

The Effect of Lateral Position with Head Up 45° on Oxygenation in Pleural Effusion Patients

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Abstract

Background: The accumulation of fluid in the pleural cavity will interfere with the restriction process, namely disruption of lung expansion so that the air entering the lungs is less than normal. One of the effects is shortness of breath and a decrease in oxygen saturation. In this case, nursing actions play an important role in inadequate ventilation, namely positioning. The lateral position is one of the recommended positions for patients with unilateral lung disease, one of which is unilateral pleural effusion. Position selection is very important to facilitate adequate breathing, namely one with a head-up of 45°. According to some literature, the 45° head-up position can reduce consumption and maximize lung expansion which will result in greater ventilation.

Purpose: To determine the effect of the lateral position with a head-up 45° on oxygen saturation and respiratory rate in a patient with unilateral pleural effusion at the Dr. H. A. Rotinsulu Lung Hospital Bandung.

Methods: The research design was a quasi-experimental design with one group pre and post-test design with a sample of 44 people. The sampling technique used consecutive sampling. The results showed that there were differences in median oxygen saturation and respiratory rate before and after the intervention.

Results: The results of a comparative study using the Wilcoxon test obtained a p value of 0.0001 (p value < 0.05). There is an effect of giving a lateral position with a head-up 45° on increasing oxygen saturation and decreasing respiratory rate.

Conclusion: Thus, it is expected for the service unit to establish a lateral position in the direction of the effusion with a head-up of 45° as the operational standard for the management of unilateral pleural effusion impaired oxygenation patients.

Keywords: gas exchange; lateral positioning; pleural effusion; unilateral lung disease.

Introduction

Pleural effusion is a condition in which there is an abnormal accumulation of pleural fluid. This is due to the formation of pleural fluid which is faster than the absorption process. The accumulation of fluid in the pleural cavity will cause disturbances in the ventilation process, namely restriction, where there is a disruption in lung development so that the air entering the lungs is less than normal. The impact of this is the presence of shortness of breath, decreased PaO₂, increased PaCO₂, and decreased oxygen saturation (Havelock, Teoh, Laws, & Glesson, 2010). Given these conditions, appropriate nursing interventions are needed. There are several nursing actions in overcoming respiratory problems in pleural effusions, namely assessment in the form of monitoring the patient's respiratory status which includes respiratory frequency, auscultation of lung sounds, monitoring of mental status, dyspnea, cyanosis, oxygen saturation, positioning, and collaborative action, namely giving oxygen therapy (Suryantoro, Isworo,

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& Upoyo, 2017). However, positioning is the most appropriate nursing intervention because it can facilitate the problem of oxygenation disorders, that is improving the ventilation process so that it can increase lung expansion to reduce tightness experienced by patients (Dean, 2014).

The position most often used by patients with unilateral pleural effusions is the lateral position directly affected by the effusion. This is evidenced by research conducted by Remolina, Khan, and Edelman (2014) that the partial pressure of O₂ (PaO₂) and optimal gas exchange occurs when the patient is positioned laterally with the healthy lung at the top. This position will produce maximum gas exchange. The lateral position is one of the positions recommended for patients with unilateral lung disease. One of the lateral positions aims to improve gas exchange in conditions of pulmonary complications. The lateral position is also often used in cases of unilateral lung damage (Bein et al., 2015). This reclining side or lateral position can be used to increase the efficiency of gas exchange, thereby avoiding the use of additional oxygen. According to Kozier, Erb, Berman, and Synder (2011) choosing a position for sufferers with respiratory problems is very important to facilitate adequate breathing, one of which is a head-up 45°. This is evidenced by research conducted by Rustandi, Fatimah, and Mulyati (2014) on the effect of positioning on tidal volume, data were obtained on the position head-up 45° which can increase tidal volume. The increase in tidal volume will cause an increase in oxygenation, where the increase in oxygenation will cause the requirement minute volume for oxygen to be quickly fulfilled so that the respiratory rate tends to decrease (Shah, Desai, & Gohil, 2013).

The head-up 45° uses gravity to help expand the chest and reduce pressure on the abdomen and diaphragm. When gravity occurs, it will pull the diaphragm down, reducing pressure to the diaphragm and relieving chest compressions so that chest expansion and pulmonary ventilation are greater (Kozier, Erb, Berman, & Synder, 2011). This is proven by other studies conducted by Safitri and Andriyani (2014), that the 45° semi-fowler position is effective in reducing shortness of breath in asthma patients. When the lung expansion becomes maximal, it will increase oxygen in the lungs so

that oxygenation disturbances in pleural effusions such as a decrease in PaO₂ which has an impact on decreasing oxygen saturation can improve (increase). When PaO₂ increases, it will increase the affinity of Hb for oxygen and a decrease in the amount of CO₂ will also increase the affinity of Hb for oxygen and vice versa, so that SaO₂ will also increase (Kozier, Erb, Berman, & Synder, 2011).

Monitoring gas exchange can be done in several ways, namely invasive monitoring and non-invasive monitoring. Because monitoring gas exchange can be done non-invasively, in this research, the author will monitor gas exchange in a non-invasive way by using pulse oximetry, considering that pulse oximetry is a tool that has few side effects, does not require calibration, is easy to use, accurate, simple, non-invasive, and inexpensive (Imak & Tinni, 2017). Considering that pleural effusion can increase the volume in the pleural cavity which results in decreased pleural pressure and has an impact on respiratory system disorders, namely impaired lung development, it is necessary to provide the right position to increase lung expansion. According to a literature review, a lateral position with the head-up 45° maximizes the expansion of the lung so it can increase oxygen saturation and respiratory rate.

The purpose of this study was to determine the effect of the lateral position with a head-up 45° on oxygen saturation and respiratory rate in unilateral pleural effusion patients at the Dr. H. A. Rotinsulu Lung Hospital Bandung.

Methods

The research design was a quasi-experimental design with one group pre and post-test design where the variables to be measured are oxygen saturation and the respiratory rate which are included in the dependent variable. The independent variable in this study is the lateral position with a head-up of 45°. The sampling technique used a consecutive sampling technique with a sample size of 44 respondents. The inclusion criteria in this study were patients with unilateral pleural effusion as evidenced by the results of an X-ray or physical examination by a doctor, the position used was a lateral position with head-up below 45°, nasal cannula oxygen was installed, while the exclusion criteria in this study

Table 1. Characteristics of Respondents (n = 44)

Characteristics of Respondents	Result
Location of Pleural Effusion n (%)	
Right pleural effusion	25 (56.8%)
Left pleural effusion	19 (43.2%)
Oxygen saturation before intervention	Median 94.00 (min-max 93–95)
Oxygen saturation after given intervention	Median 96.00 (min-max 94–98)
Respiration rate before intervention	Median 24.00 (min-max 23–24)
Respiration rate after intervention	Median 22.00 (min-max 20–24)

Table 2. Frequency Distribution of Cross-Tabulation of Pleural Effusion Locations by Gender

Pleural effusion location	Gender				Total	
	Female		Male		n	%
	n	%	n	%		
Extra pleural effusion	12	27.3	13	29.5	25	56.8
Left pleural effusion	3	6.8	16	36.4	19	43.2
Total	15	34.1	29	65.9	44	100

Table 3. The Frequency Distribution of Cross-Tabulation of Pleural Effusion Locations with Age

Location of pleural effusion	Gender				Total	
	<40 years		> 40 years		n	%
	n	%	n	%		
Extra pleural effusion	10	27.7	15	34.1	25	56.8
Left pleural effusion	6	13.6	13	29.5	19	43.2
Total	16	36.4	28	63.6	44	100

Table 4. Effect of Giving a Lateral Position with A Head-Up of 45° on Oxygen Saturation and Respiratory Rate

Variable	Mean Rank	Sum of Ranks	Z	P
Oxygen Saturation Before-after the intervention	Negative ranks 0.00	990.00	-	0.0001
	Positive ranks 22.50		5.883	
Breath Frequency Before-after intervention	Negative ranks 21.50	903.00	-	0.0001
	Positive ranks 0.00		5.808	

Table 5. Distribution of Increased Oxygen Saturation and Decreased Breath Frequency Before and After Intervention

Variable	Right pleural effusion			Left pleural effusion		
	Before Median Min-max	After Median Min-max	▲ median	Prior Median Min-max	After Median Min-max	▲ median
Oxygen Saturation	94.00 93-95	95.00 94-97	1	94.00 93-95	97.00 94-98	3
Respiratory rate	24.00 23-24	22.00 21-24	-2	24.00 23-24	22.00 20-23	-2

were respiratory rate > 25x/m and the presence of cervical trauma.

This research was conducted at the Dr. H. A. Rotinsulu Lung Hospital Bandung from April 10, 2019 to May 8, 2019. Ethical considerations in the study were the researcher explanation about the objectives, benefits, and research procedures of unilateral pleural effusion patients, and respondents who were willing to become research respondents were asked to fill out an informed consent form. In performing the study, researchers conform and consider the ethical principles of research including respecting the privacy and confidentiality of respondents, providing fair treatment, and taking into account the benefits and losses incurred, paying attention to each respondent. This research was reviewed and approved by the Health Research Ethics Commission, Faculty of Medicine, Universitas Padjadjaran, No: 231/UN6.KEP/EC/2019.

In this study, data collection was adjusted to the

research protocol of giving a lateral position with a head-up of 45°. The head-up 45° is measured using the angle level. Oxygen saturation is measured using pulse oximetry with the brand Choicemmed type Md300c20 and respiratory rate is measured by calculating the frequency of breaths for 1 minute by the first author.

Data analysis used descriptive analysis (frequency, percentage, median, minimum value, and maximum value) and inferential analysis (Wilcoxon test) with a significance <0.05 which was processed using SPSS version 21 software. The Wilcoxon test was used because when the data normality test was carried out, all data were not normally distributed (p value< 0.05).

Results

Table 1 shows that some of the respondent's pleural effusion locations were left pleural effusions, the

median of oxygen saturation before intervention was 94.00 (min-max 93-95) and the median of oxygen saturation after the intervention was 96.00 (min-max. 94-98). In addition, the median of the respiratory rate before the intervention was 24.00 (min-max 23-24) and the median of the respiratory rate after the intervention was 22.00 (min-max 20-24).

Cross tabulation of pleural effusion location with gender

Based on [table 2](#), it is shown that 12 (27.3%) were female and 13 (29.5%) were male. In the left pleural effusion, there were 3 women (6.8%) and 16 men (36.4%).

Cross-tabulation of locations with age-based

From pleural effusion on [table 3](#), 10 people (22.7%) of the left pleural effusions were less than 40 years old and 15 people (34.1%) were over the age of 40 years old. In the left pleural effusion, there were 6 people aged less than 40 years (13.6%) and 13 people aged over 40 years old (29.5%).

Discussion

Based on the results of the study by [table 1](#), there were respondents who experienced oxygenation disturbances before intervention, namely oxygen saturation below normal values and breathing frequencies above normal values, where the median of oxygen saturation before intervention was 94.00 and the median of the respiratory rate before the intervention was 24.00. This shows that there are respondents who experienced oxygenation disorders, namely oxygen saturation below normal values, where the normal value of oxygen saturation is 95-100% ([Suryantoro, Isworo, & Upoyo, 2017](#)). In addition, another disturbance of oxygenation is an increase in respiratory rate, where the normal value of the respiratory rate is 12-15 x / minute ([Kozier, Erb, Berman, & Synder, 2011](#)). This can occur because pleural effusion patients experience interference with the ventilation process due to a buildup of fluid in the pleural cavity. Ventilation is the process of leaving and entering air into the lungs. The ventilation disturbance that occurs in pleural effusion patients is a restriction, where there is a disruption in lung expansion so that the air entering the lungs is less than normal. As a result, in pleural effusion patients it can be observed that there is an increase in breath effort through an increase in the frequency of breaths as compensation for the body to meet the demand oxygen in the body ([Suryantoro, Isworo, & Upoyo, 2017](#)).

Oxygen is the main body requirement of living things. All cell metabolism in the human body requires oxygen. Disorders of the respiratory system can directly result in reduced oxygen levels in the blood. This state of lack of oxygen in the blood is called hypoxia. Hypoxia can be observed clinically,

one of which is the increase in breath effort, where this condition can be detected by examining oxygen saturation ([Sherwood, 2018](#)). After being given the intervention with a lateral position of a head-up of 45° for 15 minutes, the median value of oxygen saturation has increased and the median value of the respiratory rate has decreased, where after being given the intervention, the median value of oxygen saturation is 96.00 and the median value of the respiratory rate is 22.00. This indicates that there is a change in the median oxygen saturation value and the median respiratory rate before and after the intervention. This can occur because giving a lateral position in the direction of the effusion in the pleural effusion can maximize lung expansion in a healthy lung, resulting in maximum gas exchange.

The research conducted by [Remolina, Khan, and Edelman \(2014\)](#) explains that lying in the direction affected by pleural effusion/lungs which experience pleural effusion is at a lower level when the lateral position results in optimal gas exchange and PaO₂ will be maximum. This is reinforced by research conducted by [Yeaw \(2013\)](#) that patients with unilateral lung damage experience a decrease in the frequency of breaths in the SDL (sick lung down) position or the position of the lungs that are damaged in unilateral lung disease at a lower level compared to the position HDL (health lung down) or a healthy lung position at a lower level. When the SDL (sick lung down) position is given to a patient with unilateral pleural effusion or in other words the healthy lung is above, this position can increase gas exchange in healthy lungs for cases of unilateral pleural effusion. However, when an unhealthy lung (submerged in fluid) depends/is above in a lateral position, it will cause an increase in blood flow to the infected lung area causing a physiological shift (ventilation-perfusion miss-matching) which then causes hypoxemia. This condition will trigger oxygen desaturation (the blood does not get enough oxygen) which will cause an increase in heart work ([Suryantoro, Isworo, & Upoyo, 2017](#)). The right position can also increase the relaxation of additional muscles so that it can reduce breathing effort /dyspnea, reduce oxygen consumption and maximal expansion and increase comfort. As a result, this position is effectively given to patients with shortness of breath ([Kozier, Erb, Berman, & Synder, 2011](#)).

A similar study was conducted by [Fiskasianita \(2014\)](#), comparing the lateral, supine, and fowler positions of the SaO₂ (oxygen saturation) and PaO₂. The result is that the lateral position with a head-up of 10-15° can increase oxygen saturation in patients with pleural effusions compared to supine and fowler positions which each intervention is carried out for 15 minutes. The results showed that the SaO₂ (oxygen saturation) and PaO₂ values were the highest in the lateral position. In this study, the SaO₂ data were obtained in supine position (94.30%), fowler position (96.40%), and lateral position (96.60%). The PaO₂ value in the

unknown sleeping position was 56.00 mmHg, the fowler position 89.50 mmHg, and the lateral position 90.30 mmHg. Thus, it can be concluded that the lateral position with a head-up 10-15° can increase oxygen saturation and PaO₂ optimally compared to the supine and fowler positions in unilateral pleural effusion patients. [Remolina, Khan, and Edelman \(2014\)](#) in their study stated that the detrimental effect of the lateral position with the diseased side of the lung depends (is on) on unilateral lung damage, which will result in a decrease in PaO₂. This is evidenced in the results of his research that there is a decrease in PaO₂ by an average of 2.3 mmHg from the lateral position on the healthy side above to the lateral position on the affected side above. The PaO₂ value in the lateral position with the diseased lung which is on higher level is lower than the PaO₂ value in the lateral position with the healthy lung position above in unilateral lung disease. Thus, O₂ partial pressure (PaO₂) and optimal gas exchange occur when the patient is positioned laterally with the healthy lung on top. Giving a head up of 45° can facilitate adequate breathing.

This is evidenced by research conducted by [Rustandi, Fatimah, and Mulyati \(2014\)](#) on the effect of positioning on tidal volume. Data obtained on the position stated that head-up 45° can increase tidal volume. The increase in tidal volume will cause an increase in oxygenation, where the increase in oxygenation will cause the required minute volume for oxygen to be quickly fulfilled so that the respiratory rate tends to decrease ([Shah, Desai, & Gohil, 2013](#)). Hence, it is hoped that the provision of a lateral position with a head-up of 45° can maximize lung expansion so that the respiratory rate decreases and oxygen saturation increases. Giving a lateral position with a head-up of 45° can also reduce tension in the abdominal muscles by gravitating the contents of the abdomen and the abdominal mass falling, thereby reducing pressure on the diaphragm and relieving chest compressions. At the time of inspiration, the pressure in the lungs is much lower than normal than the atmospheric pressure, which causes more air to be drawn into the lungs ([Jones & Bartlett, 2012](#)). This position will reduce damage to the alveolar membrane due to fluid accumulation in clients with pleural effusions. This is influenced by the force of gravity so that oxygen flow becomes optimal. The higher the position of the head than the pelvis, the greater the force of gravity ([Remolina, Khan, & Edelman, 2014](#)).

Increased Oxygen Saturation and Decreased Breath Frequency by Location of Pleural Effusion

The results showed that respondents who were diagnosed with left pleural effusions after the intervention experienced a greater increase in oxygen saturation than those with left pleural effusions. Likewise, with the frequency of breaths after the intervention, respondents who were diagnosed with left pleural effusions experienced a

greater decrease in respiratory rate than those with right pleural effusions. It can be seen in table 5 that the median oxygen saturation value after intervention in the right pleural effusion has increased by one and in the left pleural effusion by three. However, the variable frequency of breaths in the right pleural effusion and left pleural effusion has no difference in decreasing breath frequency after the intervention. This is not by the research conducted by [Katz, Nissim, Ariel, Yacov, and Esther-Lee \(2018\)](#) that the oxygen saturation in the left lateral position is lower than that of the right lateral. This occurs because the left lateral position has a less gas exchange effect than the right lateral position. This happens because of the left lung which is smaller than the right lung and the compressive effect of the heart and mediastinum in the left lateral position, thereby reducing the volume of the left lung when given the left lateral position.

When the volume of the left lung is reduced, the ventilation in the left lung is reduced so that the oxygen entering the left lung is less than optimal ([Kozier, Erb, Berman, & Synder, 2011](#)). However, in this study, left lateral pleural effusions given the left lateral position had an increase in oxygen saturation and a greater decrease in respiratory rate compared to right pleural effusions given the right lateral position, which may occur because it is influenced by several factors that can affect lung function lung such as age, gender, height and weight, comorbidities, and pleural fluid volume. Age can affect lung function because when the age is over 40 years, there will be a decrease in the elasticity of the alveoli, bronchial thickening, and a decrease in lung capacity which is affected by aging. This is by table 3, namely the age characteristics of respondents based on the location of pleural effusions in this study. Respondents with extrapleural effusions who are over 40 years old are 15 respondents and those with left pleural effusions who are over 40 years old are 13 people. Thus, the respondent to the right pleural effusion who was over 40 years old was more than the respondents who were diagnosed with left pleural effusion. This causes oxygen saturation and respiratory rate in respondents with left pleural effusions to have a greater increase than respondents with left pleural effusions. Another factor that can influence is gender.

Gender can affect the function of ventilation where the ventilation function of men is 20-25% higher than in women ([Guyton & Hall, 2014](#)). This is related to the anatomical size of the male lung which is greater than that of women. In addition, male activity is higher so that recoil and compliance pulmonary are trained. This is by table 2, namely the characteristics of the sex seen based on the location of the pleural effusion in this study that the respondents with left pleural effusions who were female were 3 respondents and on the left pleural effusions who were male were 16 people. Hence, the male respondents for left pleural effusions were more than the female respondents for left pleural

effusions. This is consistent with the theory that gender affects lung function. Therefore, this causes oxygen saturation and respiratory rate in left pleural effusions to have a greater increase than right pleural effusions.

Another factor is height and weight, as an example someone who has a tall and large body, has a higher pulmonary ventilation function compared to a person who is small and short (Guyton & Hall, 2014). Concomitant diseases can also affect the ventilation process in lateral positioning. This is consistent with the statement of Katz, Nissim, Ariel, Yacov, and Esther-Lee (2018) in their study that comorbidities that are closely related to age, which is related to cardiopulmonary status such as increased body weight and increased heart volume as well as mass can cause changes in ventilation function so that it will have an impact on decreasing oxygen saturation and increased respiratory rate. Unilateral pleural effusion accompanied by infection in the lung parenchyma (airway, alveoli, and blood vessels) can also affect the ventilation process, where when given a lateral position to the affected lung parenchyma will cause a physiological shift (ventilation-perfusion miss-matching) which then causes hypoxemia (Guyton & Hall, 2014). Then, the amount of fluid in the pleural cavity can also affect the ventilation process. This can occur because the amount of fluid in the pleural cavity will affect the volume in the pleural cavity which has an impact on intrapleural pressure, where intrapleural pressure will affect lung development in the process of respiration (Pratomo & Yunus, 2013). However, in this study, body weight, height, comorbidities, and fluid volume in the pleural cavity were not included.

Effect of Lateral Position with a Head-Up of 45° on Oxygen Saturation and Respiratory Rate

The statistical test results obtained a p value of 0.0001 ($p \leq 0.05$), which means that giving a lateral position to the direction experiencing effusion with a head-up of 45° can increase oxygen saturation and decrease breath rate. Performing routine lateral repositioning is a relatively safe standard practice. However, if the patient's oxygenation drops during the change of position, of course, it becomes dangerous and requires prompt medical attention. During the study, none of the respondents experienced a decrease in oxygenation (increased respiratory rate and decreased oxygen saturation). This is supported by research conducted by Hewitt, Bucknall, and Faraone (2016) which examined the effect of lateral position on arterial oxygen partial pressure (PaO₂) as a measure of detecting hypoxemia in critical patients with unilateral pulmonary disease. The results of this study showed a difference of 50 mmHg in PaO₂ between the lateral with a bad lung position and those with unilateral lung damage compared to the healthy lung without unilateral damage at the bottom arterial oxygen partial pressure (PaO₂Lower), that is in a

lateral position with a poor/unilateral lung damaged position at the bottom.

This is due to the gravitational force when given a lateral position. When applied in a lateral position, the force of gravity can increase the intra-pleural pressure at the base of the lungs (the lower lungs). This condition results in more air exchange occurring at the top than at the base of the lungs (the lower lungs). Increasing gravity can increase the amount of effort required for ventilation. Hence, when the patient is positioned laterally in the direction of the effusion, the unilateral pleural effusion will maximize healthy lungs because in this section there is no increase in intra-pleural pressure so that the process of ventilation and lung expansion will be better (Rustandi, Fatimah, & Mulyati, 2014).

However, in this study, there was only a slight difference in oxygen saturation values and respiratory rates before and after the intervention. This can be seen in table 4 where the average oxygen saturation value after being given the intervention increased by 1.73 and the average respiratory rate after being given the intervention decreased by 1.98. This is caused by many affecting factors such as hemoglobin values and comorbidities. However, in this study, hemoglobin values and comorbidities were not included. Hemoglobin value can affect oxygen saturation, where low hemoglobin will result in inadequate oxygen supply so that it will have an impact on low oxygen saturation values (Sherwood, 2018). However, when determining the location of the pleural effusion, all respondents were examined for the conjunctiva, the result is that none of the respondents were anemic. The conjunctiva is the indentation of the eye. In normal condition, the conjunctiva is reddish. However, in certain conditions, namely low hemoglobin, the conjunctiva will be pale, which is called anemic conjunctiva. The presence of low hemoglobin will affect oxygen intake throughout the body, while the conjunctiva is one of the sensitive areas that will appear pale if not flowed with blood. Therefore, the conjunctiva can be used as a predictor of low hemoglobin. This is consistent with research conducted by Qalbi, Razak, and Aminuddin (2014) that there is a significant relationship between conjunctival features and hemoglobin status.

Although there was only slight changes in oxygen saturation value and respiratory rate after the intervention was given, positioning is quite helpful as the first aid in dealing with impaired oxygenation in pleural effusion patients. However, in dealing with impaired oxygenation in pleural effusion patients, it cannot be overcome by positioning alone, which must be assisted with other measures such as oxygen therapy, thoracocentesis, pleurodesis, and chest tube insertion / WSD (Klopp, 2013). Therefore, based on the results of the study, positioning needs to be done by the hospital as the first aid in dealing with oxygenation disorders in pleural effusion patients.

Conclusion

There is a significant difference in the value of oxygen saturation before and after the intervention, also in the frequency of breaths before and after the intervention is given a lateral position with a head-up of 45° to oxygen saturation and respiratory rate in unilateral pleural effusion patients. Researchers recommend that the service unit establishes a lateral position which is directly affected by the effusion with a head-up of 45° as the operational standard for the management of impaired oxygenation in unilateral pleural effusion patients. The limitations of this study are that it does not control for confounding variables such as hemoglobin value, body weight, height, comorbidities, oxygen flow, and fluid volume in the pleural cavity. Hence, further research can be done by paying attention to confounding variables.

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