by patients admitted to critical care, especially in patients with head injuries, because in intensive care the procedure is a routine treatment and head injury patients need sufficient oxygen saturation to prevent secondary injuries due to hypoxia and increased intracranial pressure. Suction should pay attention to the amount of mucus and oxygen saturation after hyperoxygenation, if the patient's oxygen saturation is <95% after hyperoxygenation, a pressure of 100 mmHg can be considered, but if the amount of mucus is large and after hyperoxygenation the patient's oxygenation is >95%, suction pressure of 120 mmHg and 150 mmHg can be used.

The researcher assumed that the pressure of 130 mmHg in this study was effective in increasing oxygen saturation because the pressure was in accordance with recommendations and standard operating procedures (SPO). Respondents need adequate oxygen saturation to prevent secondary injuries due to hypoxia and increased intracranial pressure. With suction, the airway is cleared of secretions, which will result in the transfer of O_2 from the atmosphere into the lungs will become more effective, so that saturation increases.

The results of the O_2 saturation analysis in the intervention group giving 140 mmHg pressure suction increased significantly. These results are in line with other studies conducted by Subhan involving 28 patients attached to the ventilator which showed a difference in SPO_2 given a pressure of 150 mmHg with a significance level of p = 0.000 (Subhan, 2019). Muhaji, et al in his research explained about Comparison of the effectiveness of two levels of suction pressure on oxygen saturation in patients with endotracheal tubes, where there is a statistically significant effect ofsuction using 130 mmHg pressure and 140 mmHg pressure on SpO_2 in patients with ETT with a p-value <0.005. Based on this study, it can be concluded that there is a difference between suction with 130 mmHg pressure and 140 mmHg pressure with a p-value of 0.004 (<0.005). The average difference in SpO2 between the two is 13.157 (Muhaji et al., 2017). SpO2 experienced increased by taking action suction. This is due to the freeing the airway from accumulation of secret which making transfer of oxygen into the lung to be effective. Performed suction with a semifowler position which aiming to facilitatet action suction in the endotrachea and provide an comfort to both the patient and nurses who perform (Yogasara et al., 2023).

The higher the suction pressure, the higher the suction power of secretions in the airway. This is because a clean airway will increase oxygen saturation (Muhaji et al., 2017). Negative pressure of 25 kPa is more effective in removing airway secretions and may improve oxygen saturation after suction in ventilated patients compared to 20 kPa. he conclusion of this study shows that negative pressure of 25 kPa is more effective in removing secretions in the airway and allows increasing oxygen saturation after suction in patients with ventilators compared to 20 kPa pressure (Suparti, 2019). The literature or research examining effective suction pressures in maintaining adequate oxygen saturation for patients admitted to intensive care is heavy. From several literatures and studies, the recommended negative pressure in suction is 100 mmHg, 120 mmHg and maximum 150 mmHg (Lesmana, 2019). In order for suction to not harm the patient, suction must be in accordance with the fixed procedures in the hospital. In addition, during the procedure, we must monitor the patient's condition such as shortness of breath or changes in oxygen saturation as a sign that suction is endangering the patient.

Researchers assumed that giving 140 mmHg pressure in this study was effective in increasing oxygen saturation because the pressure was in accordance with recommendations and SPO. Researchers assume that giving 140 mmHg is more effective in sucking mucus so that the secret is sucked more optimally so that airway clearance is maximized. This condition has an impact on increasing oxygen saturation. Higher saturation at 140 mmHg can result from almost complete airway clearance with this level of suction pressure.

The results showed that the average increase in oxygen saturation at 130 mmHg pressure suction was 5.933 with a standard deviation of 1.533 while the increase in oxygen saturation at 140 mmHg pressure was 6.400 with a standard deviation of 2.720. However, the statistical test results showed no difference in the average increase in O_2 saturation in the 130 mmHg pressure suction intervention with 140 mmHg pressure. These results indicate that both suction pressures have an impact on increasing oxygen saturation, but the provision of 140 mmHg pressure increases saturation better (more effective) than 130 mmHg pressure although statistically not significant. In line with the results of Suparti's research, 25 kPa negative pressure is more effective in removing secretions in the airway and allows an increase in oxygen saturation after suction in patients with ventilators compared to 20 kPa pressure (Suparti, 2019). Lesmana's study involving 28 patients attached to the ventilator showed a difference in SPO_2 given a pressure of 120 mmHg and 150 mmHg with a significance level of p=0.000. The suction pressure that proved more effective was 150 mmHg pressure compared to 120 mmHg pressure (Lesmana, 2019). Muhaji's research showed that patients who used 140 mmHg suction pressure had a higher average oxygen saturation than 130 mmHg suction pressure (Muhaji et al., 2017).

Higher pressure can maximize secretion and increase oxygen saturation, but on the one hand, high pressure can reduce oxygen saturation, trauma, hypoxemia, bronchospasm and anxiety (Lesmana, 2019). The higher the suction pressure, the higher the suction power of the secret in the airway. This is because a clean airway will increase oxygen saturation (Muhaji et al., 2017). Although there was no significant increase in saturation between the two interventions, the results of this study support the concept that higher negative pressure (140 mmHg) suction is effective in clearing secretions and a lower increase in oxygen saturation than lower pressure (130 mmHg). However, when comparing the pre-posttest difference between the two groups, the mean value has not reached a significant value. The researcher assumed that with high pressure, the removal of secret is maximized so that airway clearance is maximized. This condition has an impact on increasing oxygen saturation.

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CONCLUSION

Both 130 mmHg and 140 mmHg suction interventions are effective in increasing oxygen saturation in ARDS patients in the ICU. However, the decrease of both interventions did not show a significant difference even though 140 mmHg pressure obtained greater results in increasing oxygen saturation.

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