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BENEFITS OF PRONE POSITION COMPARED WITH DORSAL POSITION IN ADULTS/ ELDERLY PATIENTS WITH COVID-19 AND IN INVASIVE MECHANICAL VENTILATION INTERNED IN INTENSIVE MEDICINE SERVICES: A SCOPING REVIEW

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Abstract: Prone Position (PP) is widely used in patients diagnosed with Acute Respiratory Distress Syndrome (ARDS), positive for COVID-19, under Invasive Mechanical Ventilation, in order to improve oxygenation/ventilation and reduce mortality. This technique is quite used in Intensive Care Units in alternation with the Dorsal Position (DP). This Scoping Review aims to analyze parameters such as: PaO_2/FiO_2 ratio, pulmonary compliance, atelectasis/dead space, ARDS severity, PP time and mortality rate, in both positions, in order to verify the benefits of PP relatively to DP existing in the literature. Data collection was performed in the following databases: PubMed, Scopus, Web of Science and Google Scholar. The eligibility criteria were defined as: articles published between 2020 and 2022, with full text and in Portuguese and English, resulting in a total of seven articles. There were no significant differences in the following parameters: lung compliance, atelectasis/ dead spaces, ARDS severity and mortality rate. As for the time of PP, it was found that there was unanimity (average of 16 hours per day); and that the PaO_2/FiO_2 ratio, for the most part, improved during PP compared to DP, which allows for an improvement in the efficiency of oxygenation/ventilation. Thus, it is possible to conclude that the increase in the PaO_2/FiO_2 ratio is the indicator in which the best benefits are observed. It is suggested that other studies be carried out, with specific criteria, so that other more concrete evidence can be described.

Keywords: COVID-19, Mechanical ventilation, Prone position, Intensive care, Dorsal position.

INTRODUCTION

Intensive Care Units (ICUs) are units "qualified to assume full responsibility for users with organ dysfunctions, supporting, preventing and reversing life-threatening failures" (Ordem dos Enfermeiros, 2018). It is in the ICUs that critical users who need constant and differentiated monitoring and care are found. These places must be qualified to assume full responsibility for patients with organ dysfunctions, supporting, preventing and reversing failures with vital implications (Ministério da Saúde & DGS, 2013).

The COVID-19 pandemic, which emerged at the end of 2019 (SNS 24, 2022), caused by the new coronavirus SARS-COV-2, can cause severe respiratory infection such as pneumonia. It is tends to progress to Acute Respiratory Distress Syndrome (ARDS) (Bell et al., 2022; Scaramuzzo et al., 2021), which according to Fanelli et al. (2013) is a clinical syndrome characterized as an acute inflammatory process associated with lung injury, increased vascular permeability, reduced ventilated lung tissue with subsequent onset of acute dyspnea (Costa, D., 2020). The main tenets of ARDS are considered to be: hypoxemia, decreased pulmonary compliance and pathological features of alveolar lysis (hemorrhages, edema and atelectasis) (as cited in Menk et al., 2020). These conditions lead to hospitalization and treatment with Invasive Mechanical Ventilation (IMV) of 10 to 20% of infected patients (Bell et al., 2022).

Concomitantly with IMV, the Prone Position (PP) has been used in alternation with the Dorsal Position (DP). PP consists of changing the user's decubitus so that he is in a ventral position. So far, in the literature, there has not been a protocol for its application (Stilma et al., 2021; Chua et al., 2021), however the decision to choose for PP is a medical one, according to specific criteria, such as : PaO_2/FiO_2 ratio < 150 mmHg (severe ARDS cases); Positive End Expiratory Pressure (PEEP) > 5 cmH_2O; $FiO2 \geq 0.6$ (Stilma et al., 2021; WHO, 2021).

PP is used for its effect on improving

oxygenation and decreasing the mortality rate (Gattinoni et al., 2013). These improvements are possible, given that there is greater thoracic expansion and, consequently, oxygenation of the dorsal areas of the lungs (Langer et al., 2021). There is also a redistribution of ventilation in areas with good perfusion, resulting in a reduction in atelectasis (Scaramuzzo, et al., 2021) and can reduce stress and tension associated with IMV, reducing the risk of lung injuries associated with ventilation. There are hospitals that during the pandemic developed their own protocols (Chiu et al., 2021; Shelhamer et al., 2021) and describe the need of a multidisciplinary team of at least five to six qualified health professionals (Guérin et al, 2020; Langer et al., 2021).

Considering this problem, it was decided to carry out a Scoping Review, with the following research question: "What are the benefits of the Prone Position compared to the dorsal position in adult/elderly patients, positives for COVID-19 and in invasive mechanical ventilation, hospitalized in Intensive Medicine/Intensive Care services?", constructed using the PICO methodology. Thus, the objective of this review is to demonstrate the effectiveness and benefits of PP compared to DP, in patients positives for COVID-19, undergoing IMV.

METHODOLOGY

The present Scoping Review followed the methodology proposed by Lockwood et al. (2022), Sousa et al. (2017) and Souza et al. (2010), with the objective of identifying the available evidence in response to the research question, following the PICO strategy (Population, Intervention, Context and Outcomes) (Munn, Z., 2021). For each of these requirements, one or more descriptors were defined according to Table 1. As specific objectives, the ventilatory parameters are analyzed, such as: PaO_2/FiO_2 ratio, pulmonary compliance and atelectasis/dead space; the severity of ARDS; PP time and mortality rate, in both positions, in order to support the initial objective.

The search was carried out in four electronic databases: PubMed, Scopus, Web of Science and Google Scholar; following a search strategy for articles indexed with Medical Subject Headings (MeSH) and Health Sciences Descriptors (DeCS) on par with the boolean expressions OR and AND.

With the support of the Rayyan operating system, the articles were uploaded and the number of duplicate articles was tracked (16). Articles from quantitative studies and mixed design studies were considered; published between 2020 and 2022, in English and Portuguese, available in full text, and which had as inclusion criteria: age over 18 years, positive COVID-19 and under IMV; and exclusion: not allusive to the theme; type of study/document (pamphlets, symposium documents, theses, books, literature reviews, among others), does not address prone position, only addresses dorsal position and only addresses prone position.

This search strategy resulted in a total of 277 articles after duplication. After reading their titles and abstracts, 7 articles were selected for full text review, of which 7 met the eligibility criteria defined above. Their bibliographic references were consulted to identify possible additional articles of interest to the topic, based on the relevance of their title, and no additional article was selected. The final sample resulted in a total of 7 articles, which were submitted to quality assessment following the analysis guidelines of Kmet et al. (2004). This was carried out by two reviewers, independently, and later, the scores obtained were compared (Table 2). Documents with a score greater than 0.75 were included in the Scoping Review, resulting in a total of 7 studies. The process of identification, selection,

PICO method		Descriptors	
		DeCS	*MeSH*
P (Users)	Adults; COVID-19; Invasive Mechanical Ventilation	Adult; Seniors; COVID-19; SARS-CoV-2 infection; Mechanical ventilation/ Artificial respiration	Adult; Aged COVID-19; SARS CoV 2 Infection;Mechanical Ventilation/Artificial Respiration
I (Intervention)	*Prone Position*	Prone	Prone Position
C (Context)	Intensive care	Intensive Care	Critical Care; Intensive Care; Critical Illness
O (Outcomes)	Dorsal Position	Supine	Supine position; dorsal position

Table 1: PICO method and DeCS and MeSH descriptors used in the literature review.

Author, Year	Reviewer 1	Reviewer 2	Conclusion
Parker et al. (2021)	0.86	0.90	Included
Langer et al. (2021)	0.78	0.8	Included
Stilma et al. (2021)	0.95	1	Included
Scaramuzzo et al. (2021)	0.95	1	Included
Taenaka et al. (2021)	1	0.75	Included
Rossi et al. (2022)	0.85	0.85	Included
Bell et al. (2022)	0.95	0.95	Included

Table 2: Results of the evaluation of the quality of articles according to the analysis guidelines of Kmet et al. (2004)

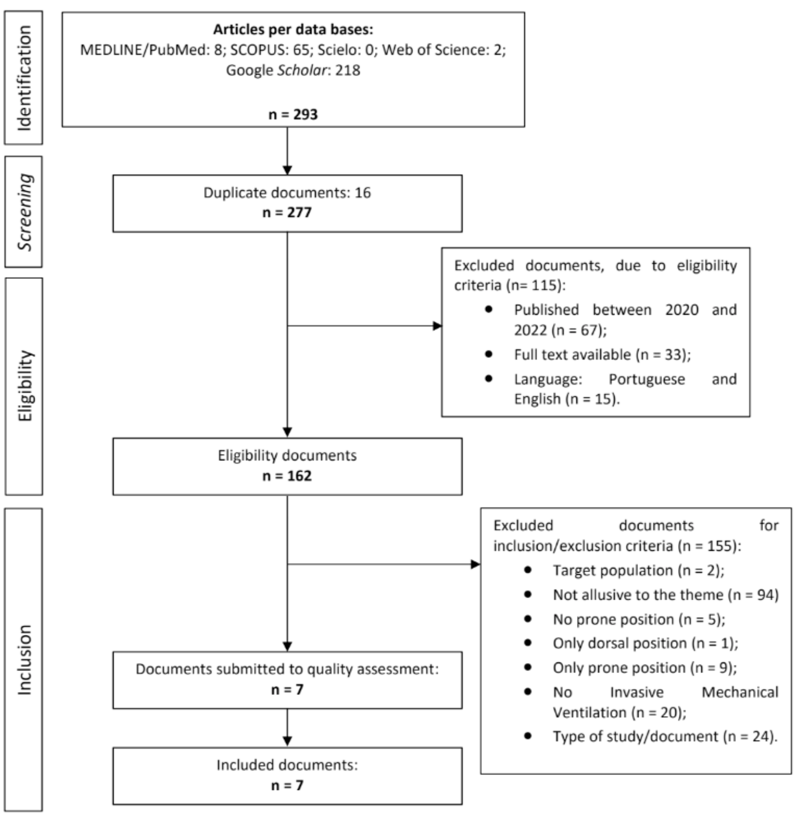

Figure 1: Research flowchart (PRISMA).

eligibility and inclusion of articles followed the PRISMA flowchart recommended by Moher et al. (2009) (Figure 1).

Then proceeded to the extraction of data including the identification of the article, type of ARDS, duration of PP, parameters evaluated, effects of DP, effects of PP and conclusions (Table 3).

RESULTS

GENERAL CHARACTERIZATION OF STUDIES

All included studies are quantitative studies, of which three are retrospective observational studies (case-control study) (Parker et al., 2021; Bell et al., 2022; Langer et al., 2021), three analytical observational studies (Stilma et al., 2021; Scaramuzzo et al., 2021; Rossi et al., 2022) and a case study (Taenaka et al., 2021).

Study patients are adults over 18 years of age, admitted to ICU, diagnosed with mild to severe ARDS, associated with COVID-19, under IMV. Furthermore, the patients were submitted at least once to the alternation from DP to PP. The sample size ranged from 20 to 1057 users, with the exception of the study by Taenaka et al. (2021) which only includes 2 users.

EFFECTS OF PRONE POSITION COMPARED TO DORSAL POSITION

Oxygenation and mortality are two of the parameters described that benefit from the application of PP in patients with COVID-19 under IMV (Parker et al, 2021). The main parameters referred to in the articles included in this review are: perfusion and gas exchange (PaO_2/FiO_2 ratio and resupination cycles), mechanical ventilation parameters (compliance, atelectasis), ARDS severity, PP time and associated mortality. Next, each of these parameters is explored.

PERFUSION PARAMETERS AND GAS EXCHANGE

- PaO_2/FiO_2 ratio

Parker et al. (2021), Scaramuzzo et al. (2021), Taenaka et al. (2021) and Bell et al. (2022) report that after using PP, there is an increase in the PaO_2/FiO_2 ratio, compared to DP. More specifically, the article by Scaramuzzo et al. (2021) presents, before the PP, values of the PaO_2/FiO_2 ratio of 101 (80 - 127) mmHg in the "responders" users and of 105 (90 - 130) mmHg for the "non-responders". After the PP, they found that there was an increase in the values in all patients, but the best response was found in the "responders" patients, with an increase in the PaO_2/FiO_2 ratio to 210 (161-276) mmHg, while the "non-responders" presented PaO_2/FiO_2 ratio values of 127 (100 - 150) mmHg.

In the study by Taenaka et al. (2021), in which patients are subjected to IMV with low and high PEEP, in both positions, it appears that there is an increase in the PaO_2/FiO_2 ratio after PP. The PaO_2/FiO_2 ratio values are higher when a high PEEP value is applied (230 mmHg dorsal and 255 mmHg in prone with high PEEP vs 166 mmHg in dorsal and 176 mmHg in prone with low PEEP) - case 1. In case 2, with low PEEP, there are significant improvements in the PaO_2/FiO_2 ratio, with an increase from 243 mmHg in DP to a value of 495 mmHg in PP. When PEEP increases, they report a decrease in oxygenation and in the PaO_2/FiO_2 ratio, compared with low PEEP; however, PP, with high PEEP, reveals a higher PaO_2/FiO_2 ratio (436 mmHg) compared to DP (196 mmHg). For Bell et al. (2022), the PaO2/FiO2 ratio improved by 19% after PP.

As for Langer et al. (2021), in a first analysis, mentions that the PaO_2/FiO_2 ratio decreases when positioned in PP, which can be explained by the high number of patients diagnosed with severe ARDS, with indication

Author (Year)	ARDS type	Prone position duration (PP)	Evaluated parameters	Dorsal position effects	Prone position effects	Conclusions
Parker et al. (2021).	Moderate to severe	1, 7, 12, 24, 32 and > 39h, 51 and 93h	PaO_2/ FiO_2 ratio, compliance, PP Duration, Mortality, Time under IMV	Prior to PP (initial DP): * Lower PaO_2/FiO_2 ratio (130 mmHg). reproning: * Decreased PaO_2/FiO_2 ratio compared to PP. DP alternating with PP: * Initial DP - PaO_2/ FiO_2 Ratio lower (141 mmHg); * Resupination - PaO_2/ FiO_2 ratio gradually decreased. 2nd Resupination (7h): * Constant increase in PaO_2/FiO_2 Ratio.	prone prolonged (>39h): * Improvement in PaO_2/ FiO_2 Ratio (170-198 mmHg); Reproning: * PaO_2/FiO_2 ratio increases at 51 and 93 h. PP alternating with dorsal: * 1st PP - improvement in the PaO_2/FiO_2 Ratio (188-208 mmHg); * reproning- PaO_2/FiO_2 ratio increased (195-199 mmHg).	In the use of Prolonged PP, an improvement in oxygenation was evidenced by the increase in the PaO_2/FiO_2 ratio in PP when compared to the initial position of DP, from 18:00 onwards. The repetition of the PP demonstrates a higher PaO_2/FiO_2 ratio, compared to the prolonged PP. In patients who underwent a PP alternating with DP, it was found that reprone is not necessary to improve oxygenation, maintaining a PaO_2/FiO_2 ratio identical to that of the initial DP. Pulmonary compliance does not show significant differences.
Stilma et al. (2021),	Mild, moderate and severe	Average of 15h/ day	Mortality at 28 and 90 days.	Population without indication and placed in DP: * Lower mortality compared to those placed in PP (28.6%). Population with indication and placed in DP: * Higher mortality compared to those placed in PP (41.3%).	Population without indication and placed in PP: * Higher mortality compared with those who were kept in DP (31.3%). Population with indication and placed in PP: * Lower mortality compared with patients who were kept on DP (34.1%).	No significant differences in mortality rate at 28 and 90 days. However, it appears that it was lower in patients without indication of PP and higher in patients with indication, but variables related to the characteristics of the population must be taken into account for the analysis of the results.
Scaramuzzo et al. (2021).	Moderate or severe	16h/day (average)	PaO_2/ FiO_2 Ratio, Mortality	Patients who responded to the PP - DPinitial: * PaO_2/FiO_2 ratio (101 mmHg) Patients who did not respond to the PP: * PaO_2/FiO_2 ratio (105 mmHg)	Patients who responder the PP: * Increase of PaO_2/FiO_2 ratio (210mmHg) Patients who did not respond to the PP: * Slight increase in PaO_2/FiO_2 Ratio (127 mmHg) * Higher mortality rate.	It analyzes the effects of PP, referring to data before PP and after, in two population groups: those who responded positively to the PaO_2/FiO_2 Ratio with an increase relative to the population mean; and those who did not respond (decreased PaO_2/ FiO_2 ratio, relative to the population mean). The authors found that after PP, in patients classified as “responders”, there was a significant increase in the PaO_2/ FiO_2 ratio, which was associated with shorter IMV time, lower mortality and tracheostomy rates.

Taenaka et al. (2021).	Mild and moderate	N/A	PaO_2/ FiO_2 Ratio, Pulmonary Compliance, Dead Space	Case 1: Low PEEP: * Lower PaO_2/FiO_2 ratio (166 mmHg); * Largest dead space (28%). High PEEP: * Lower PaO_2/FiO_2 ratio (166 mmHg); * Largest dead space (11%). Case 2: Low PEEP: * Lower PaO_2/FiO_2 ratio (243 mmHg); * Largest dead space (17%). High PEEP: * Less dead space (10%); * Lower PaO_2/FiO_2 ratio (196 mmHg).	Case 1: Low PEEP: * Increase in the PaO_2/ FiO_2 ratio (176 mmHg); * Reduces the amount of dead space (8%); High PEEP: * Best PaO_2/FiO_2 ratio (255 mmHg); * Less dead space (3%); Case 2: Low PEEP: * Decrease in dead spaces (8%); * Improves oxygenation - PaO_2/FiO_2 ratio of 495 mmHg. High PEEP: * Increase in dead spaces (14%); * Increase in the PaO_2/ FiO_2 ratio (436 mmHg).	In both cases, PP was effective in improving oxygenation and reducing dead spaces. The combination of high PEEP with PP allows for greater oxygenation, with an increase in the PaO_2/ FiO_2 ratio and a reduction in dead spaces. No significant changes in lung compliance.
Rossi et al. (2022).	Mild, moderate and severe	N/A	PaO_2/ FiO_2 ratio; atelectasis	In DP: * Atelectasis at the dorsal level. Resupination: * Well-oxygenated tissues increase; * Poorly oxygenated tissue decreased and non-oxygenated tissue decreased significantly; * Atelectasis decrease; * Increase in PaO_2/FiO_2 Ratio (from 129.9 to 147.2 mmHg).	In PP: * Atelectasis decreases from 13% to 8%; * Increase in PaO_2/FiO_2 Ratio (144.3 mmHg); * Increase in oxygenated tissues of the dorsal regions; * Atelectasis at the ventral level.	Repositioning (DP to PP) changes the position of atelectasis. What does not allow to verify a significant improvement in the PaO_2/FiO_2 Ratio. During PP, non-oxygenated areas decrease, while well-oxygenated and low-oxygenated tissue do not show significant differences. Mortality is 32% of its users. PP acts on respiratory mechanisms and gas exchange, improving oxygenation.
Bell et al. (2022).	Severe, moderate	Average of 23h/ day (14 to 49h/day), interval of on average 12h (5 to 24h) between each pronation	PaO_2/ FiO_2 Ratio, Pulmonary Compliance	DP: * PaO_2/FiO_2 ratio of 115 mmHg; * compliance and pulmonary: 26 ml/ cmH2O. Return to Dorsal Position: * Increase in PaO_2/FiO_2 ratio of 137 mmHg; * compliance pulmonary: remained the same.	Start PP: * compliance pulmonary: 27 ml/ cmH2O. End of PP: * PaO_2/FiO_2 ratio increases to 140 mmHg; * compliance pulmonary: 29 ml/ cmH2O.	PP was associated with an increase in the PaO_2/FiO_2 Ratio of 19%. There are also improvements in the PaO_2/FiO_2 ratio right after PP and it is maintained in resupination. Lung compliance is higher at the end of PP, however without significant variations. The best value of the PaO_2/FiO_2 Ratio is verified at the end of the PP. These authors mention priority to PP in users whose PaO_2/FiO_2 ratio is less than 100 mmHg.

Langer et al. (2021).	Mild, moderate and severe	1 to 4 sessions, from 16 to 22 hours/day	PaO_2/FiO_2 Ratio, Pulmonary Compliance, Mortality	DP only: * Upper PaO_2/FiO_2 ratio: 145 (107 to 197 mmHg); * Less hospitalization time and fewer days on IMV 10 (6 to 19 days). Group of 78 patients and 3 evaluation moments: * Resupination slightly lowers the PaO_2/FiO_2 Ratio: 128 (87 to 174 mmHg), higher than DP 98 (72 to 121 mmHg); * DP – pulmonary compliance (26 to 51) mL/cmH2O	At least once in PP: * Lower PaO_2/FiO_2 ratio: 108 (81 to 148 mmHg); * Mortality and time in ICU is higher, with more users with severe ARDS; * More days under VMI 16 (10 to 30 days). Group of 78 people and 3 evaluation moments: * PP increases PaO_2/FiO_2 Ratio: 158 (112 to 220) mmHg.	The number of users with severe ARDS is higher, which leads to a higher mortality rate (41%). And, it is the majority of users proposed for PP (77%). PP is the most frequent option when there is severe ARDS (44%). Group 78 patients: * 78% showed improvements in the PaO_2/FiO_2 ratio, greater than or equal to 20 mmHg (42 to 117 mmHg). PP is an inexpensive procedure and allows to improve the oxygenation of users, by improving ventilation/perfusion.

* N/A - Not applied; DP - Dorsal Position; PEEP - Positive end-expiratory pressure; PP- Prone Position; ARDS - Acute respiratory distress syndrome; ICU - Intensive Care Unit; VMI - Invasive Mechanical Ventilation.

Table 3: Summary of results of the studies analyzed in the Scoping Review

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for PP. In a second study, with 78 users, they found that the ratio increased.

Contrary to the first mentioned studies, the article by Rossi et al., (2022) indicates that there were no significant changes in the PaO_2/FiO_2 ratio, given that 65% of the participants were considered non-responder, Delta PaO_2/FiO_2 value (difference between prone and DP PaO_2/FiO_2 ratio) ≤ 20 mmHg; and that 35% had a negative Delta PaO_2/FiO_2.

· Resupination cycles

Several studies have verified that after resupination there are changes in the parameters of the PaO_2/FiO_2 ratio, in compliance and in the formation of atelectasis. Parker et al. (2021), Bell et al. (2022) and Langer et al. (2021) found that during resupination there is a decrease in the PaO_2/FiO_2 ratio when compared to PP. However, there is an improvement when compared to the base values of the first DP. Bell et al. (2022) adds that there is an improvement in oxygenation, but not in compliance.

For Parker et al. (2021), the alternation of decubitus allows to obtain a higher PaO_2/FiO_2 ratio, being greater during the time of PP in alternation with DP, compared with the prolonged PP (> 39h). However, he also adds that a single repositioning in prolonged PP significantly improves oxygenation.

In the study by Rossi et al. (2022), it was found that after resupination the amount of atelectasis decreased considerably when compared to DP. Well-oxygenated tissues increase, poorly oxygenated tissues decrease, and non-oxygenated tissues decrease significantly. This is demonstrated by the fact that the PaO_2/FiO_2 ratio increases (from 129.9 to 147.2 mmHg).

As for pulmonary compliance, it increased in DP (after resupination) in the study by Parker et al. (2021) and in Rossi et al. (2022).

MECHANICAL PARAMETERS OF VENTILATION

· *Compliance* pulmonary

In the studies by Bell et al. (2022), Langer et al. (2021) and Taenaka et al. (2021), pulmonary compliance had no significant changes. However, in the article by Parker et al. (2021), it is reported that during the 36-h PP, there is a non-significant gradual increase in respiratory compliance.

In the article by Taenaka et al., (2021), superior pulmonary compliance (28 ml/cmH_2O) is reported when the patient in case 1 is positioned in PP and under ventilation with high PEEP. In contrast, the patient in case 2 reveals better lung compliance when in DP under low PEEP (58 ml/cmH_2O). For Parker et al., (2021), the lowest value occurs in DP before PP (27 ml/cmH_2O), afterwards there is an insignificant increase in it. However, higher values are reached with frequent alternation of decubitus (from dorsal to PP), reaching a value of 38 ml/cmH_2O.

· Atelectasis and Dead Spaces

According to the study by Taenaka et al., (2021), with increasing PEEP, the amount of lung dead space decreases, either associated with PP or DP (case 1), and the presence of dead space in the PP position with high PEEP, it has the lowest value (3%). As for case 2, it is shown that with the change of decubitus, in lower PEEP, the dead space decreases from 17% to 8% (dorsal vs prone), in line with what happened with the patient in case 1. However, when there is an increase in PEEP, in PP compared to DP, the dead space increased.

Rossi et al., (2022), describe that when patients are positioned in PP, new atelectasis in the ventral region are formed, while dorsal atelectasis, previously present in dorsal position, disappear. This is because in PP, there is an increase in the compression exerted by the weight of the lung in the ventral region and a decompression in the dorsal region. This phenomenon allows for a redistribution of oxygenated tissue.

GENERAL PARAMETERS

· ARDS severity

All the articles under analysis demonstrate the inclusion of patients classified, according to the Berlin criteria, by the three types of ARDS severity (mild, moderate and severe), with the exception of Scaramuzzo et al. (2021) and Bell et al. (2022) that only identify patients with moderate and severe ARDS and Taenaka et al. (2021) that included patients with mild and moderate ARDS. The highest percentage of users had severe pathology, followed by moderate and, in a smaller number, mild pathology.

· Prone Position Time

Stilma et al. (2021) report that, on average, PP is applied for 15h/day, and users with indication to to fulfill PP are in this position for longer (average of 16h/day) than those who do not have an indication for PP (average of 14 hours/day). For Scaramuzzo et al. (2021), the PP time averaged 16h/day. Bell et al. (2022) applied a longer period of PP, on average 23h/day, with an interval of on average 12h between pronations; and the first episode of PP, of each user, had an average of 16 hours. Still, there is reference that the application of longer periods of PP with a lower initial PaO_2/FiO_2 ratio, allow a superior response to PP, that is, a greater increase in oxygenation (Bell et al., 2022). It is also mentioned in the article by Langer et al., (2021) that the PP was applied on average 18.5h/day (16h to 22h).

Parker et al. (2021), is the only author who presents data on the variability of PP time per participant, with a minimum time of 1h and a maximum of 93h. This demonstrates a positive effect, with an increase in the PaO_2/FiO_2 ratio at 39h, 51h and 93h, and that it tends to be maintained after 7h, even in DP.

· Mortality rate

As for the mortality rate, Stilma et al. (2021) showed no significant differences at 28 days or 90 days. However, they found that patients with no indication to comply with PP had a lower rate (28.6% in patients not positioned in PP and 31.3% in patients in PP). For patients with indication for PP, the mortality rate was 41.3% in patients who did not comply with PP vs 34.1% in those who did. At 90 days, the authors report similar values. When analyzing the population with indication for PP, the group that fulfilled PP, despite having a greater number of users with severe and moderate ARDS, and a reason $PaO_2/FiO_2 <$ 150 mmHg, showed a lower mortality rate (34.1%), compared to those who did not comply with PP (41.3%).

For Scaramuzzo et al., (2021), the mortality rate in ICU was higher in the case of patients who did not respond to PP. For Langer et al., (2021), the mortality rate is higher in PP (41%), as is the severity of ARDS by COVID-19.

DISCUSSION

Of the analyzed studies, there is a discrepancy in the analyzed population, by each author. Even so, the total number of cases (n = 2154 users) analyzed is considered an adequate group to be able to infer conclusions.

The patients included in the studies were classified mainly in terms of severe and moderate pathology, according to the Berlin criteria (value of the PaO_2/FiO_2 ratio). According to WHO data, when the ratio value is less than 150 mmHg, the greater the indication to perform PP, whose time must be between 12 to 16 hours a day (Parker et al., 2021). Most studies included in the Scoping Review corroborate this indication, having applied PP for an average of 15 to 16 hours per day. Thus, it can be said that the minimum time to apply in the PP must be 16 hours.

Regarding the PaO_2/FiO_2 ratio, five of the seven articles analyzed are unanimous in the presentation of results, referring to an improvement in the PaO_2/FiO_2 ratio, as soon as the user is positioned in PP. Taenaka et al. (2021) found that, regardless of the PEEP value, the PaO_2/FiO_2 ratio was higher when patients were in PP. Langer et al., (2021), analyzed two working groups, verifying that in the first the ratio decreases and in the second it meets the expected, the increase in the ratio. The difference in their results can be explained by the high number of patients diagnosed with severe ARDS, with indication to comply with PP, present in the first group, which can reduce the positive results. Finally, Rossi et al., (2022), infer that they do not verify significant differences in the value of the ratio between the dorsal position and the PP, since the alteration of the users' decubitus allows the alteration of the positioning of the atelectasis, which becomes a compensatory mechanism. This is explained by the fact that PP allows the expansion of the collapsed dorsal lung regions, that results in a better ventilation/perfusion ratio and in a more homogeneous lung ventilation.

In terms of resupination cycles, it must be noted that after resupination, changes in the PaO_2/FiO_2 ratio, pulmonary compliance and formation of atelectasis are evident compared to previous values. Thus, Parker et al., (2021); Bell et al., (2022) and Langer et al., (2021) demonstrated a decrease in the PaO_2/FiO_2 ratio after the patient was placed in DP, following PP. However, comparing these values with those of the initial DP, the increase is evident. These changes are due to the fact that the posterior side of the lungs has a larger area, compared to the anterior side, which will allow gas exchange to be carried out more efficiently. As for the existence of atelectasis, only addressed in Rossi et al. (2022) he argues that after resupination, the amount of atelectasis is small relative to the initial DP, due to, in PP, the atelectasis change to the anterior side of the lung, so the posterior lung can made an effective oxigenation/ventilation.

According to Parker et al. (2021) and Rossi et al. (2022), following resupination, there is a decrease in the pressure exerted on the rib cage, so the work of breathing will decrease and, consequently, lung compliance will increase.

Regarding pulmonary compliance, Bell et al. (2022) and Langer et al. (2021), argue that there are no significant changes. Taenaka et al. (2021), which evaluates the parameter according to the variation of the PEEP value, finds discrepancies in high PEEP. This difference is justified by the fact that when there is an increase in the value of PEEP, there is an induction of hyperinflation of the lung, leading to changes in perfusion. However, about pulmonar compliance no assurance evidencies, because the results reveal insignificant numerical discrepancies.

When a COVID-19 infection occurs, there is a deficit in oxygenation and ventilation and a continuous accumulation of secretions, which leads to the appearance of atelectasis and dead spaces (Steinbach, T., 2021). On one of the studies analyzed, there was a decrease in atelectasis and dead spaces when applying PP (Taenaka et al., 2021). However, once again, differences were presented by Taenaka et al., (2021), in case 2, when there is an increase in PEEP, in which the dead space increased, being higher in the PP. The justification for the increase in the value of PEEP and its action on the ineffectiveness of gas exchange due to lung hyperinflation. Rossi et al., (2022), verifies that there is a redistribution of the location of atelectasis and that their decrease is notorious. This happens because in PP, there is an increase in the compression exerted by the weight of the lung in the ventral region and a decompression in the dorsal region (Rossi et al., 2022).

Regarding the mortality rate, there is a discrepancy in the values, with the same varying between 28.6% and 53.7%. Langer et al. (2021), start by showing a higher mortality rate in PP. However, its population has more severe ARDS (PaO_2/FiO_2 ratio < 150 mmHg), which in itself is a poor prognostic factor for increased mortality. The same finds Stilma et al., (2021).

As for the limitations of the present study, the great heterogeneity of the criteria/ parameters applied in the PP and in the modes of application of the IMV stands out, which can create variants in the conclusions obtained. Furthermore, as it is a relatively recent topic, with little scientific evidence and no protocols, it does not allow significant conclusions to be applied in clinical practice.

CONCLUSION

The applicability of PP is not yet clearly described in the literature. However, given the results presented, it appears that the PP, in patients under IMV with COVID-19, compared to DP, presents benefits. The parameter with the best results is the PaO_2/FiO_2 ratio, showing its increase. Another point of agreement among the authors is the time of PP, which must be applied for at least a period of 16 hours a day. The remaining parameters evaluated present discrepancies and minor changes, which leads us to infer that there are several variables to be taken into account, such as the characteristics of patients, type and severity of the pathology and the need for more controlled studies with a more homogeneous population. Thus, it is important to encourage further studies on this topic, with the application of standard and specific protocols, to achieve more complete results on the subject.

However, PP must not be undervalued, both in clinical nursing practice and in the health area itself, as it may induce health gains. In the context of clinical practice, we infer that the PP may continue to be applied to a greater number of patients, depending on the clinical evaluation, despite the need for protocols, since no worsening of the health status of the users was identified after this intervention.

REFERENCES

Bell, J., Pike, C. W., Kreisel, C., Sonti, R., & Cobb, N. (2022). Predicting impact of prone position on oxygenation in mechanically ventilated patients with COVID-19. *Journal of Intensive Care Medicine*, 1–7. Retrieved from: https://doi.org/10.1177/08850666221081757

Chiu, M., Goldberg, A., Moses, S., Scala, P., Fine, C., & Ryan, P. (2021). Developing and Implementing a Dedicated Prone Positioning Team for Mechanically Ventilated ARDS Patients During the COVID-19 Crisis. *Joint Commission Journal on Quality and Patient Safety*, *47*(6), 347–353. https://doi.org/10.1016/j.jcjq.2021.02.007

Costa, D. (2020). Mestrado Integrado Em Medicina: Síndrome de Dificuldade Respiratória Aguda – ARDS.Retrieved from: https://repositorio-aberto.up.pt/bitstream/10216/128219/2/411093.pdf?fbclid=IwAR3FPVVWchfjM28tR2f67XmZBFm3oo3c26Hcdv0IjiVFrQl-e-bZXQ3b7QY

Fanelli, V., Vlachou, A., Ghannadian, S., Simonetti, U., Slutsky, A. S., & Zhang, H. (2013). Acute respiratory distress syndrome: new definition, current and future therapeutic options. *Journal of Thoracic Disease*, *5*(3), 326–334. https://doi.org/10.3978/j.issn.2072-1439.2013.04.05

Gattinoni, L., Taccone, P., Carlesso, E., & Marini, J. J. (2013). Prone Position in Acute Respiratory Distress Syndrome. Rationale, Indications, and Limits. American Journal of Respiratory and Critical Care Medicine, 188(11), 1286–1293. DOI: https://doi.org/10.1164/rccm.201308-1532CI

Guérin, C., Albert, R. K., Beitler, J., Gattinoni, L., Jaber, S., Marini, J. J., Munshi, L., Papazian, L., Pesenti, A., Vieillard-Baron, A., & Mancebo, J. (2020). Prone position in ARDS patients: why, when, how and for whom. Intensive Care Medicine, 46(12), 2385–2396. https://doi.org/10.1007/s00134-020-06306-w

Kmet, L. M., Lee, R. C., & Cook, L. S. (2004). *Standard quality assessment criteria for evaluating primary research papers from a variety of fields* (Vol. 144, Issue 13). Alberta Heritage Foundation for Medical Research. https://doi.org/10.5858/arpa.2020-0217-sa

Langer, T., Brioni, M., Guzzardella, A., Carlesso, E., Cabrini, L., Castelli, G., Dalla Corte, F., De Robertis, E., Favarato, M., Forastieri, A., Forlini, C., Girardis, M., Grieco, D. L., Mirabella, L., Noseda, V., Previtali, P., Protti, A., Rona, R., Tardini, F., Grasselli, G. (2021). Prone position in intubated, mechanically ventilated patients with COVID-19: a multi-centric study of more than 1000 patients. *Critical Care*, *25*(1), 1–11. https://doi.org/10.1186/s13054-021-03552-2

Lockwood, C., Porrit, K., Rittenmeyer, L., Salmond, S., Bjerrum, M., Loveday, H., Carrier, J., & Stannard, D. (2022). *Systematic reviews of qualitative evidence - JBI Manual for Evidence Synthesis - JBI Global Wiki*. Aromataris E, Munn Z. https://jbi-global-wiki.refined.site/space/MANUAL/4688637/Chapter+2%3A+Systematic+reviews+of+qualitative+evidence

Menk, M., Estenssoro, E., Sahetya, S. K., Neto, A. S., Sinha, P., Slutsky, A. S., Summers, C., Yoshida, T., Bein, T., & Ferguson, N. D. (2020). Current and evolving standards of care for patients with ARDS. In Intensive Care Medicine (Vol. 46, Issue 12, pp. 2157–2167). https://doi.org/10.1007/s00134-020-06299-6

Ministério da Saúde, & Direção-Geral da Saúde. (2013). Cuidados intensivos - Recomendações para o seu desenvolvimento. Revista de Enfermagem, 18(1), 35–43. Retrieved from: https://www.bing.com/ck/a?!&&p=075f5b69c3bf137a1345acd72ec8ec1b410a0bde9a83f186217fcf7fe9bff974JmltdHM9MTY1NTE2NDMzNyZpZ3VpZD1hZWVhZDlkYS0wYjgzLTQ5NWItYWYxNS0xN2IzYTNjNjM2ZTImaW5zaWQ9NTE2Nw&ptn=3&fclid=db26e7d7-eb73-11ec-98e2-054cca841bc6&u=a1aHR0cHM6Ly93d3cuZGdzLnB0L3VwbG9hZC9tZW1icm8uaWQvZmljaGVpcm9zL2kwMDYxODUucGRm&ntb=1

Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ. 2009 Jul 21;339:b2535. DOI: 10.1136/bmj.b2535. PMID: 19622551; PMCID: PMC2714657.

Munn, Z. (2021). JBI Manual for Evidence Synthesis - JBI Global Wiki. Retrieved from: https://jbi-global-wiki.refined.site/space/MANUAL/4688110/3.2.2+Review+question(s)

Ordem dos Enfermeiros. (2018). Parecer N.º 15/2018: Funções Do Enfermeiro Especialista Em Enfermagem Médico-Cirúrgica Nas Unidades De Cuidados Intensivos/Serviços De Medicina Intensiva. *Mesa Do Colégio Da Especialidade Em Enfermagem Médico-Cirúrgica*, *2018*, 1–4. https://www.ordemenfermeiros.pt/media/8264/parecer-n%BA15_2018-fun%E7%F5es-eeemc-de-cuidados-intensivos-e-medicina-intensiva.pdf

Parker, E. M., Bittner, E. A., Berra, L., & Pino, R. M. (2021). Efficiency of prolonged prone positioning for mechanically ventilated patients infected with covid-19. *Journal of Clinical Medicine*, *10*(13), 2969. https://doi.org/10.3390/jcm10132969

Rossi, S., Palumbo, M. M., Sverzellati, N., Busana, M., Malchiodi, L., Bresciani, P., Ceccarelli, P., Sani, E., Romitti, F., Bonifazi, M., Gattarello, S., Steinberg, I., Palermo, P., Lazzari, S., Collino, F., Cressoni, M., Herrmann, P., Saager, L., Meissner, K., … Gattinoni, L. (2022). Mechanisms of oxygenation responses to proning and recruitment in COVID-19 pneumonia. *Intensive Care Medicine*, *48*(1), 56–66. https://doi.org/10.1007/s00134-021-06562-4

Scaramuzzo, G., Gamberini, L., Tonetti, T., Zani, G., Ottaviani, I., Mazzoli, C. A., Capozzi, C., Giampalma, E., Bacchi Reggiani, M. L., Bertellini, E., Castelli, A., Cavalli, I., Colombo, D., Crimaldi, F., Damiani, F., Fusari, M., Gamberini, E., Gordini, G., Laici, C., … Spadaro, S. (2021). Sustained oxygenation improvement after first prone positioning is associated with liberation from mechanical ventilation and mortality in critically ill COVID-19 patients: a cohort study. *Annals of Intensive Care*, *11*(63), 1–10. https://doi.org/10.1186/s13613-021-00853-1

Shelhamer, M. C., Wesson, P. D., Solari, I. L., Jensen, D. L., Steele, W. A., Dimitrov, V. G., Kelly, J. D., Aziz, S., Gutierrez, V. P., Vittinghoff, E., Chung, K. K., Menon, V. P., Ambris, H. A., & Baxi, S. M. (2021). Prone Positioning in Moderate to Severe Acute Respiratory Distress Syndrome Due to COVID-19: A Cohort Study and Analysis of Physiology. *Journal of Intensive Care Medicine*, *36*(2), 241–252. https://doi.org/10.1177/0885066620980399

SNS 24. (2022). Temas em Saúde: COVID-19. https://www.sns24.gov.pt/tema/doencas-infecciosas/covid-19/#sec-0

Sousa, L. M. M. de, Marques-Vieira, C. M. A., Severino, S. S. P., & Antunes, A. V. (2017). Metodologia de Revisão Integrativa da Literatura em Enfermagem. *Revista Investigação Em Enfermagem*, *Novembro*, 17–26. https://www.researchgate.net/publication/321319742

Souza, M. T. de, Silva, M. D. da, & Carvalho, R. de. (2010). Revisão integrativa: o que é e como fazer. *Einstein*, *8*(1), 102–106. https://doi.org/10.1111/pedi.12792

Steinbach, T. (2021). Atelectasia. Manual MSD. https://www.msdmanuals.com/pt-pt/profissional/dist%C3%BArbios-pulmonares/bronquiectasia-e-atelectasia/atelectasia

Stilma, W., van Meenen, D. M. P., Valk, C. M. A., de Bruin, H., Paulus, F., Neto, A. S., & Schultz, M. J. (2021). Incidence and practice of early prone positioning in invasively ventilated COVID-19 patients—insights from the PRoVENTCOVID observational study. *Journal of Clinical Medicine*, *10*(20), 4783. https://doi.org/10.3390/jcm10204783

Taenaka, H., Yoshida, T., Hashimoto, H., Iwata, H., Koyama, Y., Uchiyama, A., & Fujino, Y. (2021). Individualized ventilatory management in patients with COVID-19-associated acute respiratory distress syndrome. *Respiratory Medicine Case Reports*, *33*(May), 101433. https://doi.org/10.1016/j.rmcr.2021.101433

World Health Organization. (2021). Guideline Clinical management of COVID-19 patients: living guideline, 18 November 2021.