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[Original Research]

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Semi-Fowler Position Increasing Oxygen Saturation in Non-Hemorrhagic Stroke Patients: A Quasi-experiment Study

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Abstract

Background: Stroke is a disruption of blood and oxygen flow to the brain that represents a major global and national health problem, causing hypoxia and cerebral injury due to obstruction or rupture of cerebral blood vessels, with risk factors including hypertension, lifestyle, and diet. Prompt management is essential, one of which is the 30° semi-Fowler position, which is believed to improve oxygenation. **Aims:** aimed to analyze the effect of the 30° semi-Fowler position on increasing oxygen saturation in non-hemorrhagic stroke patients at Dr. Rehatta Regional Hospital, Central Java Province. **Method:** The research design was a quasi-experiment without a control group, conducted in June–July 2025 with a total of 20 respondents using a total sampling technique. Inclusion criteria were patients diagnosed with stroke by a physician, level of consciousness 12–15, and hospitalized, while exclusion criteria were patients with mechanical ventilators. The research instrument was a Nihon Kohden oximeter, type 68042-17 BSM, calibrated in advance. The intervention consisted of the 30° semi-Fowler position for 30 minutes, carried out twice daily for two days (a total of four sessions). Oxygen saturation (SpO_2) was measured at minutes 0, 15, and 30, along with vital signs monitoring. Data analysis using the Wilcoxon Test showed a significant difference in SpO_2 values before and after the intervention ($p<0.000$; $p<0.05$). **Result:** The results demonstrated that the 30° semi-Fowler position effectively increases oxygen saturation in non-hemorrhagic stroke patients. The implication of this study is the need for hospitals to develop standard operating procedures (SOPs) for the application of the 30° semi-Fowler position in non-hemorrhagic stroke patients, especially in Intensive Care Units, as an evidence-based independent nursing intervention to improve the quality of care and patient safety.

Keywords: Oxygen Saturation, Semi-Fowler, Stroke

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Introduction

Stroke is one of several cerebrovascular diseases that poses the greatest threat of disability and death in human life, with attacks occurring suddenly, rapidly, and unexpectedly (Sholekhah and Suyanto 2023). This occurs due to cerebrovascular disorders. Clinical signs that develop can include focal and global neurological deficits that can worsen and last for 24 hours or more. Stroke is classified into two categories: hemorrhagic stroke and

non-hemorrhagic stroke. Non-hemorrhagic stroke is caused by a blockage in the blood vessels to the brain (Ferawati et al., 2021).

Stroke remains a major global health problem, ranking as the second leading cause of death and the third leading cause of disability. According to the World Stroke Organization (2022), more than 12.2 million people experience stroke each year, with ischemic strokes accounting for 62% of cases, while 28% are intracerebral hemorrhages and 1.2 million are subarachnoid hemorrhages. Based on the results of the Basic Health Research (Riskesdas 2023), it is known that the prevalence of stroke in Indonesia reached 8.3% per 1,000 population. In Indonesia, stroke is the main cause of disability and death, amounting to 11.2% of the total disability and 18.5% of the total death. Stroke is also one of the catastrophic diseases with the third-highest financing after heart disease and cancer, reaching 5.2 trillion in 2023 (Ministry of Health, 2023). Men have a higher stroke prevention rate (11%), and women have a lower stroke prevalence rate (10%). The prevalence of stroke in urban areas is greater (63.9%) compared to those living in rural areas (36.1%).

In 2018, the prevalence of stroke in Central Java was 14.6% (Ministry of Health of the Republic of Indonesia, 2018). Stroke is one of the ten most common diseases treated in the Intensive Care Unit (ICU) of Dr. Rehatta Regional Hospital, Central Java Province. According to data from the ICU of Dr. Rehatta Regional Hospital, the average number of stroke patients treated in the past year was 70 (Rehatta Regional Hospital Register, 2021).

Non-hemorrhagic strokes are generally caused by two factors. The first is genetic, or related to normal bodily function and therefore non-modifiable, including age, gender, race, family history of stroke, and previous transient ischemic attacks or strokes. The second factor is a result of a person's lifestyle and can be modified, including hypertension, diabetes mellitus, smoking, hyperlipidemia, and alcohol intoxication (Hutagalung & Puspitasari 2021).

Meanwhile, the main cause of non-hemorrhagic stroke is an obstruction or clot in one or more large arteries in the cerebral circulation. This obstruction or clot can occur due to a thrombus, or blood clot, forming on the blood vessel wall; an embolus, or blockage in blood flow, which can be a blood clot, fat, or air bubble; and atrial fibrillation. The blood vessel blockage that occurs in non-hemorrhagic stroke can disrupt metabolic processes in the brain and result in a decrease in blood and oxygen supply to the brain (Hutagalung & Puspitasari 2021).

Non-hemorrhagic strokes can have a wide range of impacts, from minor to life-threatening. One of the less severe consequences is a reduced quality of life, as stroke patients often experience muscle weakness that limits their mobility. Another significant effect is impaired cerebral circulation, which can lead to symptoms such as cerebral tissue hypoxia. Hypoxia in brain tissue increases intracranial pressure and, if not treated promptly, may result in respiratory failure. Empirical research by Pertami, Munawaroh, and Rosmala found that impaired blood flow in stroke patients leads to hemodynamic disturbances, including reduced oxygen saturation. Therefore, proper monitoring is essential, as hemodynamic status greatly influences oxygen delivery throughout the body and ultimately affects cardiac function (Pertami et al., 2019).

Oxygen saturation is the percentage of oxygen that has combined with hemoglobin molecules. Oxygen combines with hemoglobin in sufficient quantities to meet the body's needs, while oxygen is released to meet tissue needs. Oxygen saturation measurements can determine the adequacy of oxygen in the body and thus aid in determining further therapy (Pertami, Munawaroh, & Rosmala 2019). Treatment for stroke patients must be carried out quickly and appropriately to improve hemodynamic status and prevent further complications, primarily to prevent ineffective cerebral perfusion (Mahendra, 2024).

The intervention carried out in this study was a 30° semi-Fowler position. According to Pratiwi et al. (2020), the semi-Fowler position is a position where the patient can lie down half-sitting; this is done to maximize oxygen supply to the lungs. If the oxygen supply enters optimally, it can increase the patient's oxygen saturation value (Utami, Siwi, & Nurya 2022). It is hoped that the 30° semi-Fowler position can increase blood flow to the brain and maximize brain tissue oxygenation (Mahendra, 2024). Stroke patients may experience impaired oxygen transfer or decreased cerebrovascular blood flow, which results in decreased tissue perfusion and causes ischemia. One action that can be taken is the 30° semi-Fowler position. The purpose of this is to increase oxygen saturation values (Syahfitri, Perangin-angin, & Oksigen 2024).

Stroke is a brain disease in which blood vessels to the brain are blocked, causing hypoxia, as oxygen is a vital need for every living creature. semi-Fowler 30°, which is useful for improving blood circulation to the brain nerves, improving gas exchange in the body, and increasing the level of consciousness, thereby increasing oxygen saturation (Nugraheni & Anita 2025). Mustikarani & Mustofa (2020) reported the effects of head of bed elevations at 15°, 30°, and 45° positions on clients experiencing increased intracranial pressure on tissue perfusion, namely that there was a difference in tissue perfusion values in each position compared to the flat 0° position (Mustikarani & Mustofa 2020). This is in line

with research by Sands et al. (2020) that suggests that head elevation above 0° can be used to improve SpO2 values. To prevent an increased risk of decreased cerebral perfusion pressure, elevation above 45° is not recommended, as it can worsen ischemia in brain tissue (Sands et al., 2020).

Based on several articles explaining the effectiveness of the 30° semi-Fowler's position in stroke patients, adjusting the head position to a 30° head-up angle is an intervention that has been shown to increase venous blood flow from the brain, reduce intracranial pressure, and maintain cerebral perfusion (Riberholt et al., 2020). Furthermore, oxygen administration can help prevent hypoxia, which can worsen brain tissue damage caused by ischemia (Riberholt et al., 2020). However, the implementation of this intervention requires careful evaluation of its effectiveness and impact in patients with acute conditions.

However, studies on the effectiveness of providing a 30° head-up position in increasing oxygen saturation in stroke patients are still limited, so the author is interested in further examining the effect of providing this position. *head up* 30° on increasing oxygen saturation in non-hemorrhagic stroke patients at Dr. Rehatta Regional General Hospital, Central Java Province. According to previous research results (Pertami, Munawaroh, and Dwi Rosmala 2019), it was concluded that this study has an effect of the 30° semi-Fowler position on oxygen saturation in non-hemorrhagic stroke patients to maximize oxygenation to cerebral tissue.

Previous research used inpatient room location settings, purposive sampling techniques, and portable oximeter research instruments. The research conducted used ICU room location settings, total sampling techniques, and research instruments using a Nihon Kohden brand oximeter bedside monitor type 68042-17 BSM calibrated from August 24, 2024, to August 24, 2025. The implications of the author's research results are able to show independent interventions in the management of stroke patients that are effective in increasing oxygen saturation, namely by providing a 30° semi-Fowler position to colleagues and other caregivers. In addition, this study aims to provide new insights to health workers in conducting evidence-based interventions to improve the quality of nursing services. The results of the study become the basis for nurses in carrying out independent nursing actions based on scientific evidence. This proves that nurses as professional health workers are able to carry out nursing actions independently and based on evidence. The results of the study can also improve the development of nursing science in the form of nursing interventions that can be scientifically proven.

In this case, it can show the role of nurses as caregivers in providing a 30° semi-Fowler position, the role of nurses as educators in providing education to patients and families at home, and the role of nurses as researchers to see the effect of providing a 30° semi-Fowler position on oxygen saturation. The purpose of this study was to analyze the effect of the 30° semi-Fowler position on oxygen saturation in non-hemorrhagic stroke patients, thereby providing evidence-based nursing intervention to improve oxygen management and enhance the quality of patient care.

Methods

This study is quantitative research using a quasi-experimental design with a one-group pre-test-post-test approach without a control group, as the number of eligible patients was limited. This research was conducted in the Intensive Care Unit of Dr. Rehatta Hospital, Central Java Province, in June - July 2025. The independent variable is the 30° semi-Fowler position, and the dependent variable is oxygen saturation.

Population: This study used an accessible population, where the population to be studied is limited or can be calculated based on location and time. Therefore, the population in this study is all stroke patients treated at Dr. Rehatta Hospital, Central Java Province. In the last two months, from June to July 2025, the number of non-hemorrhagic stroke cases in the ICU was 20 patients.

The sample studied was 20 non-hemorrhagic stroke patients in the ICU of Dr. Rehatta Regional General Hospital, Central Java Province, who were taken and selected using the total sampling technique. Inclusion criteria were patients diagnosed with non-hemorrhagic stroke by a doctor, patients who were hospitalized, and patients with a level of consciousness of 12-15 so they were able to follow the researcher's instructions. Meanwhile, exclusion criteria included patients with congestive heart failure, chronic obstructive pulmonary disease, and patients on mechanical ventilators.

This research instrument uses pre- and post-observation sheets. The observations carried out were oxygen saturation assessments using pulse oximetry on a Nihon Kohden brand bedside monitor, Nihon Kohden type 68042-17 BSM, calibrated from August 24, 2024, to August 24, 2025. The intervention consisted of the 30° semi-Fowler position for 30 minutes, carried out twice daily for two days (a total of four sessions). Oxygen saturation (SpO_2) was measured at minutes 0, 15, and 30, along with vital signs monitoring. Data analysis used the Wilcoxon test with SPSS software version 29 to compare

oxygen saturation before and after the 30° semi-Fowler position. This study has been declared to have passed the ethical test from the Public Health Research Ethics Commission on May 26, 2025, with the number 379 / Z-7 / KEPK / UMKU / U / 2025.

Results

Table 1 Age of Non-Hemorrhagic Stroke Patients in the ICU of Dr. Rehatta Regional Hospital (n=20)

Variables	Mean	Median	Min-Max	SD
Age	58.95	60.50	50-65	4,199

Table 1 shows that the mean age of non-hemorrhagic stroke patients in the ICU of Dr. Rehatta Regional Hospital was 58.95 ± 4.20 years, with a median of 60.5 years (range 50–65 years).

Table 2. Gender of Non-Hemorrhagic Stroke Patients in the ICU of Dr. Rehatta Regional Hospital (n=20)

Gender	f	%
Man	12	60
Woman	8	40
Total	**20**	**100**

Table 2 explains that half of the non-hemorrhagic stroke patients were male, namely 12 patients (60%).

Table 3. Oxygen Saturation Values of Non-Hemorrhagic Stroke Patients in the ICU of Dr. Rehatta Regional Hospital (n=20)

Oxygen Saturation (SpO2)	Mean	Median	Min	Max	SD
Pretest	95.25	95	93	97	1.208
Post-test	98.15	98	97	99	0.670

Table 3 describes that the median oxygen saturation value of non-hemorrhagic stroke patients in the ICU of Dr. Rehatta Regional Hospital before the intervention was 95%, with the lowest oxygen saturation being 93% and the highest being 97%. The median oxygen saturation value after the intervention was 98%, with the lowest oxygen saturation being 97% and the highest being 99%.

Table 4. Analysis of Differences in Oxygen Saturation of Non-Hemorrhagic Stroke Patients in the ICU of Dr. Rehatta Regional Hospital Before and After Providing a Semi-Fowler Position 30

Oxygen Saturation (SpO2)	Median	Sum	p-value
Pretest-posttest	10.5	210	0,000

Table 4 concludes that there is a statistically significant difference in oxygen saturation values before and after administering a 30° semi-Fowler position with a p-value = <0.001 (p < 0.005).

Discussion

The study results show that the average age of non-hemorrhagic stroke patients falls within the pre-elderly category. This is supported by research stating that as a person ages, the heart tends to enlarge and the muscles become thicker, but compensatory capacity decreases (Hutagalung & Puspitasari 2021). This occurs due to structural and functional changes in the peripheral vascular system. These changes include loss of connective tissue elasticity and decreased relaxation of vascular smooth muscle, which reduces the distension and tensile strength of blood vessels. This condition can lead to stiffness and thickening of the blood vessels, known as atherosclerosis, which is one of the causes of non-hemorrhagic stroke (Hutagalung & Puspitasari 2021).

Stroke is a disease caused by narrowing of the blood vessels in the brain so that the flow of blood and oxygen to the brain is stopped. This blockage can cause the nervous system that is cut off from its blood and oxygen supply to be damaged or even die so that the organs related to the nervous system will be difficult or even unable to move (Faridah, 2019). According to Hutagalung (2021), one of the signs and symptoms of non-hemorrhagic stroke is thrombolytic stroke: usually the picture is as follows: Sudden/subacute neurological deficit occurs, often some time before feeling stiff, somewhat weak, or aching throughout the body. Accompanied by or without dizziness, severe headache, nausea, vomiting, or fever, No history of head trauma; it more often occurs in people aged 50 years and over.

This can also be seen from the distribution of non-hemorrhagic strokes by age in this study: the incidence rate in the case group aged <45 years was less than that of those over 45 years; this is associated with a decrease in estrogen hormones in menopausal women aged >50 years (Hardika, Yuwono, & Zulkarnain 2020). In this study, the number of non-hemorrhagic stroke sufferers in the ICU of Dr. Rehatta Regional Hospital was mostly male patients. According to Riskesdas (2019), there are several risk factors for stroke, including obesity, comorbidities such as hypercholesterolemia, hypertension, and diabetes mellitus, poor diet, and smoking. Most stroke sufferers are over 40 years old, and the majority are men compared to

women; this is because women have the hormone estrogen.

Data in Indonesia, based on gender characteristics, shows that the percentage of stroke sufferers in men (7.1%) is higher than in women. This study aligns with the data. Furthermore, the incidence of stroke in women is lower than in men due to the hormone estrogen, which functions as a protective factor against atherosclerosis. Furthermore, the incidence of stroke in women is lower than in men due to the presence of the hormone estrogen, which functions as a protective factor against atherosclerosis (Hardika, Yuwono, & Zulkarnain 2020).

This study stated that the median/middle value of SpO_2 before the 30° semi-Fowler position was 95%, with the lowest SpO_2 value being 93% and the highest SpO_2 value being 95%. According to Pratiwi (2020), several factors influence oxygen saturation measurements, such as hemoglobin, circulation, and activity or changes in position. The semi-Fowler position at 30° can increase oxygen saturation because elevating the head of the bed reduces pressure on the diaphragm, thereby improving lung expansion and ventilation. This position also enhances functional residual capacity, facilitates better alveolar gas exchange, and reduces the risk of hypoventilation. In stroke patients, it helps optimize cerebral oxygen delivery by improving systemic oxygenation while minimizing intracranial pressure (Pratiwi, Setiyawan, & Sulistyawati 2020). An empirical study by Setyarini et al. (2023) proved that impaired blood flow in stroke patients results in hemodynamic disturbances, including oxygen saturation. Therefore, proper monitoring is necessary because hemodynamic conditions significantly affect oxygen delivery throughout the body, ultimately affecting heart function (Sholekhah & Suyanto 2023).

One complication of stroke is impaired cerebral circulation, which can lead to several symptoms, including cerebral tissue hypoxia. Empirical studies by Setyarini have shown that impaired blood flow in stroke patients results in hemodynamic disturbances, including oxygen saturation. Therefore, proper monitoring is necessary, as hemodynamic conditions significantly affect oxygen delivery throughout the body, ultimately affecting heart function (Fadlilah, Hamdani Rahil, & Lanni 2020).

Oxygen saturation values can be used as a reference to determine how well the body is meeting its oxygen needs. There are several types of sitting, including semi-Fowler, high-Fowler, and head-up. One nursing action for stroke patients aimed at increasing oxygen saturation levels is head elevation. According to research findings conducted by Trisila et al. (2022), there was an effect on oxygen saturation after administering a 30° head-up position to stroke patients in the emergency room of Dr. T.C. Maumere Regional Hospital.

Oxygen saturation (SpO2) is the ability of hemoglobin to bind oxygen (Fadlilah et al., 2020). Oxygen saturation is the level of oxygen in the blood (hemoglobin) found in body tissues (Sholekhah & Suyanto 2023). Oxygen saturation can identify the oxygen condition in organs so that further interventions related to treatment can be carried out (Sholekhah & Suyanto 2023). Oxygen saturation (SpO2) is the percentage of oxygen contained in the blood, in drinking water, or in the air that is inhaled in an amount sufficient to meet the body's needs, while at the same time oxygen is released to meet tissue needs. The oxygen saturation value serves as a reference to determine whether the body's oxygen needs are met and is useful for determining further therapy (Syahfitri, Perangin-angin, & Oksigen 2024).

Based on these sources, it can be concluded that oxygen saturation is the total amount of oxygen bound to hemoglobin. Normal oxygen saturation values, measured using a pulse oximetry device, range from 95% to 100% (Fadlilah, Hamdani Rahil, & Lanni 2020). An oxygen saturation value of less than 94% indicates that the body's tissues are not receiving enough oxygen (Fadlilah et al., 2020).

Stroke is the leading cause of death and disability worldwide. Stroke is a neurological deficit that has a sudden onset, lasts more than 24 hours, and is caused by cerebrovascular disorders. Stroke, or cerebrovascular injury, is the loss of brain function due to the cessation or reduction of blood supply to part of the brain, causing local or global nerve function disorders, appearing suddenly and progressively (Mustikarani & Mustofa 2020). Impaired blood flow in stroke patients results in impaired oxygen supply, so proper monitoring and treatment are necessary. (Mustikarani & Mustofa 2020). Poor blood flow in stroke patients can cause hemodynamic abnormalities, with hemodynamic conditions affecting oxygen distribution in the body, reducing oxygen saturation (Kusuma & Surakarta 2023).

The results of the study showed that there was a statistically significant difference in oxygen saturation values before and after intervention in non-hemorrhagic stroke patients. This is supported by research conducted by Kadir showing the effect of the 30-degree semi-Fowler position on oxygen saturation in non-hemorrhagic stroke patients, wherein in the supine position the oxygen saturation was 96%, while when the head was in the 30-degree semi-Fowler position for 30 minutes, the saturation level became 98%. Theoretically, the 30° semi-Fowler position is based on a physiological response, a change in position to increase blood flow to the brain and prevent increased ICP/intracranial pressure. Increased

ICP/intracranial pressure is a serious complication due to pressure on vital centers in the brain (herniation) and can result in brain cell death (Mustikarani & Mustofa, 2020).

Providing a 30° semi-Fowler position is one of the non-pharmacological therapies, in the form of independent nursing actions that are routinely carried out on stroke patients, where this position is to raise the head of the bed at an angle of about 30° with the body in a parallel position and legs straight or not bent (Tunik, 2022). The physiological reasons for providing a 30° head-up position, according to Tunik (2022), are: The theory underlying this 30° semi-Fowler position is the elevation of the limbs above the heart with a vertical axis, causing cerebrospinal fluid (CSF) to be distributed from the cranial to the spinal subarachnoid space and facilitating cerebral venous return so that venous return is good, then making oxygen circulation to the brain better.

According to a different study conducted by Mustikarani & Mustofa (2020), the application of the head position to a 30° semi-Fowler's position affects oxygen saturation in hemorrhagic stroke patients. Over a 30-minute period, oxygen saturation was seen to increase from 96 percent in the supine position to 98 percent when the head was positioned at a 30° elevation. The consequences of another review conducted by Mustikarani & Mustofa (2020) showed that changing the position from head elevation to semi-Fowler's position generally decreases the respiratory rate, but from the semi-Fowler's position to the Fowler's position, it generally remains the same. This is supported by the findings of research by Pertami et al. (2019), which showed that patients with hemorrhagic stroke and non-hemorrhagic stroke experienced an increase in oxygen saturation of 2.48 percent when in a 30° head elevation position. This is because this action has the potential to increase brain tissue oxygenation and improve blood flow to the brain.

Based on several findings of this study, it can be concluded that lifting/elevating the head will result in increased oxygen saturation in patients suffering from impaired brain or peripheral tissue perfusion due to stroke or heart failure. According to Lam et al (2020), adjusting the head elevation position to 30° is expected to increase venous return, improve brain tissue metabolic function, expedite the rate of oxygenation to the brain, and improve brain function to its original state so that hemodynamic status will return to normal. During observation, pulse oximetry is used as an aid to measure oxygen saturation values.

Theoretically, the supine position accompanied by semi-Fowler shows that the blood flow from the inferior part to the right atrium is quite good because the resistance of the blood vessels and the pressure of the right atrium are not too high, so that the volume of blood entering (venous return) to the right atrium is quite good and the right ventricular filling pressure (preload) increases, which can lead to an increase in stroke volume and cardiac output. The patient's head up 30° will increase blood flow in the brain and maximize cerebral tissue oxygenation, improving hemodynamic conditions by facilitating increased blood flow to the brain and maximizing oxygenation to the cerebral tissue.

Another study, entitled "The Influence of Different Degrees of Head Elevation on Respiratory Mechanics in Mechanically Ventilated Patients," found that oxygen saturation was better in the 30° semi-Fowler's position compared to the 0° position (Mustikarani & Mustofa 2020). Another study also stated that the majority of saturation distributions were >95% in the 30° semi-Fowler's position, with a p-value of <0.05. It can be concluded that the 30° semi-Fowler's position affects oxygen saturation levels in patients, especially stroke patients (Mustikarani & Mustofa 2020).

Limitations of this study include the fact that it involved only one group, making it impossible to compare with a control group. However, the researchers carefully considered the inclusion and exclusion criteria to maximize the results. Furthermore, the sample size was limited; therefore, this study used total sampling, involving all non-hemorrhagic stroke patients treated in the ICU. The short length of stay, typically 3-5 days, presented a challenge, so the researchers obtained informed consent from patients who met the inclusion and exclusion criteria immediately upon admission to the ICU.

Conclusion

The results showed that there was a difference in SpO_2 values before and after the 30° semi-Fowler position intervention, indicating that the semi-Fowler position can increase oxygen saturation. Because the significance value is <0.05, the hypothesis is accepted, which means that both data have a significant difference in oxygen saturation values in non-hemorrhagic stroke patients at RSUD dr. Rehatta before and after the 30° semi-fowler position intervention. Based on the results of this study, it is expected that clients and families can understand that the semi-Fowler position can help increase oxygen saturation so that the patient's condition becomes stable. The hospital makes a semi-Fowler position SOP, which is then socialized to colleagues and then applied, monitored, and documented. For Muhammadiyah Kudus University, it is hoped that this research can be used as study material and learning material in medical, surgical, and critical emergencies so

that students can apply it when they are in the field. For further research, it is expected to add control variables, add interventions and combinations of therapies, and develop dependent variables on shortness of breath and hemodynamics.

Declaration of Conflicting Interest

The authors declare that there is no conflict of interest regarding the publication of this article. No financial, professional, or personal relationships have influenced the research, authorship, or publication of this study.

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Author's Contribution

All authors made significant contributions to this study. The first author was responsible for designing the research, collecting data, and drafting the initial manuscript. The second author contributed to data analysis and interpretation of the findings and helped improve the clarity of the manuscript. The third author was involved in coordinating clinical activities, monitoring patients, and ensuring adherence to ethical procedures. The fourth author, an international collaborator, provided critical academic input, assisted in refining the discussion, and enhanced the global perspective of the research. All authors reviewed and approved the final version of the manuscript prior to submission.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. All data have been anonymized to protect participant confidentiality.

Declaration of Use of AI in Academic Writing

The authors declare that generative artificial intelligence (AI), including large language models such as ChatGPT by OpenAI, was used to assist in the improvement of language clarity, grammar, and structure during the preparation of this manuscript. All content has been reviewed and verified for accuracy, and the intellectual contributions remain those of the authors. The use of AI did not influence the research design, data collection, analysis, or interpretation of results.

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