



## REVISIONES

### Nursing approach to the person in critical situation submitted to extracorporeal membrane oxygenation: Scoping Review

Abordagem de enfermagem à pessoa em situação crítica submetida a oxigenação por membrana extracorporeal: Scoping review

Enfoque de enfermagem a la persona en situación crítica sometida a oxigenación por membrana extracorpórea: Scoping review

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#### ABSTRACT:

Extracorporeal Membrane Oxygenation (ECMO) corresponds to a form of mechanical cardiopulmonary support used to treat severe respiratory failure, since it allows extracorporeal gas exchange. Additionally, in patients with severe heart failure, or experiencing cardiorespiratory arrest, this technique also provides systemic circulation. Nevertheless, ECMO carries some risks, such as clot formation. It is in this context that the nurse has a key role.

**Objective:** To map the available scientific evidence about the nurses' approach to the critically ill person subjected to ECMO.

**Method:** We conducted a scoping review, using databases accessed through the EBSCOhost platform and following the methodology proposed by the Joanna Briggs Institute. Through the combination of appropriate MeSH descriptors, we selected articles published between 2009 and 2019, written in Portuguese or English.

**Results:** Five studies were included in the review. Their analysis allowed us to verify that the nurse's approach focuses on the monitoring, surveillance, management and coordination of the care provided to critically ill patients subjected to ECMO. It was also found that the adoption of adequate protocols, the training of the multidisciplinary teams and an efficient communication between team members contributed to an effective, safe and high-quality performance when facing patients subjected to ECMO.

**Conclusion:** An appropriate nursing approach is essential to ensure the provision of care with quality, and safety, to the patient subjected to ECMO.

**Keywords:** nursing; care; ECMO; extracorporeal membrane oxygenation; critically ill patient; intensive care.

## RESUMO:

A Oxigenação Extracorporeal por Membrana (ECMO, na sigla inglesa) corresponde a um suporte cardiopulmonar mecânico utilizado para tratar a insuficiência respiratória grave, ao permitir trocas gasosas extracorporais. Adicionalmente, em pacientes com insuficiência cardíaca grave, ou em paragem cardiorrespiratória, esta técnica também providencia circulação sistémica. Contudo, a ECMO acarreta alguns riscos, como a formação de coágulos. É neste contexto que o enfermeiro desempenha uma função primordial.

**Objetivo:** Mapear a evidência científica disponível sobre a abordagem dos enfermeiros à pessoa em situação crítica submetida a ECMO.

**Método:** Realizou-se uma revisão abrangente da literatura (*scoping review*), recorrendo a bases de dados acedidas através da plataforma EBSCOhost e seguindo a metodologia proposta pelo Joanna Briggs Institute. Mediante a conjugação de descritores MeSH apropriados, foram selecionados estudos em Português, ou Inglês, e publicados entre 2009 e 2019.

**Resultados:** Foram incluídos cinco estudos na revisão. A sua análise permitiu averiguar que a abordagem do enfermeiro se centra na monitorização, vigilância, gestão e coordenação dos cuidados prestados à pessoa em situação crítica submetida a ECMO. Verificou-se, ainda, que a adoção de protocolos adequados, o treino das equipas multidisciplinares e uma comunicação eficiente entre os membros de equipa, contribuem para uma atuação eficaz, segura, e de qualidade, perante os doentes submetidos a ECMO.

**Conclusão:** Uma abordagem apropriada, por parte do enfermeiro, é fundamental para garantir a prestação de cuidados com qualidade, e segurança, ao doente submetido a ECMO.

**Palavras-Chave:** enfermagem; cuidados; ECMO; oxigenação por membrana extracorpórea; doente crítico; cuidados intensivos.

## RESUMEN:

La Oxigenación con Membrana Extracorpórea (ECMO en inglés) es un tipo de soporte artificial cardiopulmonar usado para tratar el fallo respiratorio severo ya que permite la oxigenación extracorpórea. Además, en pacientes con fallo cardíaco severo o que han sufrido un infarto, esta técnica provee circulación sistémica. Sin embargo, la ECMO conlleva algunos riesgos, por ejemplo, coagulopatías. El enfermero tiene un papel clave en esta situación.

**Objetivo:** Dejar clara la función científica de los enfermeros en relación con el paciente crítico en tratamiento con ECMO.

**Método:** Llevamos a cabo un estudio usando las bases de datos de la plataforma EBSCO host y siguiendo la metodología propuesta por el Instituto Joanna Briggs. Con base en los descriptores de la MeSH, hemos seleccionado estudios publicados entre el 2009 y 2019, escritos en portugués e inglés.

**Resultados:** Se han incluido 5 estudios en esta revisión. El análisis de los artículos nos permitió verificar que la labor del enfermero se basa en la monitorización, supervisión, dirección y coordinación del cuidado de los pacientes críticos sometidos a ECMO. También se apreció que el uso de protocolos adecuados, la formación de equipos multidisciplinares y la comunicación adecuada entre los componentes del equipo contribuye a un abordaje eficaz, seguro y de calidad para tratar a los pacientes sometidos a ECMO.

**Conclusión:** El papel del enfermero es fundamental para la calidad y seguridad de los cuidados prestados a los pacientes críticos sometidos a ECMO.

**Palabras clave:** enfermería, cuidados, ECMO, oxigenación por membrana extracorpórea, paciente crítico, cuidados intensivos.

## INTRODUCTION

Extracorporeal Membrane Oxygenation (ECMO) is considered a form of mechanical cardiopulmonary support. It is used in the treatment of severe respiratory failure, heart failure, or both <sup>(1)</sup>. Initially, this technique was developed to be applied solely during cardiac surgery. However, nowadays, its application has been extended to intensive care. ECMO is currently used as a rescue technique — it can be employed in extreme cases of ARDS (Acute Respiratory Distress Syndrome) which are refractory to conventional ventilation techniques, or even during Cardiorespiratory Arrest (CRA), being named Extracorporeal Cardiopulmonary Resuscitation (ECPR). Certain studies

demonstrate that ECPR is more effective than conventional Cardiopulmonary Resuscitation (CPR). According to a document written by the Extracorporeal Life Support Organization (ELSO) <sup>(2,3,4)</sup>, only 28% of the ECPR procedures performed in adults are effective. Nevertheless, the same document highlights that ECPR is associated with a better survival rate, due to various modifiable and non-modifiable factors, such as adequate pre-ECPR resuscitation, efficient implementation of the extracorporeal support and adequate patient selection <sup>(2-6)</sup>.

The ECMO technique consists of extracting the blood from the body, by means of several cannulae, which are placed in central veins. The extraction is achieved using a mechanical pump — the oxygenator — that also performs the necessary gas exchanges when the blood passes through it, removing carbon dioxide and adding oxygen. After the gas exchanges, the blood returns to the body, by means of other cannulae, inserted in central arteries or central veins, depending on the ECMO modality <sup>(1,8)</sup>.

The patient's physiological needs dictate whether the ECMO will perform cardiopulmonary support, or simply pulmonary support. In the first case, it is preferable a veno-arterial (VA) cannulation — extraction of the blood through a vein, usually a femoral vein, followed by the return of the blood through an artery, generally the femoral artery. If the patient only requires pulmonary support, a veno-venous (VV) cannulation is preferred, because, in that case, the ECMO functions as an artificial lung. The patient's heart ensures blood circulation, while blood oxygenation is carried out externally, by the oxygenator, allowing the lungs to rest <sup>(4,9)</sup>.

It should be noted that, like all invasive procedures, ECMO is associated with adverse events, such as clot presence and/or formation, gas embolism, and/or failure of the oxygenator during the technique's execution. Additionally, it has also been reported that patients subjected to ECMO can experience clinical complications, due to interactions between the blood and the circuit's artificial surfaces, as well as changes in blood flow patterns. The prolonged use of the technique has also been related to a greater number of complications. Nonetheless, it is important to stress that the results reported in literature reveal the existence of a reducing factor for all these adverse events, which affects their incidence, their severity, and the consequences of possible mechanical complications — the presence of a team specialized in ECMO, composed of physicians and nurses with appropriate experience and training. These professionals provide daily care to the patients who are subjected to ECMO. Their knowledge allows a more accurate prediction of errors, as well as a care directed both to the patient's needs and to the technique's demands <sup>(4,5,10,11,12)</sup>. When we were faced with the abovementioned considerations, the following research question emerged: What is the nurses' approach to the critically ill person subjected to ECMO? The present study — through a content analysis using the Scoping Review methodology based on the principles recommended by the Joanna Briggs Institute — aims to map the available scientific evidence about the nurses' approach to the critically ill person subjected to ECMO.

## MATERIALS AND METHODS

This study portrays a scoping review, which is organized according to the structure proposed by the Joanna Briggs Institute, in "Methodology for The Joanna Briggs Institute Scoping Reviews" <sup>(13)</sup>. Given that the synthesis of evidence, by means of

systematic reviews, is at the core of evidence-based practice, there are different review objectives and review questions that require the development of new approaches. These approaches, which include the scoping review, are designed to synthesize the most effective and rigorous evidence <sup>(14)</sup>. The scoping review model adopts the following main objectives: to map the existing evidence underlying a determined research area; to identify gaps in the existing evidence; and to represent a preliminary exercise that justifies and informs the execution of a systematic literature review. The greatest and most significant particularity of this model is that it not only analyzes the methodological quality of the included studies, but also maps the existing scientific evidence contained in them <sup>(13,14)</sup>.

The research question was formulated using the “Population, Concept and Context” (PCC) strategy: the “Population” consisted of critically ill adult patients (ages between 18 and 64 years old); the “Concept” corresponded to the nursing care provided to those patients when subjected to ECMO; the “Context” was not applicable in this particular case.

The following inclusion criteria were established, in order to guide the literature’s search and selection according to the intended results and the formulated question: samples consisting of critically ill adult patients (ages between 18 and 64 years old); studies that referred to nursing interventions applied to patients subjected to ECMO; articles available in full text and free of charge, published between June 2009 and June 2019, and written in Portuguese, Spanish, or English. These criteria are summarized in Table 1.

**Table 1** — Inclusion criteria.

Inclusion criteria	
<b>Participants</b>	Critically ill adult patients (ages between 18 and 64 years old).
<b>Interventions / Studied Phenomena</b>	Nursing interventions applied to patients subjected to ECMO.
<b>Articles</b>	Available in full text and free of charge; Published between June 2009 and June 2019; Written in Portuguese, Spanish, or English.
<b>Outcomes</b>	Nursing interventions applied to critically ill patients subjected to ECMO.

Studies published in other languages, as well as those that referred to interventions performed without the participation of nurses, were excluded. The purpose of the ten-year time span, ending in 2019, was to identify the most recent scientific evidence.

Two researchers carried out the search and selection process. The search strategy encompassed only published studies and consisted of a three-step search. An initial survey was executed using the EBSCO Host Research Platform, with the following databases selected: CINAHL Complete, MEDLINE Complete, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Cochrane Methodology Register. This was followed by a search for these specific words in the titles, abstracts and descriptors: “*nursing interventions*”, “*extracorporeal membrane oxygenation*”, and “*critical patient*”. Subsequently, a second survey was performed,

using all the previously identified keywords and descriptors in the selected databases. Finally, some of the references found in the identified articles were analyzed to identify additional studies. The search was conducted in June 2019, using the referred search terms, the Boolean operator “AND”, and the previously mentioned PCC strategy components.

The preliminary search results were evaluated and sorted according to their suitability for inclusion, considering only the information available in the respective titles and abstracts. Afterwards, the selected studies were read in full, before their integration into the final sample. The level of evidence and the grade of recommendation were classified according to the “*New JBI Levels of Evidence*”<sup>(18)</sup>, which allowed to preliminarily appraise the methodological quality and the accuracy of the evidence found in those works<sup>(17,18)</sup>.

Both researchers, acting as independent reviewers, also conducted the critical evaluation, extraction and synthesis of data. Concerning the critical evaluation, it was ensured by reading the studies, as well as by assessing their methodological quality through the JBI instrument “*Checklist for Diagnostic Test Accuracy Studies*”<sup>(19)</sup>, during the article selection process. Due to some disagreements between the reviewers, the evaluation of a third reviewer was requested. In the end, a consensus was reached — all studies were considered to present high quality and, therefore, none was excluded. Data extraction was carried out by interpreting the articles and highlighting the results that better conveyed an answer to our research question. Last, but not least, we performed a synthesis of the obtained knowledge with respect to the care provided by nurses to critically ill adult patients subjected to ECMO. This synthesis was carried out using an instrument adapted from the one proposed in “*The Joanna Briggs Institute Reviewers’ Manual: 2015 edition*”<sup>(13)</sup>.

## RESULTS

Through our initial database search, we identified 23 studies that were in agreement with the various key concepts. One of the studies was excluded through the search limiters because it was a duplicate. Of the remaining 22 articles, five were rejected after reading the title, because they did not correspond to research studies and/or only addressed ECMO as a technique. Of the remaining 17 studies, after reading the full text, 12 were excluded because they did not pass the methodological quality assessment and/or did not fully meet the inclusion criteria. The remaining five articles were considered relevant, because they referred to nursing interventions/programs within this work’s scope, and were thus included in the review. Figure 1 illustrates this selection process.

**Figure 1** — Flowchart of the process used to select the studies

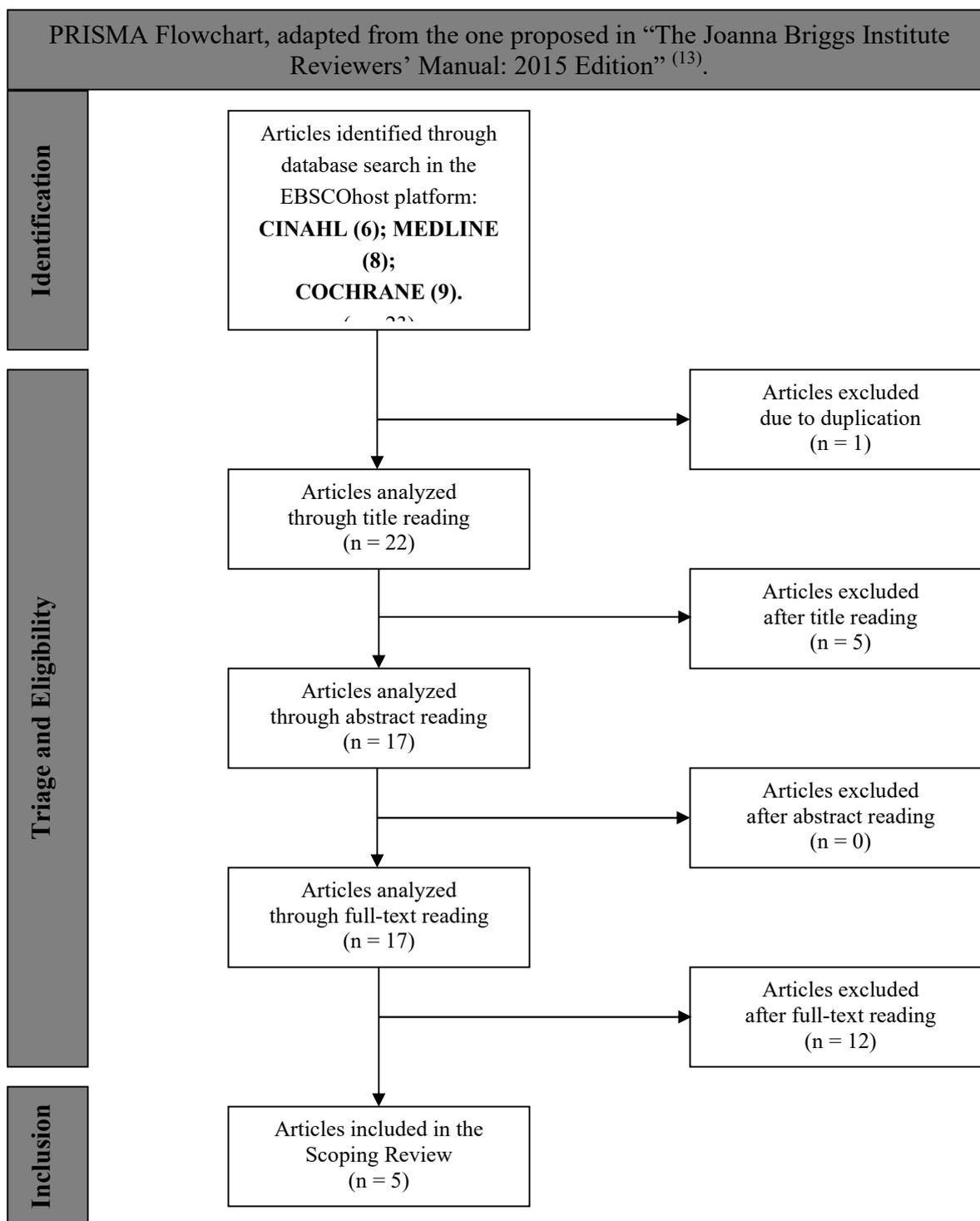


Table 2 lists the five studies<sup>(4-6,9,10)</sup> — identified as A1<sup>(4)</sup>, A2<sup>(9)</sup>, A3<sup>(5)</sup>, A4<sup>(6)</sup> and A5<sup>(10)</sup>, respectively — that were included in the review after the selection process, specifying their author(s), the year in which they were published, the research design used in each one, the characteristics of the studied population, and the level of evidence according to the “*New JBI Levels of Evidence*”<sup>(18)</sup>. It can be observed that the research efforts are dispersed in time (from 2011 up to 2018) and the ensuing works are essentially of a qualitative nature. Studies A2, A3 and A4 present a “Literature Review” modality and, regarding the level of evidence, were therefore categorized as “Level 4.a” (systematic review of descriptive studies)<sup>(18)</sup>. On the other

hand, A1 and A5 present a “Case Study” modality and were thus categorized as “Level 2.d” (pre-test/post-test, or historical/retrospective, control group study) <sup>(18)</sup>. With respect to the studied populations, the latter studies resorted to adult individuals who had been subjected to the ECMO technique at some point in time.

**Table 2** — Studies included in the review, organized by year of publication, research design, studied population, and level of evidence.

Author(s)	Year	Design	Studied Population	Level of Evidence
A1. Fernandes, H.; Saraiva, E.; Souza, C. <sup>(4)</sup>	2018	Qualitative, descriptive and retrospective study, in the Case Study modality	Adult individuals subjected to VA ECMO.	2.d
A2. Ilic, D.; Davies, A.; Pellegrino, V.; Romero, L.; Hodgson, C.; Tramm, R. <sup>(9)</sup>	2015	Qualitative study, in the Systematic Literature Review modality	---	4.a
A3. Bibro, C.; Lasich, C.; Rickman, F.; Folev, N.; Kunugiyama, S.; Moore, E.; Brien, A.; Sherman, N.; Schulman, C. <sup>(5)</sup>	2011	Qualitative study, in the Systematic Literature Review modality	---	4.a
A4. Redealli, S.; Zanella, A.; Milan, M.; Isgro, S.; Lucchini, A.; Pesenti, A.; Patroniti, N. <sup>(6)</sup>	2016	Qualitative study, in the Systematic Literature Review modality	---	4.a
A5. Costa, L.; Hora, M.; Araújo, E.; Pedreira, E. <sup>(10)</sup>	2016	Exploratory qualitative study (instrumental, retrospective and documentary Case Study)	Adult individuals with severe respiratory failure, subjected to VV ECMO	2.d

Table 3 displays the previous articles according to the studies’ purpose, the relevant nursing interventions under analysis, and the main conclusions that were reached. These findings will be subsequently discussed.

**Table 3** — Studies included in the review, organized by purpose, nursing interventions and main conclusions.

Author(s)	Purpose of the Study	Relevant Nursing Interventions	Main Conclusions
<p>A1. Fernandes, H.; Saraiva, E.; Souza, C. (4)</p>	<p>To present the work performed by a team of specialist nurses, concerning the care of patients who were subjected to VA ECMO after cardiorespiratory arrest.</p>	<ul style="list-style-type: none"> <li>• To monitor:               <ul style="list-style-type: none"> <li>• coagulation index;</li> <li>• gasometry;</li> <li>• oxygenator output;</li> <li>• cannulae pressures;</li> <li>• circuit temperature;</li> </ul> </li> <li>• To keep the cannulae intact;</li> <li>• To apply checklists and action protocols.</li> </ul>	<ul style="list-style-type: none"> <li>• The standardization of care, as well as the application of checklists and protocols, ensure the safety of the care provided to ECMO patients.</li> </ul>
<p>A2. Ilic, D.; Davies, A.; Pellegrino, V.; Romero, L.; Hodgson, C.; Tramm, R. (9)</p>	<p>To understand whether the use of ECMO is more effective than conventional resuscitation, in adults experiencing cardiorespiratory arrest.</p>	<ul style="list-style-type: none"> <li>• To perform theoretical and practical training of the health professionals' team;</li> <li>• To encourage the sharing of experiences and knowledge.</li> </ul>	<ul style="list-style-type: none"> <li>• Trained and experienced teams are empowered to provide care to ECMO patients. This leads to an improvement in the quality and safety of the provided care.</li> </ul>
<p>A3. Bibro, C.; Lasich, C.; Rickman, F.; Folev, N.; Kunugiyama, S.; Moore, E.; Brien, A.; Sherman, N.; Schulman, C. (5)</p>	<p>To describe the nursing care and the care pattern variation required in patients infected with H1N1 and subjected to ECMO.</p>	<ul style="list-style-type: none"> <li>• To manage nursing care provided to ECMO patients;</li> <li>• To monitor:               <ul style="list-style-type: none"> <li>• vital parameters;</li> <li>• neurological system;</li> <li>• blood loss;</li> <li>• gasometric parameters;</li> <li>• patient positioning;</li> <li>• ventilation parameters;</li> <li>• diuresis;</li> <li>• capillary glycemia;</li> <li>• family-centered care;</li> </ul> </li> <li>• To communicate and plan as a multidisciplinary</li> </ul>	<ul style="list-style-type: none"> <li>• Nurses are responsible for monitoring and managing all the care provided to ECMO patients. Their professional responsibilities include the early detection of possible changes and the anticipation of secondary problems related to the ECMO technique.</li> <li>• An effective inter-professional communication, and the ability to plan and to work as a team, are indicators</li> </ul>

		team.	of good practice for the technique's success.
A4. Redealli, S.; Zanella, A.; Milan, M.; Isgro, S.; Lucchini, A.; Pesenti, A.; Patroniti, N. <sup>(6)</sup>	To assess the feasibility and safety of daily nursing care, in patients subjected to VV ECMO for the treatment of severe respiratory failure.	<ul style="list-style-type: none"> <li>• To monitor: <ul style="list-style-type: none"> <li>• cannulae care procedures;</li> <li>• oxygenator output;</li> <li>• oxygenator rotations;</li> <li>• oxygenator temperature;</li> <li>• vital parameters;</li> <li>• ventilation parameters;</li> <li>• neurological parameters;</li> </ul> </li> <li>• To communicate and plan as a multidisciplinary team.</li> </ul>	<ul style="list-style-type: none"> <li>• The nursing approach to ECMO patients has a significant impact on the quality and safety of the received care.</li> <li>• The importance of a team effort is highlighted, regarding the prevention of adverse phenomena observed in ECMO patients.</li> </ul>
A5. Costa, L.; Hora, M.; Araújo, E.; Pedreira, E. <sup>(10)</sup>	To understand the experience of providing care to a patient with Acute Respiratory Distress Syndrome (ARDS) subjected to ECMO. To present the diagnoses, as well as the implemented nursing care.	<ul style="list-style-type: none"> <li>• To identify nursing problems and diagnoses, meeting the basic human needs of ECMO patients;</li> <li>• To train the teams responsible for the provision of care, thus enabling them to practice safely and effectively;</li> <li>• To apply internationally defined protocols, in order to standardize the provision of care.</li> </ul>	<ul style="list-style-type: none"> <li>• The nursing diagnosis is an important scientific tool, since it provides measurable criteria for the evaluation and planning of care provision.</li> <li>• Inexperienced multidisciplinary teams need continuous theoretical and practical training, and also to debate with experienced professionals.</li> <li>• The importance of establishing evidence-based protocols is highlighted.</li> </ul>

## DISCUSSION

The results of this review highlight the nurses' approach to the critically ill patient subjected to ECMO. Although the number of included articles constitutes a small sample, the latter is consistent with the proposed framework. The studies are essentially of a qualitative nature, as stated previously, and exhibit results that are transversal to several practice contexts. Nonetheless, it is noticeable a low geographic variety, since the selected studies were mainly conducted in North and South America.

Our findings show that ECMO is a highly complex technique that also entails high costs. It requires several resources, namely adequate material, a laboratory, technological equipment and trained professionals <sup>(4)</sup>.

The nurse's approach to the critically ill person subjected to ECMO is perceived as essential to the success of the overall process. It is this professional's responsibility to always be there for the patient, as well as to monitor, supervise and prevent complications <sup>(4,5,9)</sup>, while managing and coordinating the provision of care <sup>(10)</sup>.

The monitoring task encompasses two facets: (i) monitoring the ECMO technique, namely cannulae care procedures, oxygenator output, oxygenator rotations, oxygenator pressures, oxygenator gasometry, circuit temperature, and coagulation index; (ii) monitoring the patient, which involves the assessment of vital parameters, capillary glycemia, neurological system, diuresis, hematic losses, positioning, and ventilatory and gasometric parameters <sup>(4-6,10)</sup>. At the same time, the support and care provided to the ECMO patient's family is also relevant in the overall care process <sup>(4-6,10)</sup>.

On the subject of the ECMO technique's monitoring, circuit care stands out, particularly with regard to cannulation sites and the integrity of the cannulae themselves <sup>(4,6)</sup>.

With respect to care management, the importance of checklists for the standardization of care, as well as the daily control of all the abovementioned interventions, is highlighted <sup>(1)</sup>. Such interventions contribute to the standardization of procedures, the establishment of good practices and the improvement of the care provided to critically ill patients subjected to ECMO <sup>(4,9)</sup>.

Nursing professionals who provide care to ECMO patients should be experts <sup>(6,10)</sup>. However, the authors argue that, in order to achieve full expertise, nurses need appropriate training, as well as supervised experience, so that they are able to identify the individual's needs and, consequently, to plan specific interventions <sup>(6,10)</sup>. It is through this skill acquisition methodology that the professional may become aware of his/her weaknesses regarding the provision of care to critically ill ECMO patients. Continuous training, theme-based discussion within the multidisciplinary team, training the procedure with more experienced professionals and the implementation of protocols based on scientific evidence are decisive tools for an effective, safe and high-quality approach to ECMO patients <sup>(9,10)</sup>.

In addition to the above, the literature is consensual on the importance of communication to the technique's success. In this regard, inter-team communication is highlighted — namely with the attending physician, about the person's condition and care planning <sup>(6,9,10)</sup>.

This relatively recent topic in Nursing literature is emerging in health care, due to its growing implementation in the context of critically ill patients <sup>(7)</sup>.

The limitations of this study relate to the fact that most of the results obtained in the review focus on medical experiences, and also the fact that nursing literature is scarce.

That scarcity stresses the importance of continuing to conduct primary research in this particular field.

## CONCLUSION

This study made it possible to understand the existing scientific evidence with respect to the nurses' approach to critically ill adult patients subjected to ECMO. According to the reviewed studies, we found that ECMO is considered an increasingly present technique in the care provided to critically ill patients that require mechanical cardiopulmonary support, due to severe respiratory failure, heart failure, or even both conditions.

As health professionals, nurses have the responsibility to monitor, supervise and manage all the care provided to critically ill individuals subjected to ECMO, in order to prevent any issues. Nursing teams are in a particularly privileged position to observe, intervene and anticipate complications, either related to the technique itself, or to the patient's adaptation. In this context, benefits have been obtained through the implementation of protocols, since they help nurses to standardize care and, thus, ensure a safe, correct and targeted intervention.

Additionally, to achieve the successful application of the ECMO technique, it is fundamental to guarantee an effective communication within the multidisciplinary team, as well as to provide training to its members. These aspects have a decisive influence on the practice, leading to a faster, more assertive and confident approach, since an adjusted communication and the acquisition of up-to-date practical and scientific knowledge ensure the provision of high-quality care.

Further research on this matter is required and supported by the need for an evidence-based practice. Therefore, we consider that this topic should continue to be a subject of discussion and debate within the scientific community.

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