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THE BENEFITS OF PRONE POSITION IN PATIENTS WITH ACUTE RESPIRATORY DISTRESS SYNDROME IN INTENSIVE CARE UNITS

OS BENEFÍCIOS DO DECÚBITO VENTRAL NO DOENTE COM SÍNDROME DE DIFICULDADE RESPIRATÓRIA AGUDA EM UNIDADES DE CUIDADOS INTENSIVOS

LOS BENEFICIOS DE LA POSICIÓN PRONA EN PACIENTES CON SÍNDROME DE DIFICULTAD RESPIRATORIA AGUDA EN UNIDADES DE CUIDADOS INTENSIVOS

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ABSTRACT

Introduction: The objective was to know the scientific evidence of the benefits of prone position in patients with Acute Respiratory Distress Syndrome in intensive care units.

Methodology: It consists of a systematic literature review, based on the question “What are the benefits of prone position in patients with acute respiratory distress syndrome in intensive care units?”. The research process took place in February 2021, using the EBSCOhost platform, and descriptors properly validated in MeSH. As inclusion criteria we considered adult individuals (aged over 18 years-old) and full text with publication date 2015-2021. In the end, after the analysis process, 6 articles were selected.

Results: After analyzing the 6 articles, it was found that patients with acute respiratory distress syndrome can be benefited from prone position due to better air distribution in the lungs with optimization of gas exchange, facilitating the drainage of secretions and reducing the mortality rate. It is important to select and to assess the individual risk of each patient before adopting the prone position.

Conclusion: The prone position seems to work effectively in most cases of acute respiratory distress syndrome. Careful planning and proper assessment of the patient's condition can make the procedure safe and effective.

Keywords: Acute Respiratory Distress Syndrome; Intensive Care Units; Prone Position.

RESUMO

Introdução: O objetivo foi conhecer a evidência científica dos benefícios do decúbito ventral em doentes com síndrome de desconforto respiratório agudo em unidades de cuidados intensivos.

Metodologia: Consiste numa revisão sistemática da literatura, baseada na pergunta “Quais os benefícios do decúbito ventral no doente com síndrome de desconforto respiratório agudo em unidades de cuidados intensivos?”. O processo de pesquisa realizou-se no mês de fevereiro de 2021, utilizando a plataforma EBSCOhost, tendo sido usados descritores devidamente validados no MeSH. Como critérios de inclusão considerámos indivíduos adultos (idade superior a 18 anos) e texto completo com data de publicação 2015-2021. No final, após processo de análise foram selecionados 6 artigos.

Resultados: Após análise dos 6 artigos constatou-se que os doentes com síndrome de desconforto respiratório agudo podem beneficiar com o decúbito ventral devido a uma melhor distribuição de ar nos pulmões com otimização das trocas gasosas, facilitando na dre-

nagem das secreções e diminuindo a taxa de mortalidade. É importante selecionar e avaliar o risco individual de cada doente antes de adotar o decúbito ventral.

Conclusão: O decúbito ventral parece funcionar de forma eficaz na maioria dos casos de síndrome de desconforto respiratório agudo. O planejamento cuidadoso e a avaliação adequada da condição do doente podem tornar o procedimento seguro e eficaz.

Palavras-chave: Decúbito Ventral; Síndrome do Desconforto Respiratório Agudo; Unidades de Cuidados Intensivos.

RESUMEN

Objetivo: Conocer la evidencia científica de los beneficios de la posición prona en pacientes con síndrome de dificultad respiratoria aguda en unidades de cuidados intensivos.

Metodología: Consiste en una revisión sistemática de la literatura, basada en la pregunta “¿Cuáles son los beneficios de la posición prona en pacientes con síndrome de dificultad respiratoria aguda en unidades de cuidados intensivos?”. El proceso de investigación se llevó a cabo en febrero de 2021, utilizando la plataforma EBSCOhost, utilizando descriptores debidamente validados en MeSH. Como criterios de inclusión se consideraron individuos adultos (mayores de 18 años) y texto completo con fecha de publicación 2015-2021. Al final, luego del proceso de análisis, se seleccionaron 6 artículos.

Resultados: Después de analizar los 6 artículos, se encontró que los pacientes con síndrome de dificultad respiratoria aguda pueden beneficiarse de la posición prona debido a una mejor distribución del aire en los pulmones con optimización del intercambio gaseoso, facilitando el drenaje de secreciones y reduciendo la tasa de mortalidad. Es importante seleccionar y evaluar el riesgo individual de cada paciente antes de adoptar la posición de decúbito prono.

Conclusión: La posición boca abajo parece funcionar eficazmente en la mayoría de los casos de síndrome de dificultad respiratoria aguda. Una planificación cuidadosa y una evaluación adecuada del estado del paciente pueden hacer que el procedimiento sea seguro y eficaz.

Descriptores: Posición Prona; Síndrome de Dificultad Respiratoria Aguda; Unidades de Cuidados Intensivos.

INTRODUCTION

Acute respiratory distress syndrome, known by its acronym ARDS, was defined in 1994 by the American-European Consensus Conference (AECC) as an acute inflammatory syndrome manifested by diffuse pulmonary edema and respiratory failure, although without apparent explanation. Only in 2011 through an initiative of the European Society of Intensive Care Medicine approved by the American Thoracic Society and the Society of Critical Care Medicine, was created the definition of Berlin characterizing the ARDS through a framework focused on feasibility, reliability and validity as a condition of acute hypoxemia with inflammation of the lung tissue, based on four criteria: time of onset, imaging findings, origin of edema, and PaO₂/FiO₂ ratio⁽¹⁾.

This type of acute respiratory failure associated with a rapid progression of symptoms has a high prevalence rate associated with a high mortality rate throughout the world, which has increasingly allowed the development of studies in this area. According to a 2018 study, it is estimated that ARDS affects approximately 200 000 patients each year in the United States, resulting in nearly 75 000 deaths annually, and that worldwide ARDS accounts for 10% of admissions to intensive care units, representing more 3 million patients annually⁽²⁾.

As there is no properly targeted treatment for this pathology, several ventilatory strategies have been developed over the years as effective measures in the treatment of patients with ARDS, including the use of protective ventilation through the use of low tidal volumes (TV ≤ 6 mL/kg ideal weight); ventilation and plateau pressure limitation with permissive hypercapnia; the prone position called “prone position”; increase in positive end-expiratory pressure (PEEP); alveolar recruitment maneuvers; use of extracorporeal membrane oxygenation (ECMO) or by removal of extracorporeal carbon dioxide (ECCO2R)⁽³⁾.

The main objectives of the prone position are to improve oxygenation and respiratory mechanics; to homogenize the pleural pressure gradient, alveolar insufflation and ventilation distribution; to increase lung volume and to reduce the number of atelectasis regions; to facilitate the drainage of secretions and to reduce the pulmonary injury associated with the ventilator, caused by pulmonary hypertension often present in patients with this pathology. The reduction in pleural pressure in the posterior alveolar units through the gravitational effect and the change in lung morphology results in better pulmonary ventilation and a more homogeneous distribution of pulmonary tension⁽⁴⁾.

One of the pioneering and first described studies on the prone position dates back to 1976 where, through a retrospective study and with a sample of 5 patients with ARDS, it was possible to verify an improvement in the oxygenation of patients without the existence of major side effects⁽⁵⁾. One year later, in 1977, Douglas *et al* through a more detailed prospective study with a sample of 6 patients with ARDS, they were also able to demonstrate an improvement in the oxygenation of patients in the prone position compared to the supine position⁽⁶⁾.

These two studies were the ones that contributed a lot to make the “prone position” an important resource in this type of patients, as well as a source of research in order to better assess the pathophysiology of this respiratory mechanics.

More recently, in 2013, and considered one of the greatest current studies on this topic, Guérin *et al* carried out a multicenter, prospective, randomized and controlled clinical study with a sample of 466 patients with severe ARDS (PROSEVA study) in which 237 patients were assigned to the “ventral” group and 229 patients were assigned to the “supine” group. Although previous studies have already shown an improvement in the oxygenation of patients, it was with this study that it was possible to verify a decrease in the mortality rate at 28 and 90 days, not verifying, however, a significant difference in terms of complications except the incidence of upper cardiorespiratory arrests in the supine group⁽⁷⁾.

In this context, health care is increasingly presented as highly differentiated and complex care. An example of this is the intensive care units, which are characterized by highly complex and sophisticated services where the care of critically ill patients is the focus of care provision. In its broadest definition, intensive care units are “qualified places to take full responsibility for patients with organ dysfunction, supporting, preventing and reversing failures with vital implications”⁽⁸⁾.

In turn, critically ill patients are defined as “those who, due to dysfunction or profound failure of one or more organs or systems, have their survival dependent on advanced means of monitoring and therapy”⁽⁹⁾.

This systematic review was based on primary and 6-year studies with the main objective of discovering the scientific evidence of the benefits of prone position in patients with ARDS in Intensive Care Units, as this is a procedure increasingly adopted in this type of pathology with some studies already carried out in this area.

METHODOLOGY

This study, as a systematic literature review, aims to know the scientific evidence of the benefits of prone position in patients with acute respiratory distress syndrome in Intensive Care Units. The research question was formulated according to the PICO (Table 1⁷) methodology – population, intervention, context and outcomes⁽¹⁰⁾. The population consisted of critically ill patients aged 18 years-old or over; intervention – the adoption of the prone position in patients with ARDS; context – in intensive care units and outcome – benefits for the critically ill. Thus, the following research question was constructed: “What are the benefits of prone position in patients with acute respiratory distress syndrome in intensive care units?”.

After choosing the topic and formulating the research question, research on the topic in online scientific databases began. To search for the studies to be included in this literature review, the inclusion criteria used were the fact that they were original studies, already published in full text in English, analyzed by experts and with publication date from January 2015 to January from 2021 whose participants were adults (aged over 18) and the EBSCOhost platform was used in all its databases for the research.

The descriptors for conducting the research were extracted from the vocabulary Medical Subject Headings (MeSH)⁽¹¹⁾, and the following were obtained: “ARDS”, “Intensive care units” and “Prone position”. The Boolean operators AND, and NOT were used. The descriptors and Boolean operators were combined in the following search formula: “ARDS” AND “Intensive care units” AND “Prone position” NOT “Pediatric”, having selected the field AB Abstract and TX Full Text for the search.

The articles were initially analyzed blindly by two reviewers, analyzing all titles and abstracts of the articles in order to select the most relevant articles for this review. After this selection, the full analysis of the selected articles was carried out. To assess the methodological quality of the selected studies, the critical analysis instruments of the Joanna Briggs Institute (JBI) – Critical Appraisal Tools were used⁽¹²⁾.

The criterion defined by the authors for the inclusion of a study in the review was the answer “yes” to at least six questions from the JBI critical analysis instrument – Critical Appraisal Tools⁽¹²⁾. The articles were classified according to the level of scientific evidence and strength of recommendation based on JBI guidelines⁽¹³⁾. After this analysis, 6 studies were included in this review.

RESULTS

In an initial phase of the research, after using the aforementioned Booleans, 189 articles were obtained. After selecting only the studies available in full text in the databases and applying the publication time limitation from 2015 to 2021, we obtained 24 studies on the ESBCOhost platform. Three duplicate studies were removed and after reading the titles and abstracts, 12 articles were excluded for not meeting the previously defined inclusion criteria. Subsequently, after analyzing the full text, 3 articles were eliminated from this review for not fitting the intended theme or for not showing scientific methodology. At the end of the entire process of analyzing the articles, as represented in the flow diagram (Figure 1⁷) (adapted from PRISMA Statement⁽²⁰⁾), 6 articles were included in this review, from the Medline (four articles) and CINAHL (two articles) databases, as shown in Table 2⁷ and Table 3⁷.

The articles included in this review refer to the benefits of the prone position in relation to the supine position in patients with ARDS in the context of intensive care, taking into account several factors.

All relevant data from the articles were subsequently extracted according to the JBI grids⁽¹²⁾, namely author, study objective, sample, intervention and period, and the individual results of each study will be explored in the discussion of the results of this systematic review. In this way, the data was explained in Table 4⁷, which reflects the main data of the articles selected for this review.

DISCUSSION

This systematic review aimed to discover the scientific evidence of the benefits of prone position in patients with ARDS in Intensive Care Units. Taking into account the common objective of the studies – benefits of the prone position over the supine position in patients with ARDS in Intensive Care Units – it is possible to infer some general conclusions, which were demonstrated by the significant improvements in a variety of processes in this area, since the improvement in oxygenation as initially described by the first studies^(5,6) but also in the decrease in mortality demonstrated by the most recent studies in this area⁽⁷⁾.

The prone position associated with an improvement in oxygenation and perfusion with the use of a protective volume (≤ 6 mL/kg ideal weight) has also been associated with an improvement in respiratory mechanics, demonstrated by many studies already carried out and with strong recommendation by the latest guidelines for ARDS. Through these recommendations, we can verify that the “prone position” is not indicated in all patients, but in patients with moderate/severe ARDS, recommending the adoption of this position for a period of not less than 12 hours a day, with a significant decrease in mortality⁽²¹⁾.

Crosswise, we can observe that in the studies by Clarke *et al* (2021)⁽¹⁴⁾, Qing Nie, Aiwu Ye & Shixiong Wei (2020)⁽¹⁵⁾, Van Meenen *et al* (2019)⁽¹⁶⁾, Haddam *et al* (2016)⁽¹⁷⁾ and Xu *et al* (2015)⁽¹⁹⁾ contemplated in this systematic review, there is reference to an increase in oxygenation in all patients who are submitted to the prone position with an increase in the PaO₂/FiO₂ ratio. In the study by Ayzac *et al*⁽¹⁸⁾, this was one of the variants that was not studied, and the impact of the prone position on the incidence of ventilation associated pneumonia (VAP) and its role in mortality were evaluated. In a sample of 466 patients with severe ARDS in which 237 were placed in the prone position and 229 in the supine position for a period of at least 16 hours, there was an incidence rate of VAP of 1.18 in the supine position and 1.54 in the “prone position” for 100 days of invasive mechanical ventilation. The probability of VAP after 90 days was 46.5% and 33.5% in the prone and supine position, respectively. As described in the study itself, the difference between the two probability curves was not statistically significant, although it did not show a reduction in the incidence of VAP and this was associated with a higher mortality.

On the other hand, in the study by Clarke *et al*⁽¹⁴⁾ and in the study by Van Meenen *et al*⁽¹⁶⁾, it was possible to verify an improvement not only in the PaO₂/FiO₂ ratio, but also a decrease in the mortality rate at 28 days. In the first study where the sample consisted of 20 patients with severe ARDS, an increase of 20% in the PaO₂/FiO₂ ratio was observed in 90% of patients with the adoption of prone position for a period of at least 16 hours. In this study, the mortality rate associated with 28 days was 15%. In the study by Van Meenen *et al*⁽¹⁶⁾, which included 90 patients and aimed to assess the impact of performing the first prone position, not only was there an increase in the PaO₂/FiO₂ ratio in 90% of patients, even after repositioning in the supine position, as well as a reduction of 46% mortality at 28 days. Other variables were also considered in this study, verifying a decrease in dead space and driving pressure from 66% to 56% of patients. However, the changes in ratio, dead space and driving pressure induced by the first prone session were not enough to improve the patients' output at 28 days, denoting a difference in driving pressure between the survivors and the sick who died.

The studies by Qing Nie, Aiwu Ye & Shixiong Wei⁽¹⁵⁾ and Haddam *et al*⁽¹⁷⁾ also corroborate an improvement in the oxygenation of the patients sampled. In the first study with a sample of 9 patients with ARDS, there was an increase in PaO₂ from 74.15 to 90.13 mmHg, also providing better drainage of secretions present in these patients through the prone position. In the study by Haddam *et al*⁽¹⁸⁾ with a sample of 51 patients and with an adoption of the prone position for a period of at least 16 hours, there was an increase in the PaO₂/FiO₂ ratio in 42 patients 1 hour after resuming supine position and a 20% increase in ratio in 71% of patients.

Similar to these last two studies, the study by Xu *et al*⁽¹⁹⁾ included in this systematic review also reinforces what was previously described. With a small sample of only 6 patients, it was possible to verify an improvement in oxygenation in patients submitted to the prone position, which was maintained even after returning to the supine position, with an associated decrease in CO₂ retention.

After analyzing the studies in this systematic review, we can see that the results of the different studies are in line with the study by Guérin *et al*⁽⁷⁾ (PROSEVA study) dated 2013 confirming that the prone position significantly improves the oxygenation of patients with consequent improvement in the PaO₂/FiO₂ ratio associated with a decrease in the mortality rate.

The “prone position” is a key factor in the management of patients with moderate/severe ARDS, resulting in better oxygenation described in all articles analyzed, although small samples were seen as a limitation across the analyzed studies.

CONCLUSION

The prone position called “prone position” has been an increasingly used strategy over the years in the management of critically ill patients with moderate/severe ARDS. Considering the high complexity of existing therapies aimed at the critically ill in intensive care units, it is essential to consider all the risks inherent to the adoption of the prone position, also based on its main indications and contraindications.

After analyzing the articles in this systematic review, it was possible to meet the initial question that intended to know the scientific evidence of the benefits of prone position in patients with acute respiratory distress syndrome (ARDS) in Intensive Care Units. The small number of samples in the studies included in this systematic review constituted one of the major limitations, also manifested by the authors of the analyzed articles. With this

systematic review, it was possible to infer that the prone position promotes not only an improvement in the oxygenation of patients with a consequent increase in the PaO₂/FiO₂ ratio, but also an improvement in the drainage of secretions and a decrease in the mortality rate of hospitalized patients, warning of the increased risk of the incidence of ventilation associated pneumonia (VAP).

For all these reasons, it is concluded that the prone position has a positive impact on the “outcome” of patients, constituting an effective maneuver in the approach of patients with ARDS. The risk-benefit inherent to the prone position should be evaluated as well as the patient's condition, in order to make the procedure safe and effective, however, this procedure should continue to be the subject of future studies in order to guarantee, who knows, the prone position as a technique inserted in a “bundle” to approach ARDS.

Authors' contributions

JM: Study design and coordination, data collection, storage and analysis, review and discussion of results.

VM: Review and discussion of results.

MDS: Data analysis, review and discussion of results.

All authors read and agreed with the version published in the manuscript.

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Table 1 – Question writing scheme according to the PICO method⁽⁴⁰⁾.^κ

Research question (PICO format)	
(P) Population	Critically ill (over 18 years-old)
(I) Intervention	Adoption of prone position in patients with ARDS
(C) Context	Intensive care units
(O) Outcome/Result	Critically ill benefits

Table 2 – Types of studies present in this systematic review.^κ

Study identification	Type of study
Clarke <i>et al</i> (2021) ⁽¹⁴⁾	Prospective Cohort
Qing Nie, Aiwu Ye & Shixiong Wei (2020) ⁽¹⁵⁾	Prospective Cohort
Van Meenen <i>et al</i> (2019) ⁽¹⁶⁾	Prospective Cohort
Haddam <i>et al</i> (2016) ⁽¹⁷⁾	Prospective Cohort, observacional, multicentric
Ayzac <i>et al</i> (2016) ⁽¹⁸⁾	Prospective multicenter randomized
Xu <i>et al</i> (2015) ⁽¹⁹⁾	Prospective Cohort

Table 3 – Assessment of the level of evidence and the level of recommendation of the articles according to JBI⁽¹³⁾.^κ

Study identification	Evidence level	Recommendation strength
Clarke <i>et al</i> (2021) ⁽¹⁴⁾	3.c	STRONG
Qing Nie, Aiwu Ye & Shixiong Wei (2020) ⁽¹⁵⁾	3.c	STRONG
Van Meenen <i>et al</i> (2019) ⁽¹⁶⁾	3.c	STRONG
Haddam <i>et al</i> (2016) ⁽¹⁷⁾	3.c	STRONG
Ayzac <i>et al</i> (2016) ⁽¹⁸⁾	1.c	STRONG
Xu <i>et al</i> (2015) ⁽¹⁹⁾	3.c	STRONG

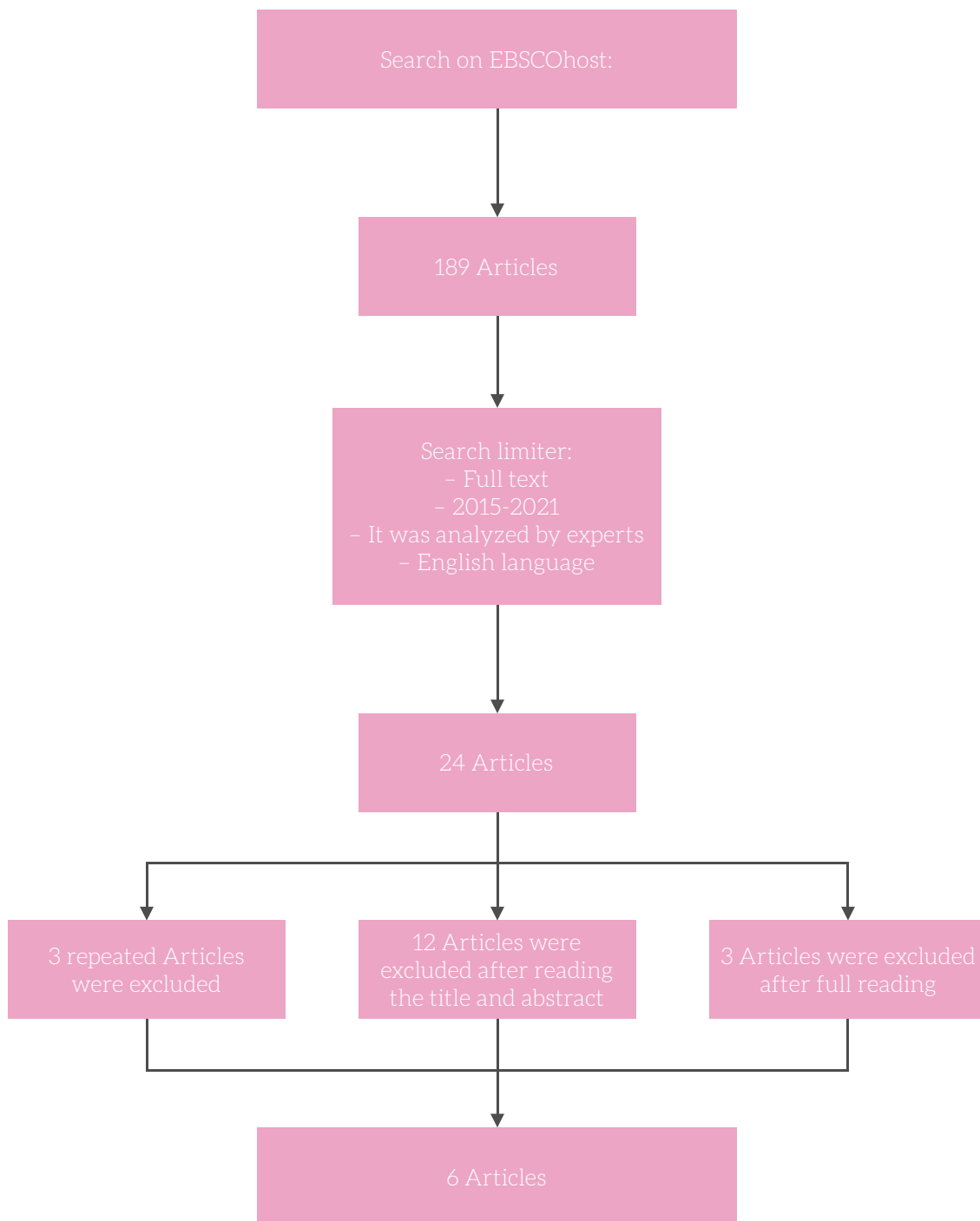


Figure 1 - Flow diagram adapted from PRISMA Statement⁽²⁰⁾ representative of the research process.⁵

Table 4 – Main data from the articles included in this systematic review.→^κ

Authors	Study aim	Sample	Intervention	Duration
Clarke <i>et al</i> (2021) ⁽¹⁴⁾	To characterize the effects of the prone position on respiratory mechanics and oxygenation in invasively ventilated patients with SARS-CoV-2 ARDS.	In total 20 patients were included in this study.	Adoption of prone position in 20 patients with ARDS due to SARS-CoV-2 under invasive mechanical ventilation in intensive care units. A descriptive statistical analysis of the results was performed.	From March 16 th , 2020 to April 8 th , 2020.
Qing Nie, Aiwu Ye & Shixiong Wei (2020) ⁽¹⁵⁾	To verify the effectiveness of the combination of prone position with ECMO in patients with SARS-CoV-2 ARDS.	Nine patients were included in this study, 8 of which were submitted to (VVA ECMO, femoral vein-jugular vein) and 1 to (VVA-ECMO, femoral vein-jugular vein-femoral artery).	Adoption of prone position to 9 patients concomitantly with ECMO in an intensive care unit.	From February 15 th to March 24 th , 2020.
Van Meenen <i>et al</i> (2019) ⁽¹⁶⁾	To determine the association between prone-induced changes in PaO ₂ / FiO ₂ , dead space fraction (VD / VT) and driving pressure (Δ PRS) using different ventilation modes before placing patients in prone position and after repositioning to position supine.	A total of 90 patients were included in this study.	Adoption of the prone position for the first time in 90 patients and check its effects compared to the supine position.	N/D.
Haddam <i>et al</i> (2016) ⁽¹⁷⁾	To assess the oxygenation response after prone position using pulmonary ultrasonography in patients with ARDS.	51 patients were included in this study.	Lung ultrasound data were collected at four time points: 1 hours before (baseline) and 1 hours after placing the patient in prone position. Data for 1 hours before and 1 hours after placing the patient back in the supine position were also evaluated.	From March 2014 to January 2015 and from December 2015 to January 2016.

Table 4 – Main data from the articles included in this systematic review.⁶⁻⁸

Authors	Study aim	Sample	Intervention	Duration
Ayzac <i>et al</i> (2016) ⁽¹⁸⁾	To assess the impact of prone position on the incidence of Ventilator-Associated Pneumonia and the role of VAP in mortality in patients with severe ARDS.	466 patients with severe ARDS were included in this study.	Collecting of bronchoalveolar lavage fluid or tracheal aspirate, establishing the comparative prone vs. supine position.	From January 1 st , 2008 to July 25 th , 2011.
Xu <i>et al</i> (2015) ⁽¹⁹⁾	To assess the impact of prone position in patients with severe H7N9 avian influenza accompanied by ARDS.	Six patients with hypoxemia refractory to H7N9 were included in this study.	Collecting data relating to mechanical respiratory and circulatory functions retrospectively every hour before and after each prone position.	From December 2013 to March 2014.