



Application of Prone Position to Increase Oxygen Saturation in Patients with Acute Respiratory Distress Syndrome (ARDS): Literature Review

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ABSTRACTS

Acute Respiratory Distress Syndrome (ARDS) is a life-threatening condition caused by severe inflammation in the lungs, which causes fluid buildup in the alveoli. This impairs the lungs' ability to exchange gases efficiently, leading to significant respiratory failure. Objective: This study aimed to determine the effectiveness of the prone position in increasing oxygen saturation in patients with acute respiratory distress syndrome (ARDS). Method: The research design used in this study was a literature review. Results: The prone position can improve oxygenation, reduce ventilator-induced lung injury (VILI) and improve clinical outcomes in patients admitted to the Intensive Care Unit (ICU) and can reduce mortality, especially in severe conditions, although there are risks such as pressure ulcers. Conclusion: It can be concluded that the prone position is an effective intervention in increasing oxygen saturation in patients with Acute Respiratory Distress Syndrome (ARDS).

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1. INTRODUCTION

Acute Respiratory Distress Syndrome (ARDS) is a life-threatening condition caused by severe inflammation in the lungs, leading to fluid accumulation in the alveoli. This impairs the lungs' ability to exchange gases efficiently, leading to significant respiratory failure (Zhao et al., 2023). ARDS can be triggered by a variety of factors, including lung infections such as pneumonia, sepsis, trauma, and aspiration of noxious substances (Thompson et al., 2020). The main symptoms of ARDS include shortness of breath, hypoxemia, and increased work of breathing, often requiring mechanical ventilation to maintain adequate oxygenation (Laffey et al., 2021).

Pathophysiologically, ARDS is characterized by damage to the alveolar-capillary membrane, causing fluid leakage into the interstitial space and alveoli, which reduces the lung's capacity for normal function (Matuschek, C., 2020). This leads to intrapulmonary shunting and reduced ventilation-perfusion, which in turn decreases blood oxygen saturation. Without appropriate intervention, ARDS can lead to serious complications, including respiratory failure and increased mortality (Bellani et al., 2016).

One non-pharmacological therapy that has been widely used to increase oxygen saturation in ARDS patients is the prone position. This technique involves turning the patient onto their stomach, which aims to optimize oxygen distribution to the lungs and improve blood perfusion (Gattinoni et al., 2020). The prone position has been shown to have a positive impact on reducing morbidity and mortality in patients with ARDS.

The prone position has emerged as an important strategy in the management of patients with Acute Respiratory Distress Syndrome (ARDS). This position improves ventilation distribution in the lungs and increases blood perfusion, thereby improving oxygen saturation (Bakker, J., & van der Hoeven, 2021). When patients with ARDS (Acute Respiratory Distress Syndrome) are positioned prone, the areas of the lungs that are compressed when the patient is supine become more open. This allows for more even ventilation distribution and improves oxygenation. The prone position reduces lung compression caused by the weight of the mediastinum, the lungs themselves, and the diaphragm. This helps prevent ventral alveolar hyperinflation and reduces dorsal atelectasis (alveolar collapse), which is particularly important for patients with ARDS, where the dorsal

lung areas tend to be denser and filled with fluid due to inflammation and edema (Guérin et al., 2020).

Several studies have shown that the prone position can significantly increase oxygen saturation, especially in patients with moderate to severe ARDS (Sunarti et al., 2022). Other studies have shown that the prone position in ARDS patients on mechanical ventilators can significantly increase oxygen saturation. Prone positioning has also been shown to be effective in reducing the risk of complications due to hypoxemia, especially when applied over a longer period. According to Iqbal et al. (2023), the use of proper prone positioning can reduce mortality rates in ARDS patients by 16-25%, making it a very important treatment method in intensive care. Furthermore, the prone position can also reduce the risk of complications due to hypoxemia, making it a very important intervention in intensive care (Mancebo, J., 2020). Therefore, a better understanding of the application of prone positioning is crucial in efforts to improve the care of ARDS patients.

2. METHODS

The research design used in this study was a literature review, which involves searching for scientific articles by reading, summarizing, comparing, critiquing, and providing opinions. The questions used in the journal review were adapted from PICO. The search was conducted electronically using several databases including Pubmed, Cochrane, Cinahl, and Google Scholar from November 2016 to May 2024. The keywords used were "Prone Position / Prone Position", "Acute Respiratory Distress Syndrome / Acute Respiratory Difficulty", "Oxygen Saturation" so that ten articles were obtained for review. The search used the above keywords with the Pubmed, Cochrane, Cinahl, and Google Scholar databases. The search results on Pubmed obtained 1,497 articles, on Cochrane obtained 3 articles, on Cinahl obtained 37,563 articles and on Google Scholar obtained 57,500 articles. The full-text articles and abstracts obtained were reviewed to select articles that fit the inclusion criteria based on the PICO (Patient, Intervention, Comparison, Outcome) framework. (P: patients with ARDS, I: prone position, O: increased saturation). The language selection used was Indonesian and English. The author took all research designs used in identifying the effectiveness of the position prone to increase oxygen saturation in patients with ARDS.

3. RESULTS AND DISCUSSION

3.1. Results

A search of four databases (Google Scholar, Pubmed, Cinahl, and Cochrane) yielded ten journal articles that met the criteria for applying the prone position to ARDS patients. The prone position involves lying face down with both arms flexed and avoiding pressure on the abdomen (Agustina & Nurhaeni, 2020). The prone position can affect ventilation and perfusion from the upper to lower lungs. Ventilation distribution in the posterior lung is better than in the anterior lung, thus maximizing ventilation distribution (Babaei et al., 2019).

3.1.1. Problems Raised for Research

Guérin's (2017) research is similar to research conducted by Dewi & Herawati (2024), Hepokoski et al. (2018), Iqbal et al. (2023), Munshi et al. (2017), Rampon et al. (2023), and Susanto & Sukmarini (2022) which reviewed the effectiveness of prone positioning in patients with Acute Respiratory Distress Syndrome (ARDS). The use of prone positioning has become an emerging strategy and has been proven effective in increasing pulmonary ventilation and perfusion and improving oxygenation levels in ARDS patients (Dewi & Herawati, 2024).

According to McNicholas et al. (2023), awake prone positioning produces physiological changes that improve oxygenation, especially in patients admitted to intensive care units or requiring further respiratory support. The greatest benefit is experienced by patients who can remain prone for several hours. This study aligns with research by Munshi et al. (2017) that found prone positioning effectively reduces the need for mechanical ventilation, reduces mortality in patients with severe ARDS, and consistently increases oxygen saturation when applied for >12 hours per day.

In general, the prone position has been shown to be effective in improving oxygenation and reducing mortality in ARDS patients, especially in severe cases. However, there are risks, such as pressure ulcers and complications, in patients who remain in this position for prolonged periods.

3.1.2. Research Steps or Research Methods Used

Several studies used as references regarding the application of the prone position to increase oxygen saturation in patients with ARDS were conducted with different designs.

The study design used by McNicholas et al. (2023) was a narrative review. Ashra et al.'s (2022) study used a meta-analysis. The studies by Dewi & Herawati (2024), Guérin (2017), and Munshi et al. (2017) used a systematic review and meta-analysis. The studies by Guérin et al. (2020), Hepokoski et al. (2018), Rampon et al. (2023), and Susanto & Sukmarini (2022) used a literature review, while the study design by Iqbal et al. (2023) used a systematic review. The study population of these ten journal articles has one thing in common: patients with ARDS.

The research methods used in this study provide a strong basis for understanding the effectiveness of prone positioning in ARDS, by combining various research approaches can provide a more comprehensive and reliable picture of the evidence.

3.2. DISCUSSION

3.2.1. Analysis of the Similarities and Differences of Each Study

Based on the research findings, ten studies focused on improving oxygenation, and the results showed that the prone position is an effective intervention in improving oxygenation in patients with ARDS. Guérin's (2017) study outlined that the prone position is a key component of lung protection for mechanical ventilation and should be used as first-line therapy in conjunction with low tidal volumes and neuromuscular blocking agents in patients with severe ARDS. The main findings of Hepokoski et al.'s (2018) study confirmed that the prone position is effective in improving oxygenation and improving clinical outcomes in ARDS patients. Despite strong evidence, the prone position is still not widely used. This study identified several barriers, namely a lack of training; many healthcare workers do not have sufficient training to perform the prone position procedure safely and effectively. Furthermore, negative perceptions also hinder this therapy; some healthcare workers still have negative perceptions about the prone position, for example, fear of complications or difficulties in its implementation.

Research by Ashra et al. (2022), Guérin et al. (2020), McNicholas et al. (2023), and Rampon et al. (2023) focused on the effectiveness of the prone position in patients with Acute Respiratory Distress Syndrome (ARDS), caused by COVID-19. All four studies showed that the prone position is effective in improving oxygenation in ARDS patients.

Research by Dewi & Herawati (2024), Iqbal et al. (2023), and Susanto & Sukmarini (2022) focused on improving oxygenation in ARDS patients through the prone position. The results of Susanto & Sukmarini's (2022) study showed that prone positioning can increase oxygen

saturation in ARDS patients, with varying durations of prone positioning, with an average of 30-90 minutes. Iqbal et al. (2023) outlined the results of a systematic review of several clinical studies showing that prone positioning is effective in increasing oxygen saturation, especially when used long-term. Meanwhile, according to research by Dewi & Herawati (2024), prolonged prone positioning has been proven effective and safe for patients. Its benefits in patients with oxygenation problems include increasing pulmonary ventilation and reducing the body's metabolic rate. The prone position increases the cardiac index, mean arterial pressure, and DO_2 invasively in patients on ventilators with ARDS, so the prone position is highly recommended for ARDS patients.

From the research that has been conducted, there are suggestions from the research of Hepokoski et al. (2018) which provides input for further research so that this intervention is carried out widely, increasing the use of the prone position in ARDS patients who meet the criteria and overcoming barriers in implementing the prone position. Meanwhile, based on a systematic review and meta-analysis conducted by Munshi et al. (2017), there are several important suggestions regarding the application of the prone position in ARDS patients, namely, studies show that the prone position provides significant benefits for ARDS patients with moderate to severe severity ($\text{PaO}_2/\text{FiO}_2 \leq 200$). then, in patients with milder severity may not require the prone position, a longer duration of the prone position (more than 12 hours) is associated with a more significant reduction in mortality. However, the optimal duration needs to be adjusted to the clinical condition of each patient.

3.2.2. Prone Procedure

The steps or methods for applying the prone position, according to (Guérin et al., 2020), are as follows:

- 1) Team preparation requires a minimum of six medical personnel to perform this maneuver. Four will be required to turn the patient, one will maintain the ECMO circuit, and one (usually a physician) will administer and protect the endotracheal tube.
- 2) When preparing the bed, use a bed that allows for easy position changes, such as a standard ICU bed or a bed with a low-air-loss system. Avoid using an auto-pronating bed.
- 3) Patient Position
 - a. Place the patient with the arms parallel to the body or in a "crawl" position.
 - b. The stomach is not supported.

- c. Face facing right or left.
- d. Change position every 2-4 hours.
- e. Eye occlusion can be performed to prevent eye complications, but the use of hydrocolloid dressings remains controversial.
- 4) Security
 - a. Secure the endotracheal tube and intravascular catheter securely.
 - b. Use a transverse roll under the pelvis and chest to avoid increasing pressure on the chest.
- 5) Ventilator Adjustment
 - a. Adjust the ventilator settings after each position change.
 - b. Consider decreasing tidal volume and increasing PEEP to improve oxygenation.

3.2.3. Prone Position Image

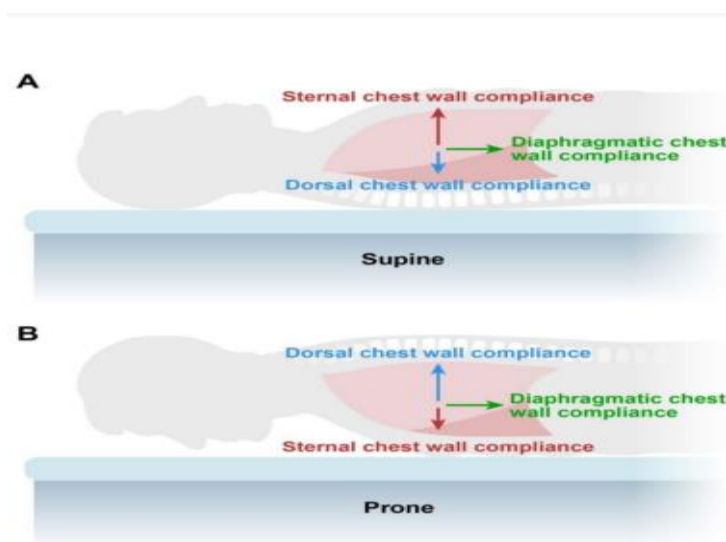


Figure 1. Supine and Prone Positions

The image explains the difference in chest wall flexibility in the supine and prone positions according to (Gattinoni et al., 2023).

1. Supine position (lying on your back). In this position, the front of the chest (sternal) The chest has greater flexibility than the back (dorsal) portion. This is due to the human anatomy, which makes the front of the chest more flexible. As a result, when breathing in a supine position, most of the air is distributed to the front of the lungs.
2. Prone Position. When moving to the prone position, the distribution of chest wall flexibility changes. The back (dorsal) chest becomes more flexible, while the front

(sternal) becomes less flexible. This change results in a more even distribution of air to the lungs. More air fills the back of the lungs, which were previously less full when lying down.

The prone position is very important for increasing oxygenation, with a more even distribution of air, the prone position can increase blood oxygenation in patients with respiratory disorders such as Acute Respiratory Distress Syndrome (ARDS) and Improvement of lung mechanics, the prone position can also improve respiratory mechanics by reducing the workload on the diaphragm and increasing lung expansion.

Table 1. Review Results

No.	Writer	Title	Respondents	Treatment	Control	Research Procedures	Results
1.	Bairbre A. McNicholas, Miguel Ibarra-Estrada, Yonatan Perez, Jie Li, Ivan Pavlov, Aileen Kharat, David L. Vines, Oriol Roca, David Cosgrave, Claude Guerin, Stephan Ehrmann, and John G. Laffey (2023)	<i>Awake Prone Positioning in Acute Hypoxaemic Respiratory Failure</i>	<i>Narrative reviews were identified through searches in PubMed.</i>	Narrative review	No control group	<i>Narrative reviews were identified through searches in PubMed and references from relevant articles using the following search terms: “prone positioning AND acute hypoxemic respiratory failure”; “prone positioning AND physiology”; “awake prone positioning AND acute respiratory failure”; “awake prone positioning AND COVID-19” and “prone positioning AND COVID-19”</i>	<i>Prone positioning in conscious patients with acute hypoxemic respiratory failure appears to produce many of the same physiological changes that improve oxygenation seen in patients on invasive ventilators with moderate-to-severe acute respiratory distress syndrome. However, there is consistent evidence that more hypoxemic patients requiring advanced respiratory support, who are managed in higher-care settings and who can be prone for several hours, benefit most from the use of awake prone positioning . We review the physiological basis for which prone positioning results in changes in lung mechanics and gas exchange and summarize the current evidence base for awake prone positioning .</i>

2.	Fauzi Ashra, Ruey Chen, Xiao Linda Kang, Kai-Jo Chiang, Li-Chung Pien, Hsiu-Ju Jen, Doresses Liu, Shu-Tai Shen Hsiao, and Kuei-Ru Chou (2022)	<i>EFFECTIVENESS OF PRONE POSITION IN ACUTE RESPIRATORY DISTRESS SYNDROME AND MODERATING FACTORS OF OBESITY CLASS AND TREATMENT DURATIONS FOR COVID-19 PATIENTS: A META-ANALYSIS</i>	Based on the results of full text screening, 15 articles were obtained that met the requirements and were included in this study.	Meta-analysis	No control group	A comprehensive search was conducted in <i>Cinahl</i> , the <i>Cochrane Library</i> , <i>Embase</i> , <i>MedlineOVID</i> , <i>NCBI SARS-CoV-2 Resources</i> , <i>ProQuest</i> , <i>Scopus</i> , and <i>Web of Science</i> without language restrictions. All studies with prospective and experimental designs evaluating the effects of prone positioning on ARDS in COVID-19 patients were included.	The results of this study indicate that the prone position significantly increases oxygen saturation in COVID-19 patients with ARDS both in patients who lie prone in the traditional way and patients who lie prone alone in a conscious state.
3.	Claude Guérin (2017)	<i>Prone Positioning Acute Respiratory Distress Syndrome Patients</i>	Patients experiencing <i>Acute Respiratory Distress Syndrome</i> (ARDS) and being treated in the <i>Intensive Care Unit (ICU)</i>	<i>Prone</i> position (lying on your back with your face facing down) in ARDS patients.	No control group	Measurement of parameters such as: Blood oxygenation level, <i>Ventilator-induced lung injury (VILI)</i> , Patient survival	<i>prone</i> position significantly improves oxygenation in many ARDS patients.
4.	Mark L. Hepokoski, Mazen Odish, Arul Malhotra, (2020)	<i>Prone position in Acute Respiratory Distress Syndrome: Why aren't We Using it More?</i>	Patients with Acute Respiratory Distress Syndrome (ARDS)	The patient is placed in a prone position (lying on his back with his face facing down).	No control group	Evaluate the effectiveness of the prone position in increasing oxygenation and improving outcomes in ARDS patients.	The prone position has been shown to be effective in improving oxygenation in ARDS patients.
5.	Claude Guérin, Richard K. Albert, Jeremy Beitler,	<i>Prone Position in ARDS Patients: Why, When, How</i>	ARDS patients after COVID-19	Changing the patient's position from <i>supination</i>	No control group	<i>Literature review</i> , a review of relevant scientific and clinical literature regarding the	<i>prone</i> position provides several significant benefits for patients with ARDS. especially in

	Luciano Gattinoni, Samir Jaber, John J. Marini, Laveena Munshi, Laurent Papazian, Antonio Pesenti, Antoine Vieillard-Baron and Jordi Mancebo (2020)	<i>and for Whom</i>		to <i>pronation</i> for a period of 12-16 hours per day. Application of the <i>prone position</i> in patients with ARDS, both intubated and spontaneously breathing (such as in COVID-19 patients before intubation).		application of the prone position in patients with ARDS.	severe cases. The <i>prone position</i> has been shown to significantly improve oxygenation by improving the distribution of ventilation and perfusion in the lungs, which is more even when the patient is in the prone position compared to the supine position.
6.	Garrett L. Rampon, Steven Q. Simpson, and Ritwick Agrawal (2023)	<i>Prone Positioning for Acute Hypoxemic Respiratory Failure and ARDS A Review</i>	Involving 2,669 patients with a meta-analysis of 11 randomized controlled trials and 19 randomized controlled trials non-randomized controlled trial	<i>Prone positioning</i> in patients with severe ARDS or acute <i>hypoxemic respiratory failure</i>	Patients placed in a <i>prone position</i>	This study used a randomized controlled clinical trial to evaluate the effects of prone positioning on patients with ARDS and acute <i>hypoxemic respiratory failure</i> . Patients were divided into two groups: one group placed in the prone position for more than 12 hours per day, and the other group placed in the supine position.	<i>Prone positioning</i> significantly reduces mortality in patients with severe ARDS. Studies have also shown a reduction in the need for mechanical ventilation in patients with acute <i>hypoxemic respiratory failure</i> , including those not intubated during the COVID-19 pandemic.
7.	Giri Susanto, Lestari Sukmarini (2022)	<i>The Effectiveness of Prone Positioning in Patients with Acute Respiratory Distress Syndrome: A Literature Review</i>	Reviewing 11 articles based on criteria related to the topic of the effectiveness of <i>prone positioning</i> on increasing oxygen saturation in ARDS patients.	<i>Prone positioning</i> in ARDS patients	No control group	Literature search using scientific databases such as <i>Proquest</i> , <i>ScienceDirect</i> and <i>Pubmed/medline</i> with keywords <i>acute respiratory distress syndrome</i> or severe <i>hypoxemia</i> and <i>positioning therapy</i> or <i>prone positioning</i>	Shows that <i>prone positioning</i> can increase oxygen saturation in ARDS patients, with varying durations of <i>prone</i> positioning, averaging 30-90 minutes.

8.	Laveena Munshi, Lorenzo Del Sorbo, Neill KJ Adhikari, Carol L. Hodgson, Hannah Wunsch, Maureen O. Meade, Elizabeth Uleryk, Jordi Mancebo, Antonio Pesenti, V. Marco Ranieri, and Eddy Fan (2017)	<i>Prone Position for Acute Respiratory Distress Syndrome A Systematic Review and Meta-Analysis</i>	Reviewing the literature from systematic reviews published in 2010, searching <i>Medline</i> , <i>Embase</i> , and <i>Central</i> (up to August 2016) based on relevant criteria regarding <i>Prone Position for Acute Respiratory Distress Syndrome</i>	Systematic Review and Meta-Analysis	No control group	This study was conducted with a systematic review and meta-analysis examining randomized controlled trials (RCTs) comparing prone versus supine positioning in mechanically ventilated adults with ARDS, and performed sensitivity analyses to explore the effects of prone ventilation duration, concurrent lung-protective ventilation, and ARDS severity.	In our systematic review of eight randomized trials evaluating prone versus supine positioning for adults undergoing mechanical ventilation, we found a reduction in mortality when prone positioning was used in patients with moderate to severe ARDS ($\text{PaO}_2/\text{FIO}_2 < 200$) and for longer duration (>12 hours). However, prone positioning is not without risks, and is associated with an increased risk of endotracheal tube obstruction and pressure ulcers.
9.	Aggi Gregia Muhammad Iqbal, Cecep Eli Kosasih, Etika Emaliyawati (2023)	<i>The Effect of Prone Position on Improving Oxygenation in Acute Respiratory Distress Syndrome (ARDS) Patients: A Systematic Review</i>	Respondents came from several related studies	ARDS patients using the <i>prone position</i>	Patients who do not use the <i>prone position</i>	This study uses a <i>systematic review method with Randomized Controlled Trials (RCT)</i> research criteria from 2010-2020.	A systematic review of several clinical studies showed that the prone position is effective in increasing oxygen saturation, especially when used long-term. Furthermore, this technique has also been shown to reduce mortality in ARDS patients on ventilators.
10.	Dewa Ayu Ari Rama Dewi, Tuti Herawati (2024)	<i>Effectiveness of Prolonged Prone Positioning in Acute Respiratory Distress Syndrome Using Mechanical Ports: A Systematic Review</i>	Respondents in this study were adult patients with acute respiratory distress syndrome (ARDS) and requiring mechanical ventilation. This	This study used a retrospective observational descriptive approach and involved a literature search of several <i>databases</i> , including <i>ScienceDirect</i> ,	No control group was explicitly mentioned in any of the studies analyzed. However, several studies included in	The authors conducted searches in several <i>databases</i> , including <i>ScienceDirect</i> , <i>Proquest</i> , <i>PubMed</i> , and <i>Scopus</i> , using relevant keywords such as " <i>prolonged prone position</i> ," " <i>ARDS</i> ," " <i>benefit</i> ," and " <i>complication</i> ."	Prolonged <i>prone positioning</i> has been proven effective and safe for patients. Its benefits in patients with oxygenation problems include improving pulmonary ventilation and reducing the body's metabolic rate. <i>Prone positioning</i> improves <i>cardiac index</i> , mean arterial pressure, and DO_2 in invasively ventilated patients

			study included a variety of studies identified through a search, including 533 respondents from five <i>systematic review journals</i> .	<i>Proquest</i> , <i>PubMed</i> , and <i>Scopus</i> , with strict inclusion and exclusion criteria to ensure the relevance and quality of the articles included in the review.	the systematic review used a design that compared outcomes between patients who received prolonged prone position intervention with patients who did not receive the intervention or who received standard care.	with ARDS, making it <i>highly</i> recommended for patients with ARDS.
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4. CONCLUSION

the reviewed literature, it can be concluded that prone positioning is an effective intervention for improving oxygen saturation in patients with Acute Respiratory Distress Syndrome (ARDS). Evidence demonstrates that this position enhances oxygenation, reduces ventilator-induced lung injury (VILI), and improves clinical outcomes for patients admitted to the Intensive Care Unit (ICU). Despite its significant clinical benefits, potential risks—such as endotracheal tube obstruction and pressure ulcers—must be carefully considered. Therefore, prone positioning must be performed with caution and under strict medical supervision.

Recommendations:

Based on the findings regarding the application of prone positioning to improve oxygen saturation in patients with ARDS, the following measures are recommended:

- a. **Nursing Education & Training:** Provide comprehensive training for nurses and healthcare personnel regarding the techniques and clinical benefits of prone positioning. Ensure staff are thoroughly proficient in operational procedures, indications, contraindications, and patient monitoring during therapy.
- b. **Protocol Implementation:** Develop and enforce clear, standardized nursing protocols for prone positioning in ARDS management. These protocols should delineate patient eligibility criteria, optimal positioning durations, and preventative steps to minimize complications.
- c. **Patient Monitoring:** Maintain continuous, rigorous monitoring of vital signs—specifically oxygen saturation, respiratory rate, and blood pressure—to evaluate real-time clinical responses to therapy.
- d. **Risk Assessment:** Conduct thorough pre-procedural risk evaluations, addressing potential pressure ulcers, airway obstructions, and patient discomfort, while proactively applying preventative measures.
- e. **Interprofessional Collaboration:** Maintain structured communication within the multidisciplinary care team to align treatment plans, evaluate ongoing patient status, and ensure a holistic approach to care.

- f. Psychosocial Support: Offer continuous psychological support and clear education to patients and their families, mitigating anxiety related to frequent positional shifts by explaining the therapeutic benefits.
- g. Outcome Evaluation: Systematically evaluate post-intervention clinical outcomes, including variations in oxygen saturation and overall patient progress, utilizing these data to refine individualized care plans.

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