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REVIEW ARTICLE

Adjuvant treatments to invasive mechanical ventilation in the management of acute respiratory distress syndrome secondary to COVID-19

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KEYWORDS
Adult respiratory distress syndrome;
Mechanical ventilation;
Prone position;
Nitric oxide;
Extracorporeal membrane oxygenation;
Nursing care;
Mortality

Abstract
Introduction: This bibliographic review is carried out in order to obtain answers about aspects related to techniques and treatments, as well as care associated with the critically ill patient diagnosed with Covid-19.
Objective: To analyze the available scientific evidence on the effectiveness of the use of invasive mechanical ventilation together with other adjuvant techniques, in reducing the mortality rate in patients with Acute Respiratory Distress Syndrome and clinical trial of Covid-19 treated in intensive care units.
Methodology: A systematized bibliographic review was carried out in the Pubmed, Cuiden, Lilacs, Medline, Cinahl and Google Scholar databases, using MeSH terms (Adult Respiratory Distress Syndrome, Mechanical Ventilation, Prone Position, Nitric Oxide, Extracorporeal Membrane Oxygenation, Nursing Care) and the corresponding Boolean operators. The selected studies underwent a critical reading carried out between December 6, 2020 and March 27, 2021 using the Critical Appraisal Skills Program tool in Spanish and a cross-sectional epidemiological studies evaluation instrument.
Results: A total of 85 articles were selected. After performing the critical reading, a total of 7 articles were included in the review, 6 being descriptive studies and 1 cohort study. After analyzing these studies, it appears that the technique that has obtained the best results is ECMO, with the care provided by qualified and trained nursing staff being very important.
Conclusion: Mortality from Covid-19 increases in patients treated with invasive mechanical ventilation compared to patients treated with extracorporeal membrane oxygenation. Nursing care and specialization can have an impact on improving patient outcomes.
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PALABRAS CLAVE
Síndrome de distrés respiratorio agudo;
Ventilación mecánica;
Posición prona;
Óxido nítrico;
Oxigenación por membrana extracorpórea;
Cuidados de enfermería;
Mortalidad

Tratamientos coadyuvantes a la ventilación mecánica invasiva en el manejo del síndrome de distrés respiratorio agudo secundario a covid-19

Resumen
Introducción: La presente revisión bibliográfica está realizada con el fin de obtener respuestas acerca de aspectos relacionados con las técnicas y tratamientos, así como cuidados asociados al paciente crítico diagnosticado con Covid-19.
Objetivo: Analizar la evidencia científica disponible sobre la efectividad de la utilización de la ventilación mecánica invasiva junto con otras técnicas coadyuvantes, en la reducción de la tasa de mortalidad en pacientes con Síndrome de Distrés Respiratorio Agudo y juicio clínico de Covid-19 atendidos en unidades de cuidados intensivos.
Metodología: Se realizó una Revisión Bibliográfica sistematizada en las bases de datos Pubmed, Cuiden, Lilacs, Medline, Cinahl y Google Scholar, utilizando términos MeSH (*Adult Respiratory Distress Syndrome, Mechanical Ventilation, Prone Position, Nitric Oxide, Extracorporeal Membrane Oxygenation, Nursing Care*) y los operadores booleanos correspondientes. Los estudios seleccionados se sometieron a una lectura crítica realizada entre el 6 de diciembre de 2020 y el 27 de marzo de 2021 utilizando la herramienta Critical Appraisal Skills Programme en español y un instrumento de evaluación de estudios epidemiológicos transversales.
Resultados: Se seleccionaron un total de 85 artículos. Tras realizar la lectura crítica se incluyeron en la revisión un total de 7 artículos siendo 6 estudios descriptivos y 1 estudio de cohortes. Tras el análisis de dichos estudios, se desprende que la técnica que mejor resultados ha obtenido es la ECMO, siendo importantes los cuidados proporcionados por el personal de enfermería cualificado y capacitado.
Conclusión: La mortalidad por Covid-19 aumenta en pacientes tratados con ventilación mecánica invasiva respecto a pacientes tratados con oxigenación por membrana extracorpórea. Los cuidados de enfermería y la especialización pueden repercutir en una mejora de los resultados en los pacientes.
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Introduction

Acute respiratory distress syndrome (ARDS) is a heterogeneous syndrome consisting of acute respiratory failure secondary to acute inflammatory lung oedema with increased capillary permeability, leading to increased fluid in the lung interstitium and alveolar spaces.[1,2] All this triggers the development of an intrapulmonary shunt, with a ventilation-perfusion ratio of 0, resulting in profound hypoxaemia refractory to high fractions of inspired oxygen (FiO_2), but responsive to the use of positive end-expiratory pressure (PEEP). In addition, there is a decrease in compliance, requiring higher transpulmonary pressure to achieve optimal lung volume. This situation can lead to the development of volutrauma.[1]

The new Berlin definition was presented at the 2012 Congress of the European Society of Intensive Care Medicine, which includes new variables such as time of onset, degree of hypoxaemia, origin of oedema, and radiological abnormalities with bilateral infiltrates, and classifies patients with ARDS into 3 levels of severity: mild ($200 < PaO_2/FIO_2 \leq 300$ mmHg), moderate ($100 < PaO_2/FIO_2 \leq 200$), and severe ($PaO_2/FIO_2 \leq 100$), all with a PEEP ≥ 5 cmH_2O.[1,3]

ARDS requires a high level of care in intensive care units (ICU) due to its high mortality rate, resource consumption, and long-term functional, neurological, and psychological consequences.[4] ARDS has an incidence of 10.4% in patients admitted to ICUs, with an associated mortality of 63% of cases[5]; that is, two-thirds of patients with ARDS die, mainly due to multi-organ dysfunction coexisting with sepsis.[1]

Risk factors triggering ARDS can be extrapulmonary/indirect, such as sepsis, severe trauma or acute brain injury, or pulmonary/direct, the most common being pneumonia,[1,2] currently associated with COVID-19.[6]

On 31 December 2019, China reported 27 cases of pneumonia of unknown aetiology to WHO in Wuhan. Within a week, a new coronavirus (SARS-CoV-2) was confirmed under the name COVID-19.[7,8]

Since the state of alert was declared in March, 124,871,140 cases and 2,744,543 deaths have been reported worldwide. In Spain, there have been 3,270,825 cases and 75,010 deaths.[9] The case fatality rate is estimated to be 6.9% worldwide,[10] and in Spain it is 9.6/1000 cases.[11]

The most common complications of COVID-19 include pneumonia, ARDS, myocarditis, acute kidney damage, and superinfections leading to septic shock.[12]

The differential elements that mark the particularities of COVID-19 with respect to ARDS lie in the clinical manifestations of pulmonary infection, which are usually evident beyond the sixth or seventh day with respect to the usual pneumonias, and in addition to the potentially poor outcome from this infection, there would be a greater risk and, therefore, a higher mortality rate due to the throm-

botic disturbances that develop in these patients. Finally, the pathophysiological alterations associated with alterations in gas exchange mean that patients may show signs of marked hypoxaemia without pulmonary compromise with low response to recruitment manoeuvres, or show typical ARDS compromise with good response to recruitment.[6]

Currently, the challenge with COVID-19 is the lack of effective treatment, severe cases are identified so that these patients are rapidly transferred to an ICU, where respiratory support is applied to reverse disease progression and decrease morbidity and mortality rates.[10]

Invasive mechanical ventilation (IMV) is the treatment of first choice in patients with ARDS and respiratory failure of any aetiology.[13] Its aim is to achieve adequate oxygenation by preventing the development of mechanical ventilation-induced lung injury, which occurs when high tidal volume and/or PEEP are applied, inducing mechanical damage that causes rupture of the alveolar epithelium and fluid passage, exacerbating pulmonary oedema.[1]

Ventilatory care strategies in patients with ARDS secondary to COVID-19 should be based on the mechanical ventilation-induced lung injury strategy with tidal volume < 5 ml/kg ideal weight, plateau pressure < 30 cmH_2O, distending pressure < 14 cmH_2O, initial PEEP of 10 cmH_2O and adjusted for recruitment, oxygenation targets between 60—80 mmHg, and early consideration of prone positioning (PP),[6] with PEEP being central to reversing hypoxaemia and improving pulmonary mechanics in ARDS patients.[1]

Nursing care is important and will be aimed at avoiding risks of hypoxaemia, hyperventilation/hypoventilation, barotrauma, preventing ventilator-associated pneumonia, accidental extubation, and pressure ulcers.[14]

There are situations where the usual treatment is not sufficient and other coadjuvant techniques are needed to manage ARDS. On the one hand, PP is a manoeuvre that improves oxygenation in patients with respiratory diseases.[3] This positioning influences the improvement of pulmonary residual capacity, redistribution of pulmonary perfusion, ventilation-perfusion ratio, and secretion clearance.[1] The responsibility for repositioning lies with the nurses, who must be prepared and trained to minimise risks and complications.[15] The nursing care includes coordinated postural changes of the head and upper limbs, adopting the swimmer's position every 2 h, monitoring and preventing pressure ulcers, performing eye and oral hygiene, and aspirating secretions, as necessary, pre-oxygenating to 100%.[14,15] On the other hand, there is extracorporeal membrane oxygenation (ECMO), which is an extracorporeal circuit developed for the treatment of acute cardiac and/or respiratory failure of reversible origin,[16] which allows the use of ultra-protective ventilation against lung injury induced by mechanical ventilation.[1] Nursing care will be directed towards monitoring, surveillance of cannulas and circuits to detect the appearance of thrombi and fibrin deposits, and control of the patient's anticoagulation to avoid thrombotic and/or haemorrhagic events.[14] And finally, inhaled nitric oxide (iNO), which is a pressurised gas that at room temperature can be administered by inhalation mixed with oxygen. The main action is selective pulmonary vasodilatation.[13] It is recommended in cases of ARDS with profound hypoxaemia and prior to veno-venous ECMO. It produces a transient improvement in oxygenation after 24 h of treatment.[16]

The main objective of this review is to analyse the available scientific evidence on the use of IMV together with other co-adjuvant techniques to reduce the mortality rate in patients with ARDS clinically judged to have COVID-19 seen in the ICU.

The secondary objectives are 1) to describe the real and potential complications derived from the use of each technique, 2) to analyse the type of nursing care specifically applied according to the technique used, and 3) to analyse the influence of nurse training on clinical improvement and reduction of mortality rate.

Methodology

Design

This is a systematic literature review of articles published in 2020, located in the databases PubMed, CUIDEN, LILACS, Medline, CINAHL, and Google Scholar.

The following keywords were used for the different search equations: adult respiratory distress syndrome, COVID-19, mechanical ventilation, prone positioning, nitric oxide, extracorporeal membrane oxygenation, mortality, nursing care, and professional training, and the Boolean operators OR and AND were used to join the different terms, as shown in Table 1.

Study eligibility criteria

The inclusion criteria applied to select the articles were studies that include as study population adults over 18 with ARDS and/or COVID-19 infection and treated with IMV and/or PP, iNO, and/or ECMO, that are available in full text from 2020, that include at least one of the following outcome variables: mortality, nursing care, and/or nursing professional training. The types of study to be included were systematic review, clinical trial, prospective and/or retrospective cohort studies, and descriptive studies, valid in both Spanish and English.

The exclusion criteria applied were studies that included pregnant or breastfeeding women, as well as those that included underlying diseases of pulmonary origin prior to the techniques to be studied (underlying lung diseases such as COPD, lung transplant, and/or involvement due to other types of virus).

Article selection

A total of 85 articles were selected and, after critical reading, a total of 7 articles were included in the review, consisting of 6 descriptive studies and 1 cohort study.

A screening process was followed for their selection; firstly, the studies were located using the search strategies shown in Table 1; secondly, a reading of titles, keywords, and abstracts was performed, discarding duplicate studies, to finish with the critical reading of the studies included in full text using the critical reading tool Critical Appraisal Skills Programme Español[17]; and for the descriptive studies, the critical reading and evaluation tool for cross-sectional epidemiological studies by Berra et al.[18] was used. The qual-

Table 1 Search equations and combination of document terms in the different databases.

Database	Search strategy	Total No of articles	Filters	No of articles after applying filters	No of articles after reading title and abstract and applying eligibility criteria	No of full text articles	No of articles after eliminating duplicates	No of articles included after critical reading
PubMed (1) 25-2-2021	(((((acute respiratory distress syndrome[MeSH Terms]) OR (Covid-19)) OR (coronavirus infections[MeSH Terms])) AND (mechanical ventilation[MeSH Terms])) AND (((extracorporeal membrane oxygenation[MeSH Terms]) OR (prone position[MeSH Terms])) OR (nitric oxide))) AND ((((mortality) OR (nursing care[MeSH Terms])) OR (professional training)) OR (continuing education[MeSH Terms]))))	499	Adults > 19 years Human 2015—2021 English and Spanish	107	43	43	43	3
PubMed (2) 27-3-2021	((coronavirus infection[MeSH Terms]) AND ((((mechanical ventilation[MeSH Terms]) OR (prone position[MeSH Terms])) OR (extracorporeal membrane oxygenation[MeSH Terms])) OR (nitric oxide))) AND ((nursing care[MeSH Terms]))	7	Adults > 19 years 2020—2021 Human	3	1	1	1	1
CUIDEN 14-2-2021	((Síndrome de dificultad respiratoria del adulto) OR (Covid-19)) AND ((((Ventilación mecánica) OR (Oxigenación por membrana extracorpórea) OR (Óxido nítrico) OR (Posición prona)))) AND (((Mortalidad) OR (Cuidados de enfermería) OR (Capacitación profesional)))	25	2015—2021	22	2	2	2	0

Table 1 (*Continued*)

Database	Search strategy	Total No of articles	Filters	No of articles after applying filters	No of articles after reading title and abstract and applying eligibility criteria	No of full text articles	No of articles after eliminating duplicates	No of articles included after critical reading
LILACS 14-2-2021	((respiratory distress syndrome, adult) OR (covid-19)) AND ((((mechanical ventilation) OR (extracorporeal membrane oxygenation) OR (prone position) OR (nitric oxide)))) AND (((mortality) OR (nursing care) OR (professional training)))	106	2015—2021	5	3	3	3	0
Medline 14-2-2021	((respiratory distress syndrome, adult) OR (covid-19)) AND ((((mechanical ventilation) OR (extracorporeal membrane oxygenation) OR (prone position) OR (nitric oxide)))) AND (((mortality) OR (nursing care) OR (professional training)))	1.418	Adults > 19 years 2015—2021 English and Spanish	247	19	19	18	1
CINAHL 14-2-2021	((Covid-19) OR (Acute respiratory distress syndrome)) AND ((((Mechanical ventilation) OR (Extracorporeal membrane oxygenation) OR (Prone position) OR (Nitric oxide)))) AND (((Mortality) OR (Nursing care) OR (Professional training)))	1.642	Adults > 19 years 2015—2021 English and Spanish	165	14	14	8	0
Google Scholar 27-3-2021	(Covid-19) AND (mechanical ventilation) AND (extracorporeal membrane oxygenation OR prone position OR nitric oxide) AND (nursing care OR mortality)	1.470	2020—2021	712	28	28	10	2

ity criteria established for using the critical reading tools of the Critical Appraisal Skills Programme Español were that the selected study responded positively to 2 of the 3 elimination questions,[17] and for the Berra et al. tool, that 3 of the 4 items to be evaluated were classified positively as good-very good.[18]

Results

A total of 7 studies were selected for the literature review (Table 2), 5 of which met the main objective, which was to analyse the use of IMV together with other adjuvant techniques (PP, iNO, and ECMO) to reduce the mortality rate. By pooling the results of these studies, a total of 221 patients undergoing IMV were analysed and of these, PP was used as an adjuvant technique in 152/221 (69%) patients, and iNO treatment in 26/221 (12%) patients as salvage therapy. In this group of patients, the mortality rate was 98/221 (44%) deaths.[20–22]

Patients arriving with a severe prognosis or worsening in the ICU were treated with ECMO support. A total of 117 patients were analysed, there was combined use of IMV, PP, and ECMO support in a total of 76/117 (65%) patients. The mortality rate in this group was 46/117 (39%) deaths.[19–23] In this group of patients, 63/76 (83%) were men compared to 13/76 (17%) women. In relation to comorbidities, obesity, with a mean BMI of 32.45 kg/m^2, hypertension in 21/76 (28%) patients, and type 2 diabetes mellitus in 14/76 (18%) patients stand out. Prior to ECMO support, mean blood gas values were PaO_2/FiO_2 74.6 mmHg, pH 7.28, and $PaCO_2$ 61.8 mmHg. In addition, attempts were made to reverse the presence of refractory hypoxaemia with other techniques and treatments, with PP being used in 52/76 (68%) patients, neuromuscular blockade in 49/76 (65%) patients, and iNO in 30/76 (40%) patients.[19,20,23]

We address the secondary objectives by topic, focusing on the complications associated with the use of ECMO, finding a response in 3 of the studies, with 76 patients. The complications are numerous: renal failure with need for continuous renal replacement therapy in 21/76 (28%) patients; deep vein thrombosis in 14/76 (18%) patients, pulmonary embolism in 2/76 (3%) patients, mechanical complications in 13/76 (17%) patients; pulmonary haemorrhages in 7/76 (9%) patients, bleeding at the cannulation site in 18/76 (24%) patients, and major haemorrhages in 13/76 (17%) patients, bloodstream infection in 4/76 (5%) patients, pneumothorax in 4/76 (5%) patients, and thrombocytopenia in 5/76 (7%) patients.[19–23]

With respect to nursing care and nurse specialisation, 2 of the studies indicate that the training of professionals working in the ICU has influenced improved patient outcomes by monitoring and detecting complications derived from the techniques used in these units.[24,25]

The study by Tu et al.,[24] which focuses on ECMO support, indicates that in order to implement this technique, the presence is required of a team of 3 doctors and 2 nurses (one expert in critical patients and the other in ECMO support). In addition, the studies by Tu et al.[24] and Nie et al.[25] coincide in highlighting a series of common care measures for patients undergoing this technique. Among others, the recommendation is to initiate sedoanalgesia considering the Richmond sedation and agitation scale with a score of -5 to 4 and the critical care pain observation tool CPOT with a score of 0. Nie et al.[25] also report that, to reduce the accumulation of sedative drugs, nurses wake patients every day to assess degree of consciousness and cooperation, and thus make a detailed record on the patient.

It is also important to manage the patient's anticoagulation, so they recommend administering, after cannulation, 3000 IU of heparin sodium followed by a continuous infusion of 50 ml of .9% saline with 250 IU/mL of heparin sodium,[24] measuring coagulation time every 2 h to prevent bleeding risks.[24,25]

However, infections associated with the cannulation site and/or IMV may develop; to prevent them, techniques were performed aseptically and the collection of samples from ECMO circuits was avoided. To prevent facial oedema and pressure ulcers, postural changes were performed every 2 h. And finally, all cannulas and peripheral accesses were properly secured to prevent mechanical complications (oxygenator head failure, gas embolism, displacement, or decannulation), Heparin, ECMO flow, and transmembrane pressure were adjusted to prevent thrombus formation.[24]

Discussion

The main objective of the present literature review was to analyse the available scientific evidence on the use of IMV together with other adjuvant techniques (PP, iNO, and ECMO) to reduce the mortality rate in patients with ARDS due to COVID-19 in the ICU. Seven articles were selected to answer this question. The studies are mainly from China and Europe.

Most studies focus on ECMO support of the critically ill patient diagnosed with COVID-19 and refractory hypoxaemia due to ARDS. Firstly, the results on the use of COVID-19 treatment/technique in ARDS patients with COVID-19 and its impact on mortality reduction are very disparate across the studies, and some studies did not even complete follow-up of their patients, thus giving a biased result. As shown in the results, the mortality rate with the sole use of IMV or supported by other techniques/treatments stands at 44%, use with ECMO therapy puts this rate in the lower range at 39%.[19–23] But how do these data vary from before the pandemic? Considering reviews conducted since 2015 and at the beginning of the pandemic, a total of 2 studies evaluating 848 ARDS patients treated with IMV were analysed; the mortality rate was 33% (277 deaths), showing a clear increase in mortality during the pandemic. Combination with ECMO had a rate of 42% (188 deaths) out of 451 patients, showing a minimal decrease in mortality[23,26] (Fig. 1).

Against this background, and based on the results obtained in patients treated with the combination of IMV and ECMO together with other strategies such as PP and iNO as salvage therapy, the results may be encouraging. The optimal timing of ECMO initiation for maximum benefit is still unknown, although studies suggest that early initiation may be associated with better outcomes.[20–23]

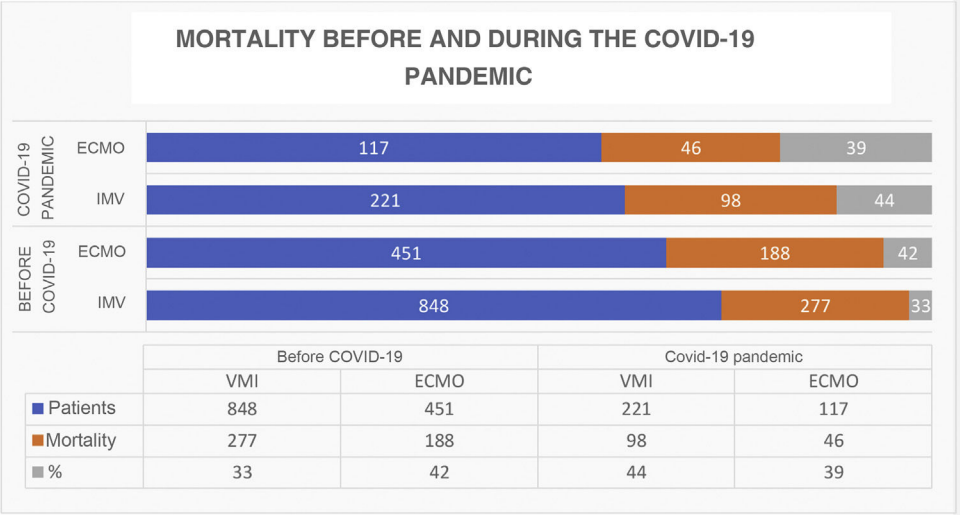
Secondly, taking into account the numerous complications that occur in an ICU and the complexity of techniques and treatments, it seems likely that nursing care and the specialisation of its professionals can have

Table 2 Study characteristics.

Author	Year	Objectives	Design	Country/sample	Results
Yang et al.[22]	2020	To summarise the clinical features, ECMO characteristics and outcomes of patients severe acute respiratory syndrome coronavirus 2 pneumonia who received ECMO	Descriptive study 2 hospitals	China 129 patients	59 patients included in the study out of a total of 129. Of the 59 patients, 38 received MV and 21 received ECMO. Patients with MV without ECMO support had a better survival trend (63.2%) vs. those with ECMO (57.1%). In both groups prone positioning was used as an adjuvant technique
Roedl et al.[21]	2021	To investigate the characteristics and outcomes of critically ill patients with COVID-19 requiring ICU admission and MV	Retrospective observational cohort study	Germany 261 patients	223 patients included in the study out of a total of 261 patients admitted to the ICU. A total of 163 patients develop ARDS and are classified by severity, of which 156 patients underwent IMV and in addition 20 patients needed ECMO. Adjuvant treatments (PP, neuromuscular blockade, and iNO) are used. Mortality in ICU is 35%.
Kon et al.[20]	2021	The hypothesis of this study is that patient and lung recovery with the use of ECMO in severe COVID-19 is possible and that a nihilistic approach to these patients is not warranted	Retrospective study	USA 412 patients	Twenty-seven patients were included. Of these, 18 (67%) had no comorbidities. All were intubated in the 7 days prior to ECMO and 7 assisted with iNO. Up to study follow-up, only one patient died, and 13 remain on ECMO
Riera et al.[19]	2020	To evaluate the performance of the ECMO recovery team in a high-volume ECMO centre during the COVID-2019 pandemic.	Case series	Spain 19 patients	19 patients on ECMO support for refractory hypoxaemia. iNO was used in one patient and neuromuscular blockade in all patients prior to ECMO support. At the end of follow-up 10.5% remained on ECMO and 21.1% had died.

Table 2 (*Continued*)

Author	Year	Objectives	Design	Country/sample	Results
Tu et al.[24]	2020		Case review	China 3 patients	It is recommended that healthcare teams for ECMO should consist of 5 health care workers. Sedoanalgesia is necessary prior to cannulation In ECMO treatment it is necessary to observe and monitor possible complications such as haemorrhage, infection, mechanical complications, etc., in which the nurse is fundamental
Cousin et al.[23]	2020	The main objective of this study was to compare the 28-day mortality of COVID-19 patients with refractory ARDS requiring V-V ECMO with a retrospective cohort of patients with influenza (A or B) supported by a similar strategy	Retrospective study	France 58 patients	The study aims to compare the mortality of patients with COVID-19 and influenza with ECMO support. A total of 52 patients meeting the selection criteria were analysed, including 30 patients diagnosed with COVID-19 and 22 with influenza (18 type A and 4 type B patients). After the use of various pre-ECMO techniques and treatments, 28-day mortality was 43.3% in the COVID-19 group and 50% in the influenza group. At 3 months, mortality increased in the COVID-19 group to 53.3% and remained at 50% in the influenza group. However, complications and adverse effects were similar in both groups except for thrombotic events, which predominated in the COVID-19 group vs. influenza group (73.3% vs. 63.3%, respectively)
Nie et al.[25]	2020	To describe the nursing experience of patients with COVID-19 treated in our hospital when receiving ECMO combined with prone position ventilation	Descriptive study	China 9 patients	Shows the role of nursing in the critically ill patient undergoing ECMO support, in terms of pre-cannulation sedoanalgesia treatment and reduction of complications. The result of the technique indicates that ECMO improves oxygenation and secretion clearance combined with MV and PP



	Before COVID-19		Covid-19 pandemic	
	VMI	ECMO	VMI	ECMO
Patients	848	451	221	117
Mortality	277	188	98	46
%	33	42	44	39

Figure 1 Mortality before and during the COVID-19 pandemic.

an impact on improving patient outcomes. Riera et al.,[19] Yang et al.,[22] Tu et al.,[24] and Nie et al.[25] advocate training professionals working in ICUs to monitor and reverse actual and potential complications arising from the techniques and treatments used in these units. Complications increase in COVID-19 patients treated with ECMO, because thrombotic events associated with the disease itself and the technique itself require closer monitoring of each patient. As demonstrated in several studies, analytical parameters in these patients are characterised by lymphopenia, thrombocytosis, and increased D-dimer and C-reactive protein, among others,[22,27] and this, added to the capacity to activate an immune response with a cascade of inflammatory cytokines by activation of macrophages through anti-interleukin 1 and 6[12,28] and the comorbidities present such as hypertension or advanced age,[20,23,27] mean that these thrombotic events at the venous and/or arterial level increase mortality and the onset of complications.

But how does the incidence of complications vary compared to before the pandemic? The complications associated with ECMO support, according to a study of 22 patients, were renal failure requiring continuous renal replacement therapy in 12 patients (55%), deep vein thrombosis in 3 patients (14%), bleeding at the cannulation site in 5 patients (23%), major haemorrhage in 9 patients (41%), and bloodstream infection in 2 patients (9%).[23] There was a clear increase in complications associated with thrombotic and haemorrhagic effects during the pandemic.

The limitations of the studies selected for the review are related to the type of study design, which is limited to descriptive studies and cohort studies; likewise, the small sample sizes and focus on case series make it impossible to extrapolate the results adequately. However, the lack of studies and/or clinical trials at a global level was noted during the database searches, although this seems logical given the seriousness of the situation and the ethical limits of the trials. Similarly, we were able to verify the lack of studies and nursing care plans with which to protocolise actions based on the scientific evidence at the time of the current pandemic.

It is interesting to highlight possible future lines of research aimed at investigating the factors associated with flare-ups and relapses, and the influence on mortality in patients with ARDS with COVID-19 after discharge from the emergency department or special services such as the ICU.

Conclusions

Based on the results obtained from the studies analysed, we can conclude that the sole use of IMV in the treatment of patients with moderate-severe ARDS due to COVID-19 does not reduce mortality at the expected rate compared to studies published before the pandemic, but its use with adjuvant techniques such as prone positioning improved gasometric parameters and reduced the mortality rate prior to the pandemic. It appears that the use of ECMO therapy improves survival rate if started early, although the ideal timing is not yet known.

Further research in the context of critical care nursing and the COVID-19 pandemic is also needed to build a solid foundation of nursing care globally towards delivering the best care even in exceptional settings.

Conflict of interests

The authors have no conflict of interests to declare.

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