Prone Position as Intervention in Improving Oxygenation Status among Covid 19 Patients : An Integrative Review

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Abstract

Happy hypoxia is a major issue among Covid 19 patient. Prone position unsurely suggested intervention to boost the oxygen level. This integrative literture review aimed to describe the use of prone position improving oxygen level among Covid 19 patient. Keywords used during the online searching were *Covid 19 and prone position and hypoxia.* Inclussion criteria was only included original paper published in Bahasa Indonesia and English during 2020. Gray literature such as proceeding and unpublished thesis will be excluded. Critical appraisal tool using Olsen Baigh Scoring. There were three search enggine has been used *Google Schoolar, Pubmed, ScienceDirect.* Based on our finding there are 14 articles as final result. There are 57,14% (n=8) studies applied awake prone postion with oxygen therapy. Prone position also applied on intubated critically ill patient with supported device. Application of prone position in well alert patient might be modified based on patient tolerance. Outome of oxygen status were determine in blood gas analysis (BGA) result, oxygen saturation, Sequential Organ Failure Assesment (SOFA) score, and Acute Physiology and Chronic Health Evaluation (APACHE) score. Prone position is feasible applied as supportive treatment among covid 19 patient with our without ventilator. This intervention potentially improves oxygen saturation but do not decreased risk of mortality.

Keywords: Covid 19, prone position, hypoxia, oxygen level

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Introduction

The Covid 19 pandemic is a global issue that has occurred from the end of 2019 to the present. Based on Worldometer data (2021), since January 2021 there are 90,786,799 cases of infection in the world. The 3 countries with the most cases are USA, India and Brazil. In Southeast Asia, confirmed cases reached 12,286,356 as the third largest territory in the world with Indonesia and the Philippines as the largest contributors. This phenomenon has caused 1,944,981 deaths with current active case data 23,921,681 consisting of 99. 5% moderate mild infections (23,813,147) and 0. 5% severe infections with ICU care (108,534) (Wordmeter, 2021).

The high spread of Covid 19 infection has resulted in excessive burden of health service. Various countries have even set up additional health care centers and made predictions for additional hospital beds, ICUs, and mechanical ventilators. In Mexico, for example, by predicting the number of hospitalizations and ICU needs using the Hospital Impact Model for Epidemics (Fowler et al., 2020). With this model, the estimation of needs is based on 3 scenarios, namely, without social distancing, social distancing with an effectiveness of 50% and 60%. The results of this study indicate an increase in hospitalization, respectively, reaching 875. 9%, 322. 8%, and 203. 5%. Meanwhile, research in the US showed the needs of ICUs and ventilators during the pandemic using a comparison study before and after Covid 19 pestilence (Murray, 2020). In 2 weeks during the pandemic the need for beds reached 64,175; ICU380; and ventilators 19,481 (Murray, 2020).

The impact of the high need for ICU and ventilator on Covid 19 patients due to pathologic effect of happy hypoxemia (Dhont et al., 2021). Happy hypoxemia is defined as a state of low oxygen levels in the blood without characteristic clinical symptoms (Machado-Curbelo, 2020). Covid 19 patients usually come without experiencing severe shortness of breath, but after a CT scan there will be atelectasis and with oxymetry measurements or blood gas analysis, oxygen levels are below normal (less than 95%) (Haryalchi et al., 2021). Some of the pathophysiological mechanisms that cause hypoxia in Covid 19 patients include intrapulmonary shunting, decreased pulmonary perfusion, intravascular microthrombus, and impaired mechanical preservation of the lungs due to sputum and virus production (Dhont et al., 2021).

Based on clinical management guidelines, oxygen therapy is given to treat hypoxia starting from the administration of nasal canules to non-rebreathings masks as the first line (WHO, 2013). If the patient has fallen on ARDS, a mechanical ventilator is needed to provide occipagenation assistance (Shang et al., 2020). However, the limited resources of mechanical ventilators and health staff in the intensive care field are inversely proportional to the needs of patients during a pandemic. This requires complementary management that can delay the use of mechanical ventilators and treat hypoxia. Based on several clinical studies, providing a prone position can improve the oxygenation status of Covid 19 patients (Lindahl, 2020). The assignment of this position is a new intervention in the management of Covid 19 patients. This research was conducted in an effort to provide recommendations for clinical decision making in evidence-based practice of treating Covid 19 patients.

Method

Study Design

This research design uses an integrative review. This methodology is a literature study that aims to analyze current knowledge about a topic. The results of this study can be an outcome in making policies, protocols, procedures and critical assessment in the formulation of evidence based practice (EBP) in the world of health and nursing. According to Souza et al (2010) there are 6 phases in conducting an integrative review.

This phase includes preparing a research question guide; literature search;

Searching Strategy

The first step in this study is to use the PICO approach in formulating research guidelines. In accordance with the formulation of the problem, the purpose of this study is to analyze the application of prone position to increase the oxygenation status of Covid 19 patients. The detailed PICO formulation is presented in table 1. Based on the PICO formula, the researcher decided to use the keywords covid 19 and prone position and hypoxia.

Table 1. PICO approach with Medical Subheading

	Contextual research determination	*Medical subheading*
Population	Patient Covid 19	Covid 19
Intervention	Prone position intervention	Prone position or PP
Comparisson	-	
Outcome	Oxygen status	Oxigenation, hypoxia, oxygen level, SpO2, PaO2

The search strategy in this study was to search online literature on health-based academic search engines. There are 3 search engines used, namely PubMed, ScienceDirect, and Google Schoolar. Search using keywords that have been formulated previously including Boolean technique: "covid 19 AND prone position AND hypoxia". As an initial detection, the 2020 publication search filter is used.

Data Selection

Related to the research outcome that wants to provide recommendations for the practice of managing hypoxia in Covid 19 patients by giving pronation positions, the researcher only included original research-based articles such as : case report / case series studies; prospective / retrospective obeservational studies; experimental studies with or without a comparison group. Expert opinions, letters to editors, commentary reports and reviews will be excluded from the sample criteria. The articles used are articles in English that can be accessed in full text. The data tracing was carried out on December 11, 2020.

Data collection, extraction and synthesis

The data collection process in this study is summarized in a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart that describes the results of the article filtering at the identification, screening, and eligibility stages. Data extraction used the table in Micrsosoft word 2007. In this table, data was collected regarding the author / author, title, research design, number of samples, characteristics of the samples involved in the study, details of pronation positions, and the impact of pronation positions on the oxygenation status of Covid 19 patients. The synthesis analysis was carried out qualitatively by describing the characteristics of the sample articles, the variance of the pronation position technique, the variation in the management of the oxygenation status of Covid patients, and the effectiveness of the prone position in the management of hypoxia in Covid patients 19.

Critical Appraisal Tool

The quality appraisal technique in this study used assessment tool for integrative review. This tool included the type of study, the sampling technique, the data collection method, and the sampling technique (Olsen, 2014). During, at least 2 researchers are

carried out. Each researcher conducted an independent assessment. Then the final results are compared. If the scores are not the same, a third researcher is required to conductdecide as the with a final result.

Data Extraction and Syntesis

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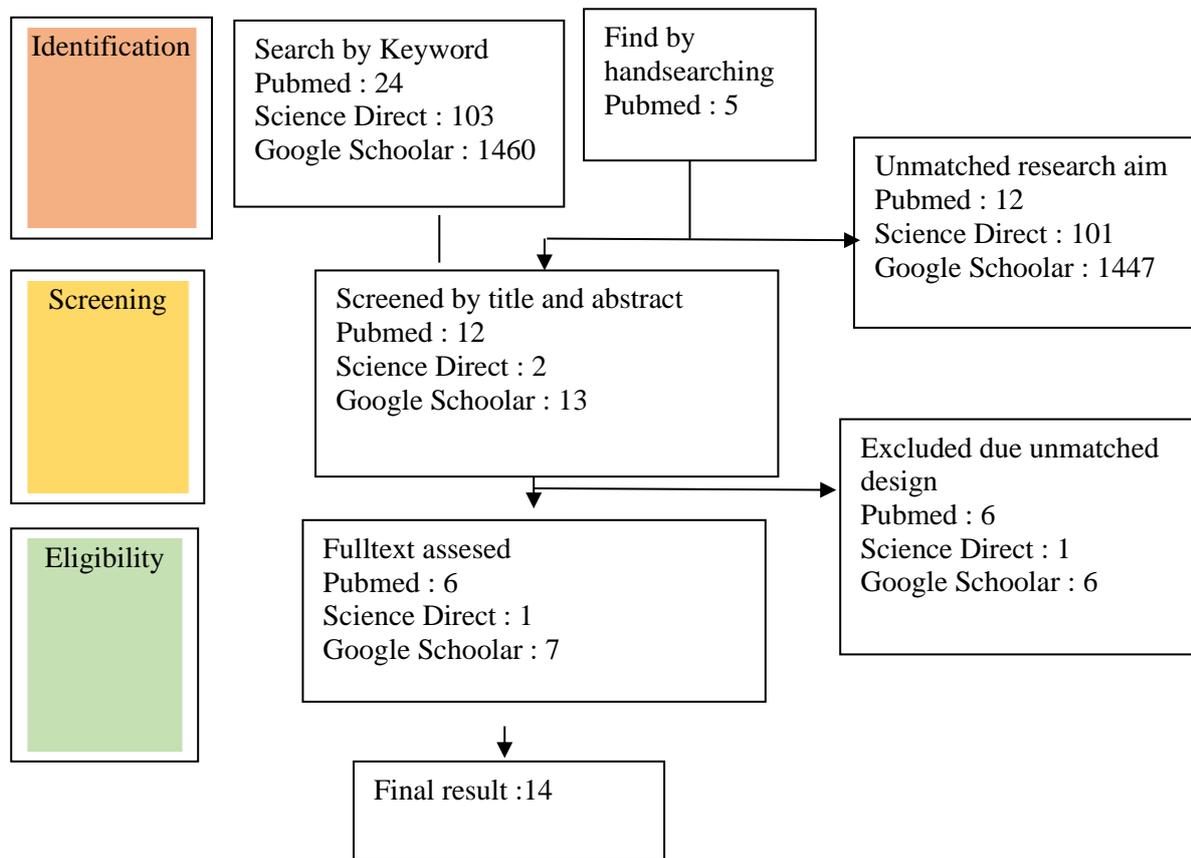

Figure 1. PRISMA Flowchart

Results

Article Characteristic

The final articles used in this study were mostly 28.57% (n = 4) published in the journals of anesthesia and intensive care (Journal of Intensive Care Medicine, Anesthesia report case in clinical practice, Canadian Journal of Anesthesia, Critical Care Explorations). Meanwhile, 21.24% (n = 3) were published in the Biomed Central Journal (BMJ); 14.28% (n = 2) journals in the scope of anesthesia and intensive care (Journal of Intensive Care Medicine, Anesthesia report case in clinical practice, Canadian Journal of Anesthesia, Critical Care Explorations); 14.28% (n = 2) journal scope of emergencies(Academic Emergency Medicine, The American Journal of Emergency Medicine) 2 articles from Respiratory Medicine Case Reports, and 21.14% (= 3) in other journals (Research Square, Case Report in Women's Health, Europe PMC). Based on the findings of 14 articles, 42.66% (n = 6) were case reports and 57.15% (n = 8) were quantitative studies. The quantitative study in this study was 50% (n = 4) prospective and 50% (n = 4) retrospective. Based on the whole article, there are 484 adult patients, 1 child patient aged 2 years, 1 elderly patient 73 years and 1 pregnant patient.

Table 2. Summary Content

Author	Title and Study Design	Sample	Prone Position Technique and unit setting	Outcome oxygenation
Paul et al (2020)	Proning in Non-Intubated (PINI) in Times of COVID-19: Case Series and a Review Case series and review	This study applied on 2 Covid 19 patients. Patient 42 years old on HFNC ,FiO2 of 0.5 ; flow of 30 L/min. Another 35 year old patient after extubated with oxygen suplementation FiO2 0,8	Awake PP given as tolarated with premedication Alprazolam and Hydroxyzine. Setting : ICU	Oxygenation getting better after 2-3 hours PP three times a day.
Whitemoore et al (2020)	Early Self-Proning in Awake, Non-intubated Patients in the Emergency Department: A Single ED's Experience During the COVID-19 Pandemic Cohort	50 Covid 19 patients on NC or NRB	Awake PP given 5 minutes and evaluated throuh pulse oxymentry Ward	SpO2 increaased on the average reached 94%

Table2. Summary Content (Cont.)

Author	Title and Study Design	Sample	Prone Position Technique and unit setting	Outcome oxygenation
Alseoudy et al(2020)	Awake proning of a 2-year-old extubated child with severe COVID-19 pneumonitis Case report	2 years old patient, during weaning process oxygen level decreased up to 84%.	PP given during reintubation. Oxygen supplementation using mask 10lpm. Both hands on sacrum. Chest, pelvic, and knee secured by pillow.PP and supine totation every 4 hours antill day 4. Setting : ICU	Clinical condition improved at day 5
Bastoni et al (2020)	Prone positioning in patients treated with non-invasive ventilation for COVID-19 pneumonia in an Italian emergency department Pilot Study	10 Covid patient without urgency to be ventilated, without comorbid, has given oxygen supplementation but no significant improvement	PP given on mild hypoxemia patient; PaO2 /FiO2 ratio of 68±5mm Hg with CPAP or helmet NIV. Continous morfin 20-30 mg/day administered to increase comfort.	Oxygen level increase after 1 hour PP measured by BGA PaO2 /FiO2 ratio (median 97±8mm Hg). Only 6 patient received PP : 1 death, 1 transfer into ward, 4 transfered intu ICU and 4 others refuse.
Winearls et al (2020)	Early conscious prone positioning in patients with COVID-19 receiving continuous positive airway pressure: a retrospective analysis Retrispective study	24 patients ARDS on CPAP with SpO2 under 94%.	PP given 30 hours after CPAP with full or semiprone position wthout sedation and antiaxiety.At least 1 nurse needed to asist the patient.First 24 hours PP 8±5hours continued 10±5 days. Setting : high care unit	PP increas ROX indeks (7.0±2.5 baseline vs 11.4±3.7) and arterial oxygen pressure (PaO2 :FiO2 ratio: 143±73mm Hg baseline vs 252±87mm Hg). Only 20 patient tolerated PP, 12 adopted full PP and 10 others do lateral position.

Table 2. Summary Content(Cont.)

Author	Title and Study Design	Sample	Prone Position Technique and unit setting	Outcome oxygenation
Ferrando et al(2020)	Awake prone positioning does not reduce the risk of intubation in COVID-19 treated with high-flow nasal oxygen therapy: a multicenter, adjusted cohort study	199 Covid patient with mechanical ventilation before HFNO (SpO_2 < 93% or at leaston NRB 15lpm.	This study compared oxygenation result between HFNO and HFNO + PP Setting : ICU	HFNO + awake PP reduce risk of intubation but not risk of mortality in 28 days.
Dubosh et al (2020)	Early, awake proning in emergency department patients with COVID-19 Cohort	Fully awake 59 Covid patients with oxygen level > 93% on NC or simple mask.	SpO_2:FiO_2 rasio evaluated after 35 minutes PP. Setting : IGD	SpO_2:FiO_2 ratio increased significantly (median: 298 (IQR: 263-352) vs 295 (IQR: 276-350).
Jacobson et al (2021)	Use of dexamethasone, remdesivir, convalescent plasma and prone positioning in the treatment of severe COVID-19 infection in pregnancy: A case report	Pregnant patient G8P6016, 42 years old severe fever, SpO_2 80% on NRB 15 LpM/ BGA pH 7.42, pCO2 24.3, PaO2 46.7, HCO3 15.7BE−8.7. Consolidated Xray on both thorax.	PP given 16-18 hours/day on intubated with ventaltor setting low tidal volume, FiO2 1005, PEEP 6cc/kgMedication dexamethasone 20 mg IV in 5 days;remdesivir 200 mg × 1; convalescent plasma ; azithromycin and ceftriaxone . At 29 weeks pregnancy patient got SC with baby weight 1310 gram. Setting : ICU	PP feasible given to pregnant patient without fetal distress effect. However left lateral position is recommended to reduced cava inferior compression.
Koeckerling et al (2020)	Awake Prone Positioning in COVID-19 Patients Retrospective case study	15 Covid patients hospilatlized in hifh care unit with SpO_2 < 90% cooperative to do PP.-	Awake PP done by patients voluntary as tolerated 1at least 1 hour after meal Setting : High care unit	PP increase oxygen level up to 98,8 % compared with supine position.
Solverson et al (2020)	Tolerability and safety of awake prone positioning COVID-19 patients with severe hypoxemic respiratory failure. Cohort retrospective	Fully alert 17 Covid patient without ventilator after resusitation (CPR, intubation and ventilator).	Initial PP given 75 minutes Setting : ICU and word	PP incrase oxygen saturation comapred with supine position. Supine 91% (84–95) vs PP 98% (92–100)

Table 2. Summary Content (Cont.)

Author	Title and Study Design	Sample	Prone Position Technique and unit setting	Outcome oxygenation
Cruz Salcedo et al (2020)	Use of Dexmedetomidine in Early Prone Positioning Combined With High-Flow Nasal Cannula and Non-Invasive Positive Pressure Ventilation in a COVID-19 Positive Patient Case report	73 years old Covid patient with commorbid asthma, hypothyroidism, hypertension, aand breast cancer remission.	PP given as complementary of High-Flow Nasal Cannula and Non-Invasive Positive Pressure Ventilation pn the average 4 hours a day. Dexmedetomidine injected to reduce anxiety Seting : ICU	Antianxiety and PP together increase oxygen level.
Elkattawy & Noori (2020)	A case of improved oxygenation in SARS-CoV-2 positive patient on nasal cannula undergoing prone positioning Case report	36 years old Covid patient after 3 days diagnosed without significant improvent with vancomycin, zosyn and azithromycin. On room air SpO2 < 88%	Awake PP done voluntary 6-8 hours a day along NC suplementation Setting: IGD	After 1 day, oxygenation status improved 95% during res and 90% during ambulation.
Jagan et al (2020)	The POSITIONED Study: Prone Positioning in Nonventilated Coronavirus Disease 2019 Patients—A Retrospective Analysis	105 Covid patient involed with 44 continoued to do PP	Based on medical report, only at least 5 times patient tolared did PP in a day involved on the study. ri.	PP reduced risk of intubation measured by *Sequential Organ Failure Assessment scores*
Astua et al (2020)	Proning During Pandemic: The Rapid Institution of a Safe, Transferable, and Effective Prone Positioning Program at Nychhc/elmhurst Hospital, A Situationally Resource Limited Facility, During the Peak of the Covid 19 Surge: Pilot study	Adult patient on ventilator less than 14 days with setting: PaO2 :FiO2 ratio (PFr)s ≤ 150 on FiO2 ≥ 0.6; positive end expiratory pressure (PEEP) ≥ 5 cm H2O	PROSEVA protocol length PP : supine postion= 16 hours : 8 hours. During postion transition sepcial equipment needed to secure midline(Anchorfast Oral Endotracheal Tube Fastener® (Hollister, Libertyville IL)..	PP based on PROCEVA protocol increase oxygenation measured by BGA indicators.

Table 3. Critical Appraisal Description

Author/year	Study Design	Sampling	Outcome measurement	Data analysis	Total score
Paul et al (2020) Journal of Intensive Care Medicine	1 case report	1 convinience sampling	1 (FiO2)	1 narative	4
Whitemoore et al (2020) Academic Emergency Medicine	4 quantitative	1 convinience sampling	1 pulse oxymetry	3 inferential	9
Alseoudy et al(2020) Anaesthesia report case in clinical practise	1 case report	1 convinience sampling	1 BGA	1 narative	4
Bastoni et al (2020) BMJ	4 quantitative	2 purposive sampling	1 PaO2 and FiO2	3 inferential	10
Winearls et al (2020) BMJ	4 quantitative	2 purposive sampling	1 PaO2 and FiO2	3 inferential	10
Ferrando et al(2020) Europe PMC	4 quantitative	2 purposive sampling	1 SOFA score, APACHE score, RR, SpO2	3 inferential	10
Dubosh et al (2020) The American Journal of Emergency Medicine	4 quantitative	2 purposive sampling	1 PaO2 and FiO2 ratio	3 inferential	10
Jacobson et al (2021) Case Report in Women's Health	1 case report	1 onvinience sampling	1 BGA	1 narative	4
Koeckerling et al (2020) Thorax BMJ	1 case report	1 convinience sampling	1 BGA	1 narative	4
Solverson et al (2020) Canadian Journal of Anaesthesia	4 quantitative	2 purposive sampling	1 SpO2 and FiO2	3 inferential	10

Table 3. Critical Appraisal Description (Cont.)

Author/year	Study Design	Sampling	Outcome measurement	Data analysis	Total score
Cruz Salcedo et al (2020) Respiratory Medicine Case Reports	1 case report	1 onvinience sampling	1 SpO2 and BGA	1 narative	4
Elkattawy & Noori (2020) Respiratory Medicine Case Reports	1 case report	1convinience sampling	1 SpO2	1 narative	4
Jagan et al (2020) Critical Care Explorations	4 quantitative	2 purposive sampling	SOFA score, APACHE score, RR, intubation onset, SpO2	3 inferential	10
Astua et al (2020) Research Square	4 quantitative	2 purposive sampling	1 BGA	3 inferential	10

Discussion

Based on the findings of the research, final result of this study included 14 articles.In this study, 57.14**% (**n = 8**)** PP was mostly given among concious and well alert patient known as the awake prone position.In performing PP, awake patients able to do proper position by their self or with minimal assistance from the nurse. Oxygen aid used during awake PP are varied such as : 4LPM nasal canul, 15LPM high flow nasal canul (HFNC), facemask, NRBM, CPAP helmet to CPAP. Meanwhile, PP was also given to intubated patients with mechanical ventilation in 43,86% (n=6). Additional equipment is required to secure the ventilator circuit during PP was Tube Fastener® (Hollister, Libertyville IL).

The PP administration technique varies according to patient tolerance. Awake PP is recommended at different intensities. Elkattawy & Noori (2020) recommend 6-8 hours per day while Koeckerling et al (2020) targeted 10-12 hours; and Alseoudy et al (2020) alternating position changes every 4 hours of pronation-supination. As for

intubated patients using the PROSEVA protocol, it is recommended that 16 hours of pronation position and 8 hours of supination position are recommended. For patients with mechanical ventilation, changing positions requires the assistance of at least 2-3 nurses. A pillow is needed to support the pelvis and chest so that the patient's abdomen hangs. Meanwhile, for conscious patients, PP is done independently and can even be adapted into a semiprone position according to patient tolerance. Conscious patients who take PP usually experience problems of discomfort, shoulder pain, anxiety, intestinal disorders such as nausea and vomiting. For this reason, PP awake is recommended to start a maximum of 1 hour before eating. Some patients even take nil orally when in the PP position. Several medicinal therapies used to treat anxiety and pain include aprazola, morphine, hydroxyzine, and Dexmedetomidine.

As a recommendation, awake PP can be a supportive therapy for the management of hypoxia in covid 19 patient. Jiang et al (2020) explained a protocol of PP that could

be applied at emergency room among concious patient. This protocol only suitable for fully alert suspected Covid 19 who undergo oxygen supplementation > 4Lpm. Patient will be educated with the steps doing PP and given hand out of the position. Firts position patient will be placed on reverse Trendelenburg or belly facing stretcher position meanwhile pillow support may required. In 30 minutes later, patients change second position into side lying on right. Third position into fowler position, and the last into side lying on left. Rotations are done by the patients as their tolarance. The nurse should do evealuation every 30 minutes in first 1 hour, and every 1 hour in the next hours. Patients are equiped with contious oxygen therapy and pulse oxymeter.

Bowe & He (2020) stated another approach of PP implementation. Inclution criteria of patient who needs PP are onset Covid 19 within 1 week with worsening respiratory symptom such as SpO2 < 94% on oxygen suplementation therapy , had bilateteral chest xray imaging and without heart failure condition. If those criterias exist PP is recommended in 30 minutes and do immediate evalutation. If the SpO2 increansed and under patience tolerance, PP will be contioued 2-3 times a day. Futher tolerability and sofety of PP also has been studied (Solverson et al., 2020). This study monitored 17 patients who received PP at ICU and ward. The average time tolerance patient on PP was 75 minutes. The barriers to maintain PP were back or shoulder pain (12%), general discomfort (35%), and delirium (6%). This study also declared PP was feasible to implemented only in one session course due tolerancebility reason.

The mechanism of PP in increasing oxygenation in ARDS cases is not certain. From the point of view of gravity, PP can limit the movement of the anterior chest so that the chest wall retraction is limited, the cross- sectional area of the posterior lungs increases to carry out gas transmission in the alveoli by involving more parenchyma tissue. This illustration is illustrated visually in figure 5 (Venus et al., 2020). Meanwhile, according to Lindahl (2020), the role of PP in hypoxia management is related to the role of the substance nitric oxide (NO) which increases oxygen perfusion in lung tissue through increased vascularity. The way this substance works utilizes citrulline media as a vasodilator. NO activity is associated with Nitric oxide synthase (NOS) and messenger ribonucleic acid (mRNA), which are more expressed in the endotheliar of the dorsal lungs than in the ventral region.

Conclusion

Based on the results 14 articles , awake PP is recommended as hypoxia management in COVID 19 patients. Initiation of PP awake can be done since the patient is in the emergency unit with an intensity that the patient can tolerate. PP can be applied to Covid 19 patients with a mechanical ventilator installed but requires more resources, both health workers and special devices to fix the airway. Awake PP can be recommended in the case of Covid 19 patients who experience hypoxia either in full or semiprone. Education related to physiological mechanisms to patients has the potential to increase patient empowerment and compliance in managing hypoxia. This intervention can be used in the referral trip setting, emergency department, follow-up care, ICU and high care unit. Minimal monitoring of deep breathing status using pulse oximetry is required for monitoring peripheral oxygen saturation. PP interventions cannot be used as a delay in intubation in patients experiencing shock and ARDS. As for the continued effectiveness of PP with a certain intensity, it is necessary to carry out further research with a randomized controlled trial design.

References

Alseoudy, M. M., Abo Elfetoh, M. A., & Alrefaey, A. K. (2020). Awake proning of a 2-year-old extubated child with severe COVID-19 pneumonitis. *Anaesthesia Reports*, *8*(2), 180–183. https://doi.org/10.1002/anr3.12084

Astua, A., Michaels, E., & Michaels, A. (2020). *Proning During Pandemic: The Rapid Institution of a Safe, Transferable, and Effective Prone Positioning Program at Nychhc/elmhurst Hospital, A Situationally Resource Limited Facility, During the Peak of the Covid 19 Surge*. 1–16. https://doi.org/10.21203/rs.3.rs-29653/v1

Bastoni, D., Poggiali, E., Vercelli, A., Demichele, E., Tinelli, V., Iannicelli, T., & Magnacavallo, A. (2020). Prone positioning in patients treated with non-invasive ventilation for COVID-19 pneumonia in an Italian emergency department. *Emergency Medicine Journal*, *37*(9), 565–566. https://doi.org/10.1136/emermed-2020-209744

Bower, G., & He, H. (2020). Protocol for awake prone positioning in COVID-19 patients: To do it earlier, easier, and longer. *Critical Care*, *24*(1), 20–22. https://doi.org/10.1186/s13054-020-03096-x

Cruz Salcedo, E. M., Rodriguez, L.-M., Patel, J., & Seevaratnam, A. R. (2020). Use of Dexmedetomidine in Early Prone Positioning Combined With High-Flow Nasal Cannula and Non-Invasive Positive Pressure Ventilation in a COVID-19 Positive Patient. *Cureus*, *12*(9), 9–13. https://doi.org/10.7759/cureus.10430

Dhont, S., Derom, E., Van Braeckel, E., Depuydt, P., & Lambrecht, B. N. (2021). Conceptions of the pathophysiology of happy hypoxemia in COVID-19. *Respiratory Research*, *22*(1), 1–10. https://doi.org/10.1186/s12931-021-01614-1

Dubosh, N. M. (2020). Early, awake proning in emergency department patients with COVID-19. *The American Journal of Emergency Medicine*. https://doi.org/10.1016/j.ajem.2020.11.074

Elkattawy, S., & Noori, M. (2020). A case of improved oxygenation in SARS-CoV-2 positive patient on nasal cannula undergoing prone positioning. *Respiratory Medicine Case Reports*, *30*(May), 101070. https://doi.org/10.1016/j.rmcr.2020.101070

Ferrando, C., Mellado-Artigas, R., Gea, A., Arruti, E., Aldecoa, C., Adalia, R., Ramasco, F., Monedero, P., Maseda, E., Tamayo, G., Hernández-Sanz, M. L., Mercadal, J., Martín-Grande, A., Kacmarek, R. M., Villar, J., & Suárez-Sipmann, F. (2020). Awake prone positioning does not reduce the risk of intubation in COVID-19 treated with high-flow nasal oxygen therapy: A multicenter, adjusted cohort study. *Critical Care*, *24*(1), 1–11. https://doi.org/10.1186/s13054-020-03314-6

Fowler, Z., Moeller, E., Roa, L., Castañeda-Alcántara, I. D., Uribe-Leitz, T., Meara, J. G., & Cervantes-Trejo, A. (2020). Projected impact of COVID-19 mitigation strategies on hospital services in the Mexico City Metropolitan Area. *PLoS ONE*, *15*(11 November), 1–14. https://doi.org/10.1371/journal.pone.0241954

Haryalchi, K., Heidarzadeh, A., Abedinzade, M., Olangian-Tehrani, S., & Tehran, S. G. (2021). The importance of happy hypoxemia in covid-19. *Anesthesiology and Pain Medicine*, *11*(1), 1–3. https://doi.org/10.5812/aapm.111872

Jacobson, J., Antony, K., Beninati, M., Alward, W., & Hoppe, K. K. (2021). Use of dexamethasone, remdesivir, convalescent plasma and prone positioning in the treatment of severe COVID-19 infection in pregnancy: A case report. *Case Reports in Women's Health*, *29*, e00273. https://doi.org/10.1016/j.crwh.2020.e00273

Jagan, N., Morrow, L. E., Walters, R. W., Klein, L. P., Wallen, T. J., Chung, J., & Plambeck, R. W. (2020). The POSITIONED Study: Prone Positioning in Nonventilated Coronavirus Disease 2019 Patients—A Retrospective Analysis. *Critical Care Explorations*, *2*(10), e0229. https://doi.org/10.1097/cce.0000000000000229

Jiang, L. G., LeBaron, J., Bodnar, D., Caputo, N. D., Chang, B. P., Chiricolo, G., Flores, S., Kenny, J., Melville, L., Sayan, O. R., Sharma, M., Shemesh, A., Suh, E., & Farmer, B. (2020). Conscious Proning: An Introduction of a Proning Protocol for Nonintubated, Awake, Hypoxic Emergency Department COVID-19 Patients. *Academic Emergency Medicine*, *27*(7), 566–569. https://doi.org/10.1111/acem.14035

Koeckerling, D., Barker, J., Mudalige, N. L., Oyefeso, O., Pan, D., Pareek, M., Thompson, J. P., & Andre Ng, G. (2020). Awake prone positioning in COVID-19. *Thorax*, *75*(10), 833–834. https://doi.org/10.1136/thoraxjnl-2020-215133

Lindahl, S. G. E. (2020). *Using the prone position could help to combat the development of fast hypoxia in some patients with COVID-19*. *May*, 1–6. https://doi.org/10.1111/apa.15382

Machado-Curbelo, C. (2020). Silent or "happy" hypoxemia: An urgent dilemma for COVID-19 patient care. *MEDICC Review*, *22*(4), 85–86. https://doi.org/10.37757/MR2020.V22.N4.9

Murray, C. J. (2020). *Forecasting COVID-19 impact on hospital bed-days, ICU-days, ventilator-days and deaths by US state in the next 4 months*. *114*. https://doi.org/10.1101/2020.03.27.20043752

Olsen, J. (2014). An integrative review of information systems and terminologies used in local health departments. *J Am Med Inform Assoc*. https://pubmed.ncbi.nlm.nih.gov/24036156/

Paul, V., Patel, S., Royse, M., Odish, M., Koenig, S., Hospital, C. F., Hospital, C. F., Diego, S., & Einstein, A. (2020). *HHS Public Access*. *35*(8), 818–824. https://doi.org/10.1177/0885066620934801.Proning

Shang, Y., Pan, C., Yang, X., Zhong, M., Shang, X., Wu, Z., Yu, Z., Zhang, W., Zhong, Q., Zheng, X., Sang, L., Jiang, L., Zhang, J., Xiong, W., Liu, J., & Chen, D. (2020). Management of critically ill patients with COVID-19 in ICU: statement from front-line intensive care experts in Wuhan, China. *Annals of Intensive Care*, *10*(1), 1–24. https://doi.org/10.1186/s13613-020-00689-1

Solverson, K., Weatherald, J., & Parhar, K. K. S. (2020). Tolerability and safety of awake prone positioning COVID-19 patients with severe hypoxemic respiratory failure. *Canadian Journal of Anesthesia*. https://doi.org/10.1007/s12630-020-01787-1

Souza, M. T. de, Silva, M. D. da, & Carvalho, R. de. (2010). Integrative review: what is it? How to do it? *Einstein (São Paulo)*, *8*(1), 102–106. https://doi.org/10.1590/s1679-45082010rw1134

Whittemore, P., Macfarlane, L., Herbert, A., & Farrant, J. (2020). Use of awake proning to avoid invasive ventilation in a patient with severe COVID-19 pneumonitis. *BMJ Case Reports*, *13*(8), 1–2. https://doi.org/10.1136/bcr-2020-236586

WHO. (2013). Clinical management of severe acute respiratory infections when novel coronavirus is suspected: What to do and what not to do. *Who*, *211kb*, 1–12. http://www.who.int/csr/disease/coronavirus_infections/InterimGuidance_ClinicalManagement_NovelCoronavirus_11Feb13u.pdf

Winearls, S., Swingwood, E. L., Hardaker, C. L., Smith, A. M., Easton, F. M., Millington, K. J., Hall, R. S., Smith, A., & Curtis, K. J. (2020). Early conscious prone positioning in patients with COVID-19 receiving continuous positive airway pressure: A retrospective analysis. *BMJ Open Respiratory Research*, *7*(1), 1–4. https://doi.org/10.1136/bmjresp-2020-000711

Wordmeter. (2021). *Corona Virus Pandemic*. https://www.worldometers.info/coronavirus/?