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Literature Review

Assessment of "Proning" Nursing Intervention to Increase ROX Index in COVID-19 Patients: A Literature Review

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ABSTRACT

Background: *COVID-19 has become a global crisis that has created public health problems. The impact of COVID-19 infection primarily affects the respiratory tract. The most prominent impairments in COVID-19 infection include difficulty breathing and decreased blood oxygen saturation. This review aims to identify available literature related to the effects of proning techniques on improving respiratory rate and oxygenation (ROX) indices, namely SPO2 and PaO2/FiO2 fractions, in patients with acute respiratory distress syndrome (ARDS) due to COVID-19.*

Methods: *A literature review design was employed. An online search strategy was conducted using major electronic databases, including Scopus, PubMed, Science Direct, ProQuest, and Google Scholar. This review design used the Preferred Reporting Items for Systemic Review and Meta-Analysis (PRISMA) Guidelines. The literature sources reviewed ranged from 2020 to 2025. Ten articles met the criteria and were reviewed.*

Results: *A total of 387 articles met the screening criteria: 159 articles were identified after screening for duplication, 25 articles met the criteria for full-text review and eligibility, and 15 articles were excluded due to study design and irrelevant results. Ten articles met the criteria and were reviewed.*

Conclusion: *Proning is the use of a prone position that can improve the body's oxygenation adequacy index, both ROX with the SpO_2 indicator and the PaO_2/FiO_2 ratio, and these findings highlight the health practice that healthcare professionals play a key role in assessing oxygenation status, safely applying prone positioning, and closely monitoring patient responses to optimize respiratory outcomes.*

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INTRODUCTION

SARS-CoV-2 is the cause of the pandemic COVID-19 cases, which have made a challenging era with the birth of new mutated variants. The World Health Organization has announced the end of the pandemic, but the crisis is still very worrying with the number of new variants that have mutated, such as the Alpha, Beta, Gamma, Delta, and

Omicron variants (Manirambona et al., 2024). WHO, (2022) as of April 13, 2022, released 500,186,525 confirmed cases with Covid-19 and 6.190.349 cases of death. In Indonesia, as of April 13, 2022, the number of confirmed cases of Covid-19 reached 6.036.909 cases.

The total number of cases declared cured reached 5.814.688 people and the total number of patients who died reached 155,746 people (Kemkes RI, 2022). Although WHO declared COVID-19 no longer a global health emergency in 2023, the virus continues to circulate with emerging subvariants that still pose respiratory risks, especially in vulnerable populations. Post-pandemic clinical data indicate that episodes of acute hypoxemia and ARDS remain present, demonstrating that effective respiratory management strategies continue to be relevant (Islam et al., 2025).

The impact caused by people infected with COVID-19 is very complex, namely experiencing multisystem disorders, especially in the respiratory system. The symptoms caused vary greatly from mild to severe, such as upper respiratory tract infections and loss of the sense of smell and can cause a decrease in oxygen saturation in the body. According to toThe WHO and China have shown that of the 55.924 laboratory-confirmed COVID-19 cases in China, 6.1% were classified as critical conditions (respiratory failure, shock, and dysfunction or failure of several organs) and 13.8% as severe (dyspnea, respiratory rate ≥30 breaths per minute, oxygen saturation ≤93%, partial pressure of arterial oxygen to oxygen fraction with a ratio of PaO2/FiO2 <300 mm Hg, and a >50% increase in lung infiltrate within 24-48 hours) (WHO, 2020).

The management of acute respiratory distress syndrome (ARI) patients with COVID-19 presents a challenge for healthcare providers in low-income countries with limited resources. The primary goal of healthcare for COVID-19 patients, particularly nurses, is to ensure effective breathing. Efforts to ensure adequate oxygen saturation in patients experiencing mild respiratory failure include oxygen ventilation to raise the pulse oximetry target to ≥90% by administering Non-Invasive Ventilation (NIV) or High-Flow Nasal Cannula (HFNC) to patients with mild ARDS. Patients with worsening respiratory function or multiorgan failure are intubated. Moderate respiratory failure with PaO2/FiO2 values ≤200 mm Hg requires moderate to higher positive end-expiratory pressure. Severe respiratory failure with PaO2/FiO2 values ≤100 mm Hg requires neuromuscular blockade and prone positioning to achieve a good oxygenation response (Phua et al., 2020).

The severity of lung infection in COVID-19 patients can progress to impaired pulmonary ventilation/perfusion, resulting in insufficient oxygenation in the body. Treatment of COVID-19 patients according to health protocols strongly recommends the application of proning for more than 12 hours/day and providing oxygenation through mechanical ventilation with a lower tidal volume (4-8 ml/kg body weight) and lower inspiratory pressure (plateau pressure <30 cm H_2O). The effectiveness and importance of proning is part of a strategy to increase blood oxygenation capacity in patients with acute respiratory distress syndrome (Fan et al., 2017).

The practice of proning in adult respiratory distress syndrome patients has been practiced since approximately the 1970s, with clinical results showing a significant increase in oxygenation adequacy (Gattinoni et al., 2023). The American Association of Critical-Care Nurses explains that the purpose of applying proning to patients experiencing acute respiratory distress due to COVID-19 infection is to provide adequate oxygenation for patients and reduce mortality rates (AACN, 2023). The application of proning should be actively considered as a therapeutic option to improve

adequate oxygenation in the blood in patients with acute respiratory distress (Park et al., 2021). Recent evidence also indicates that body positioning can influence oxygenation patterns. A study showed that prone posture improves nasal airflow and ventilation dynamics in patients with obstructive sleep apnea, supporting the physiological benefits of proning for enhancing oxygenation (Yang et al., 2024).

There is a wealth of information available on proning in the literature. However, limited clinical evidence exists regarding the effect of proning on improving oxygen saturation in nursing care for patients with acute respiratory distress syndrome (ARDS) COVID-19, both hospitalized and self-isolating. Therefore, a review of the available literature on proning is needed to enhance the independent role of nurses as the spearhead of healthcare services in improving the quality of nursing care.

The purpose of this literature review is to evaluate the available literature on the effect of proning on blood oxygen saturation (SPO2, fractional PaO2/FiO2 ratio) in hospitalized patients with acute respiratory distress syndrome (ARDS) COVID-19. Strengthening the evidence on proning is crucial not only for improving current clinical practice but also for enhancing nursing preparedness and healthcare system resilience in anticipating future respiratory outbreaks or emerging infectious diseases with ARDS-like presentations (Nie et al., 2022; Frontiers et al., 2024).

MATERIALS AND METHOD

Data Source Collection Design and Strategy

This study used a literature review design because it allows the synthesis of the most recent and relevant evidence regarding proning, hypoxemia, and the ROX index in COVID-19 patients, especially as research in this area continues to evolve rapidly. A literature review is appropriate when the purpose is to summarize current knowledge, compare methodological findings across multiple studies, identify consistent patterns of outcomes, and highlight gaps that require further investigation. The search utilized the following electronic databases: Scopus, PubMed, Science Direct, ProQuest, and Google Scholar.

The literature search process was conducted on research publications from the last 5 years, ranging from 2020 to 2025, in English and full-text articles. Articles were identified using terms related to medical subject headings (MeSH) with keywords such as “Proning OR Prone Position” AND “Hypoxemia” AND “ROX OR respiratory rate and oxygenation index” AND “Covid-19”. Before the search, all authors reviewed the proposed search term list and made necessary changes.

All authors checked the reference lists of eligible and relevant articles to identify additional articles not indexed in the searched databases. Writing the search results followed appropriate protocols and rules using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) checklist and flow diagrams.

Eligibility Criteria

Full texts were reviewed to ensure they met the following criteria: (1) articles were based on new, peer-reviewed research written in English, (2) studies aimed to investigate the effect of proning techniques; (3) studies using prospective, cross-sectional, or retrospective longitudinal designs in COVID-19 patients found to improve oxygenation adequacy outcomes; prospective randomized and non-randomized comparative studies of these interventions were included; (4) articles without full text

and not explaining the effect of proning on oxygenation adequacy outcomes were excluded with a study limit of 2020-2025.

To determine the inclusion and exclusion criteria for the article search, the PICOT guide was used as described in Table 1.

Table 1. Format PICOS

PICOT Framework	Inclusion and Exclusion Criteria
Population	Patients with confirmed respiratory distress of COVID-19
Intervention	Proning Technique
Comparison	Indefinitely
Outcomes	ROX index (SPO2, PaO2/ FiO2 fraction)
Time	2020-2025
Study design	Randomized controlled trials (RCTs), longitudinal prospective, cross-sectional, cross sectional, and retrospective
Publication years	2020-2025

Data Extraction

This literature review follows the recommended reporting guidelines for systematic reviews and meta-analyses (PRISMA) (Polit, 2018). The steps taken include (1) eliminating duplicates; (2) self-checking titles, abstracts, and keywords and discarding irrelevant articles based on the inclusion criteria; and (3) checking titles and abstracts that meet the inclusion criteria and are appropriate.

Quality Appraisal

Methodological quality and riskof bias were independently assessed by two reviewers using the Joanna Briggs Institute (JBI) critical appraisal tool. Disagreements during selection or appraisal were resolved through discussion or adjudicated by a third reviewer when necessary.

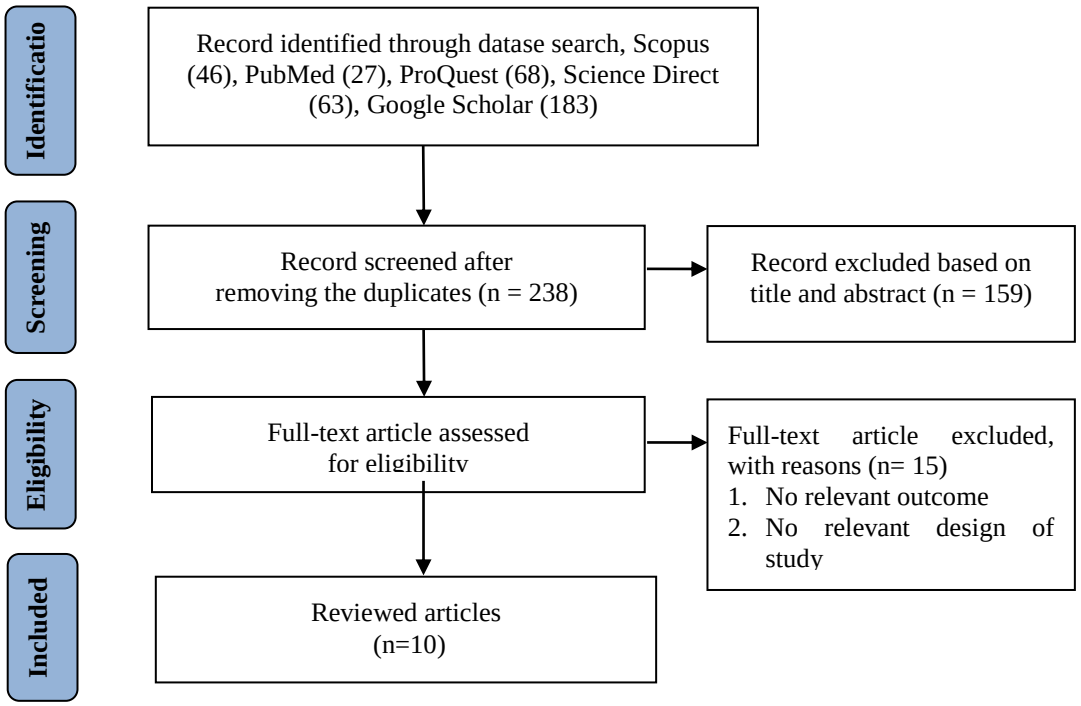

Figure 1. Search Results and Study Selection

RESULTS

A total of 387 pieces of literature met the screening criteria of Scopus (46), PubMed (27), Science Direct (63), ProQuest (68), and Google Scholar (183). 238 articles were found after screening for duplication, 159 articles were eliminated due to irrelevant titles and abstracts, 25 articles met the criteria for full-text review and eligibility, and 15 articles were excluded due to irrelevant results, study design, and data. There were 10 articles that met the criteria reviewed in this review (Figure. 1). Of the 10 articles reviewed, 3 (30%) were from Asia (India, Iran, Turkey), 5 (50%) were from Europe (Italy, France, England, Portugal, and Canada), 1 (10%) was from the Americas, and 1 (10%) was from Africa (Madagascar).

The sample size for each article varied between 17 and 123 respondents. The included studies included confirmed COVID-19 patients aged 18+. Two (20%) were published in 2020, three (30%) in 2021, one (10%) in 2022, three (30%) in 2023, and one (10%) in 2024. The research designs of each of the literature were 1 (10%) randomized controlled trial (RCT), 1 (10%) cross-sectional survey, 1 (10%) quasi-experimental, 4 (40%) retrospective, and 3 (30%) prospective.

The results of the analysis of articles related to the application of the proning effect in improving the ROX (respiratory rate and oxygenation) index value in COVID-19 ARDS patients are as follows:

Of the 10 articles analyzed, all studies showed that proning can improve the ROX index in COVID-19 patients with acute respiratory distress. Three articles identified proning to improve the ROX index through the SPO2 indicator (the first, second, eighth, ninth, and tenth articles), and four articles were related to the PaO2/FiO2 fraction indicator (the third, fourth, fifth, sixth, and seventh articles). The first literature analysis showed that awake proning prevented COVID-19 complications, increased SPO2 even to hospital discharge, and reduced hospital stay.

The second article showed that proning showed a significant improvement in short-term clinical outcomes in non-intubated COVID-19 patients. Proning was associated with significant improvements in oxygen saturation (SpO2) ($P=0.001$), RR ($P=0.004$), dyspnea severity ($P=0.014$), and MAP ($P=0.027$). The eighth article showed that proning could increase peripheral oxygen saturation (SpO2) to 98% (92–100) in the prone position compared to 91% (84–95) in the supine position. The ninth article showed that low pulse oximetry/oxygen saturation (SpO2) readings significantly improved with the proning technique. Proning significantly increased oxygen saturation (SpO2) (5% increase in pulse oximetry readings).

Median pulse oximetry increased by 83% (interquartile range, 75%-86%) on room air, 90% (interquartile range, 89%-93%) with supplemental oxygen, and 96% (interquartile range, 94%-98%) with proning ($Z=-4.48$, $P<0.001$), and the tenth article showed proning increased SpO2 in COVID-19 patients. There was a significant difference between the proning and control groups in SpO2 between the first 4 days after admission and the day of discharge ($F=3.17$, $P<0.001$). In the proning group, there were no cases of severe or critical transformation and no deaths. The proning group had a significantly lower decline in condition compared to the control group ($\chi^2=9.962$, $P<0.01$).

The results of the third literature analysis related to oxygen saturation measured by the PaO2/FiO2 ratio fraction, namely the third, fourth, fifth, sixth, and seventh literatures. The third article shows that all COVID-19 patients with acute respiratory distress who underwent proning experienced an increase in SpO2 and PaO2/FiO2. The

fourth article showed that proning was well tolerated hemodynamically, with an increase in PaO2/FiO2 (78 [68;96]), and had no effect on the risk of intubation and mortality.

The fifth article showed that proning was proven to be effective and well tolerated, could help avoid intubation, and showed an increasing trend towards PaO2/FiO2. While the sixth article showed that proning effectively increased the ROX index (SpO2/FiO2 respiratory rate, breaths/minute) significantly compared to controls (10.7[3.8] vs. 6.7[2.6], P<0.001). Furthermore, the seventh article showed that proning significantly improved oxygenation in patients with SARS-CoV-2 pneumonia, with a mean increase of 21.27% between the PaO2/FiO2 ratio before and after the proning procedure.

DISCUSSION

The Effect of Proning on Increasing the ROX SpO2 Index Value

The findings of the first, second, eighth, ninth, and tenth articles show that the use of proning improves the ROX index value as measured by SPO2 and the PaO2/FiO2 ratio. These findings suggest that proning helps reduce compression on the pulmonary cavity and right ventricle, improving ventilation distribution and gas exchange, thus leading to improved oxygenation adequacy. The results of this literature review are consistent with several other studies. The use of the prone position effectively increases oxygen saturation (0.000<0.05) in COVID-19 patients at Hermina Banyumanik Hospital (Nurani et al., 2023). The use of the prone position increased SpO_2 with a mean difference (MD) of 4.17 and a 95% CI of 2.53 to 5.81 ($p \leq 0.00001$), which was better than the supine position in COVID-19 patients (Chua et al., 2021).

Previous findings have also reported that the prone position increases the oxygen saturation level (SpO2) in the blood of premature neonates admitted to the neonatal intensive care unit (Mostafa et al., 2023). Additionally, at least 60% of patients showed an improvement of 2% or more within 10 minutes of proning. Proning in non-intubated patients improves oxygen saturation (Qayyum et al., 2022). The use of the prone position while conscious resulted in an increase in SpO2, PO2, and SaO2 of 7/13 (54%), 5/13 (38%), 2/13 (15%), and 1/13 (8%), respectively (Anand et al., 2021).

Proning Effect on Increasing the Value of the ROX PaO2/FiO2 Index

The findings of the third, fourth, fifth, sixth, and seventh literature studies show that the use of proning can improve the ROX index value as measured by PaO2/FiO2. This finding is possible because the prone position physiologically helps open the back of the lungs that are compressed when the patient is in the supine position. By opening this area, more oxygen will enter the alveoli, thereby improving gas exchange and oxygen saturation in the blood. In addition, the prone position helps reduce pressure in the mediastinum (the space between the lungs), which allows better airflow to the lungs. The prone position also helps distribute oxygen more evenly throughout the lungs, thereby increasing oxygen levels in the blood, which in turn can improve the ROX index.

The results of this literature review are also consistent with several other relevant studies. Improved oxygenation and the PaO2:FIO2 ratio were observed after the first prone position in patients with moderate to severe acute respiratory distress syndrome (Lee et al., 2020). Another similar study also revealed that using the prone position can

improve oxygenation with a PaO_2/FiO_2 ratio of ≥ 99.465% from baseline to after three cycles of prone positioning (Liang et al., 2024).

Table 2. Summary of The Literature Reviewed

Author	Country	Design	Sample	Purpose	Variable	Result
(Andriananja et al., 2024)	Madagascar	Retrospective cohort studies	123	To evaluate the benefits of proning for severe Covid-19 patients.	The effect of proning on hemodynamic stability in COVID-19 patients	Proning increases SPO2 even after leaving the hospital.
(Yarahmadi et al., 2023)	Iran	Clinical trial	82	To investigate the effect of proning on clinical out-comes of COVID-19 patients.	Proningin COVID-19 patients, clinical outcomes	Proning was associated with a significant increase in oxygen saturation (SpO2) (P = 0.001).
(Sartini et al., 2020)	Italy	Cross-sectional survey	15	To measure respiratory parameters before, and after receiving proningin COVID-19 patients.	Influence of proning techniques, respiratory parameters	All COVID-19 patients with acute respiratory distress who were prone experienced an increase in SpO2 and PaO2/FiO2.
(Jouffroy et al., 2021)	France	Retrospective observational studies	40	To evaluate the benefits of proning in Covid-19 respiratory failure patients.	Influence of proning technique, PaO2/FiO2, complications of proning technique	Proning was well tolerated hemody-namically, with an increase in PaO2/FiO2 (78 [68;96]), and had no effect on the risk of intubation and mortality.
(Ding et al., 2020)	Chicago	Prospective observational cohort studies	20	To determine whether the use of proning can avoid the need for intubation in ARDS patients.	Effects of proning techniques, intubation risk, PaO2/FiO2	Proning has been shown to be effective and well-tolerated, can help avoid intubation, and shows a trend toward improvement in PaO2/FiO2.
(Sryma et al., 2021)	India	Prospective interventi	45	To investigate whether proning improves	Proning technique, oxygenation	Proning increased the ROX index

Author	Country	Design	Sample	Purpose	Variable	Result
		on studies		oxygen-ation and prevents intubation when used early.	parameters	(SpO2/FiO2 respiratory rate) at 30 minutes compared to control (10.7 [3.8] vs. 6.7 [2.6], P < 0.001).
Manuela et al., (2023)	Portugal	Longitudinal Studies and retrospective	52	To evaluate the effects prone to the outcome of patients with SARS-Cov-2 pneumonia.	Proning technique, discharge of patients with SARS-Cov-2 pneumonia	The application of proning significantly improved oxygenation in SARS-CoV-2 patients, with an average increase of 21.27% between the PaO2/FiO2 ratio before and after proning.
(Solverson et al., 2021)	Canada	Retrospective cohort studies	17	To assess the tolerability and safety of proning in COVID-19 patients.	Proning technique, tolerance and safety of proning	Proning increases peripheral oxygen saturation (SpO2) by 98% in the prone position compared to 91% in the supine position.
(Mookerjee; et al., 2022)	England	Prospective study	55	To assess the physiological effects of proning in COVID-19 patients.	Proning techniques, physiological proning in COVID-19 patients	Proning increased oxygen saturation (SpO2) compared to the supine position (+1.62% difference; p=0.003), as measured by pulse oximetry.
(Işıldak et al., 2023)	Turkey	Quasi-experimental	40	To investigate the effect of proning on oxygen saturation in patients	Proning in COVID-19 patients, oxygen saturation (SpO2)	Proning has a positive effect on oxygen saturation (SpO2) levels in patients

Author	Country	Design	Sample	Purpose	Variable	Result
				COVID-19.		hospitalized with a diagnosis of COVID-19. The mean oxygen saturation values for each of the first four hours were 93.15±1.718 (p=0.035), 93.60±1.809 (p=0.019), 93.93±1.774 (p=0.006), and 94.15±1.718 (p=0.002).

Based on recent evidence, proning continues to be recommended as a frontline. Health practice intervention for patients with acute hypoxemia or ARDS related to COVID-19, particularly when the ROX index begins to decline despite standard oxygen therapy. Current guidelines suggest initiating proning when SpO_2 remains <94% on supplemental oxygen or when the PaO_2/FiO_2 ratio shows deterioration (Singer et al., 2023). Typical proning sessions range from 12–16 hours per day for moderate to severe ARDS, consistent with updated recommendations derived from post-PROSEVA evaluations and current clinical practice guidelines (Fan et al., 2023).

Health professionals play a crucial role in assessing appropriate candidates those who are hemodynamically stable, able to follow commands, and without contraindications such as unstable spinal injury, maxillofacial trauma, or severe obesity (Helms et al., 2023; SCCM, 2023). Continuous monitoring of oxygenation, hemodynamic status, comfort, skin integrity, and tolerance to positioning remains essential to maximize the benefits of improved ventilation-perfusion matching and to prevent complications (Chakraborty et al., 2023). Integrating this updated evidence into bedside practice supports early recognition of clinical deterioration, optimizes oxygenation, reduces intubation rates in selected patients, and contributes to improved patient outcomes.

This literature review had a significant degree of heterogeneity due to the exclusion of self-isolating COVID-19 patients and the inclusion of all study designs. Therefore, neither pooled analyses nor meta-analyses were performed, and no specific summary measures could be defined. Not all studies captured data in the same way, nor did they use the same definitions or timeframes for analysis. Although we conducted a systematic literature search, some studies meeting the inclusion criteria may have been missed.

CONCLUSION

Proning is the use of a prone position that can improve the body's oxygenation adequacy index, both ROX with the SPO2 indicator and the PaO2/FiO2 ratio. Implementing a prone position intervention is a factor that can improve oxygenation in

the body. We recommend that the patient's condition be continuously monitored, if necessary, under the supervision of a medical team, to reduce the risk of complications such as pressure injuries.

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