# Patient care in ecmo (extracorporeal membrane oxygenation): a challenge for neonatal nursing

**RESUMO |** Objetivo: avaliar as evidências científicas disponíveis sobre as intervenções de enfermagem no atendimento ao recém-nascido submetido à terapia de oxigenação por membrana extracorpórea. Método: Pesquisa bibliográfica utilizando como fonte de pesquisa plataformas online como Ovid MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials e Pubmed, SCOPUS, Scielo nos últimos 15 anos, realizada no período de junho de 2019 à outubro de 2020. Resultado: a utilização da membrana de oxigenação extracorpórea é uma terapia de alta complexidade, cabendo ao enfermeiro, privativamente, a responsabilidade pela assistência direta ao paciente submetido a esta intervenção. É primordial que o enfermeiro possua amplo conhecimento técnico-científico sobre o procedimento a fim de garantir a qualidade da assistência de enfermagem e a segurança do paciente em uso da tecnologia em estudo. Conclusão: O conhecimento científico e a capacitação profissional são vistos como fatores determinantes para o êxito na implantação e manutenção da oxigenação por membrana extracorpórea.
**Descritores:** Membrana de oxigenação extracorpórea; Neonatologia; Cuidados de enfermagem.

**ABSTRACT |** Objective: to evaluate the available scientific evidence on nursing interventions in the care of newborns submitted to extracorporeal membrane oxygenation therapy. Method: Literature search using online platforms such as Ovid MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials and Pubmed, SCOPUS, Scielo in the last 15 years, carried out between June 2019 and October 2020. Result: the use of extracorporeal membrane oxygenation is a highly complex therapy, and the nurse is privately responsible for the direct assistance to the patient undergoing this intervention. It is essential that nurses have extensive technical- scientific knowledge about the procedure in order to ensure the quality of nursing care and patient safety using the technology under study. Conclusion: Scientific knowledge and professional training are seen as determining factors for the successful implementation and maintenance of extracorporeal membrane oxygenation.
**Descriptors:** Extracorporeal oxygenation membrane; Neonatology; Nursing care.

**RESUMEN |** Objetivo: evaluar la evidencia científica disponible sobre las intervenciones de enfermería en el cuidado del recién nacido sometido a terapia de oxigenación por membrana extracorpórea. Método: Búsqueda de literatura utilizando plataformas en línea como Ovid MEDLINE, EMBASE, Registro Cochrane Central de Ensayos Controlados y Pubmed, SCOPUS, Scielo en los últimos 15 años, realizada desde junio de 2019 hasta octubre de 2020. Resultado: el uso de oxigenación por membrana extracorpórea es una terapia de alta complejidad, siendo la enfermera la responsable privada de la asistencia directa al paciente sometido a esta intervención. Es fundamental que el enfermero cuente con un amplio conocimiento técnico-científico sobre el procedimiento para garantizar la calidad de la atención de enfermería y la seguridad del paciente utilizando la tecnología en estudio. Conclusión: El conocimiento científico y la formación profesional se ven como factores determinantes para la implementación y el mantenimiento exitosos de la oxigenación por membrana extracorpórea.
**Descriptores:** Membrana de oxigenación extracorpórea; Neonatología; Cuidado de enfermera.

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## INTRODUCTION

Extracorporeal Membrane Oxygenation (Extracorporeal Membrane Oxygenation - ECMO) is a therapy that uses modified partial cardiopulmonary bypass with membrane oxygenation to provide pulmonary and/or cardiac support. It is used in patients with reversible cardiopulmonary failure from pulmonary, cardiac, or other causes. 1,2

In 1975, at the Orange County Medical Center, Bartlett successfully used ECMO on an abandoned Latino

newborn suffering from respiratory distress syndrome, and its use in infants increased in the late 1980s. Volunteers, the Extracorporeal Life Support Organization, was formed among ECMO centers in 1989. 2

In neonatal intensive care units, ECMO is being used to help treat some cardiorespiratory problems, such as meconium aspiration syndrome, persistent pulmonary hypertension in the newborn, congenital diaphragmatic hernia, sepsis/pneumonia, respiratory distress syndrome and cardiopulmonary failure. 3,4

In recent years, with the emergence of new respiratory therapies, such as the use of inhaled nitric oxide, pulmonary surfactant and high-frequency oscillatory ventilation, ECMO has been used only after careful evaluation, as it is a highly invasive procedure associated with many risks and with high cost. When used, it is a rescue therapy for many neonatal diseases, more complex and more severe cases of the primary disease, where conventional treatments have no effect, thus ensuring its superiority over many conventional treatments, as reported by some studies. 3,4,5

As shown in a multicenter, randomized, controlled study conducted in the United Kingdom of 185 newborns with severe respiratory failure in 55 hospitals, mortality and severe disability assessed at 1st, 4th, and 7th years of life were significantly reduced with the use of ECMO (59% for the conventional therapy group compared to 37% for the ECMO group). 6

The use of ECMO in near-term infants with severe but possibly reversible respiratory failure significantly improves survival without increasing severe disability and is the most cost-effective compared to other intensive care therapies. 7,8

In the last decade, ECMO has been used annually as support therapy in approximately 800 neonates who did not respond to intensive care with high-frequency oscillatory ventilation (HFO) and/or nitric oxide (NO) inhalation. Currently, the rate of ECMO use in the US is approximately one newborn per 5,000 live births. 1

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Assuming that nursing plays an important role in patient care under this type of care, the present investigation was proposed with the aim of evaluating, through a literature review, the evidence available in the literature on effective nursing interventions for the care of newborns undergoing ECMO intervention.

## METHOD

The present study is characterized as a bibliographical research, seeking to understand, from the perspective of several authors, the challenge for the nursing team in the care of patients undergoing ECMO in the Neonatal Intensive Care Unit.

Bibliographic research consists of examining productions developed throughout the evolution of humanity, for a survey and analysis of what has already been produced on a given subject, which are assumed to be the subject of scientific research. In this way, the bibliographical research allows the examination of a theme under a new focus or approach, reaching its own conclusions. 9

For the development of the study in question, from June 2019 to October 2020, online platforms such as Ovid MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials and Pubmed, SCOPUS, Scielo were sought as a research source. The descriptors in English used were: Extracorporeal membrane oxygenation AND neonatal AND nursing care. The consultation was limited to the last 15 years, with human research and full text. Articles that met the following criteria were included in the sample: articles without language restrictions, with their abstracts published in selected databases, in the period from June 2005 to May 2020. In addition, it was taken into account that the adopted methodology allowed to obtain scientific evidence about this therapy, thus, individually controlled randomized clinical trials or studies with quasi-experimental resear-

ch design and articles that portray procedures, interventions that contribute to responding to the guiding question. Studies of the literature or systematic review type, letters and editorials, theses, dissertations, course conclusion works, articles not referring to the neonatal period were excluded.

For the organization of the material, the registration system of the materials obtained was used in order to streamline the development of the research. With the selected material, we sought to contemplate the proposed objectives and thus carry out a survey of nursing care for patients in ECMO in the Neonatal ICU.

## RESULTS

The first search resulted in 351 articles of which, after applying the exclusion criteria and reading the abstracts, we identified 28 relevant publications with the guiding question of the research. From all the articles, from the language perspective, 25% of the selected ones are published in Portuguese, 67.9% in English and 7.1% in Spanish. Regarding the year of publication, 60.7% of the works were published in the last 5 years.

## DISCUSSION

After total reading of the selected articles, the information was sectioned according to the titles: ECMO physiology, indications and contraindications for ECMO, multidisciplinary team, nursing care and complications.

### Ecmo physiology

ECMO is a therapy applied in cases of respiratory failure in which blood is oxygenated outside the patient's body. This process increases gas exchange, in addition to allowing the adjustment of ventilatory parameters that are potentially harmful to the lung parenchyma. 10 Extracorporeal membrane oxygenation provides "time to rest" and pulmonary and cardiac recovery. 6

During therapy, blood is drained through a cannula in the patient's vein to an external pump (rotary or centrifugal), which circulates the blood through an exchange membrane (silicone oxygenator or polymethylpentene) for oxygenation and removal of CO2 and a heater to return blood to the patient's circulation. This therapy requires anticoagulation of the circuit and the patient with heparin administered to the ECMO system, in order to avoid activation of the coagulation cascade. In addition, various pressure, flow, bubble and temperature monitors are used. Continuous monitoring of clotting is critical with the use of activated clotting time (ACT), antifactor Xa level, platelet count, measurement of fibrinogen levels and, in some patients, antithrombin III level and thromboelastography. 1

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The therapy has two modalities, the veno-arterial (VA) which allows hemodynamic and ventilatory support where the blood is drained through a venous cannula and returned through the arterial cannula. The veno-venous (VV) mode allows gas exchange using two venous cannulas. 11

After the success of the 1975 procedure, several studies reported a significant survival of newborns undergoing ECMO for reversible severe respiratory failure due to various pathologies, making ECMO in this age group a standard treatment option. 12,13,14 In Brazil, its use is on the rise in mechanical circulatory assistance, especially in hospitals with high complexity care. 15

### Indications and contraindications for ecmo

There are currently no fixed criteria for ECMO care in neonatology. Most centers indicate newborns with a gestational age greater than 34 weeks, due to the high risk of intracranial hemorrhage resulting from the use of anticoagulants. Due to the size of the available cannulas, the therapy is indicated for newborns weighing over two kilos. Asphyxiated newborns or newborns that require therapeutic hypothermia can meet the ECMO criteria, taking care to avoid coagulation complications caused by the cooling and heparinization process. In addition to the selection

criteria, specific clinical qualification criteria are applied. 6,13,16 Pulmonary indications in neonates are: hyaline membrane disease, meconium aspiration syndrome, newborn primary pulmonary hypertension, congenital diaphragmatic hernia, neonatal sepsis, pneumonia and other pathologies associated with pulmonary hypertension. 17

Contraindications are: newborns with pre-existing diseases such as intracranial hemorrhage; some form of coagulopathy; lethal congenital or chromosomal abnormalities; and irreversible brain damage or congenital heart disease. 6

Failure to comply with the selection criteria and indications mentioned above for extracorporeal membrane oxygenation is a contraindication for the use of ECMO, in addition to irreversible and pre-existing pathologies that impair quality of life. 18

### Multidisciplinary team

According to ELSO, the ECMO specialist is "the professional trained to handle the equipment and clinical needs of the patient under the direction and supervision of an ECMO-trained physician". 1 Thus, more and more professionals seek to improve this technique and the nurse is the professional who deals with direct assistance to patients undergoing this intervention.

The multidisciplinary care of patients in ECMO in the Intensive Care Unit is important to provide a well-defined care. The cannulation procedure is critical because patients admitted to ECMO are in serious condition, sometimes requiring resuscitation maneuvers and there is a need for a quick connection to the circuit to initiate therapy. There is a need for speed, coordination and simultaneous action by the teams involved. The technical skills of the professionals involved, adequate supplies and equipment available, and available protocols and checklists contribute to successful cannulation and initiation of therapy. 19 ECMO requires a high level of technical and non-technical skills, associated with a highly trained multidisciplinary team comprising physicians, nurses and perfusionists. 20

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### Nursing assistance

The nursing process, monitoring, medication administration and circuit review are some of the tasks in which the nurse spends considerable time and which has an essential role in this therapy. 19 Nursing care for patients with ECMO must be carried out through the elaboration of the Nursing Process and based on an institutional protocol that standardizes the care provided. 21 The use of ECMO is a reality and must always be taken into account in a comprehensive and individualized nursing care where all the patient's needs are considered. 19 Which consolidates a great challenge for nurses to supply them within a reality where there is still a shortage of trained human resources.

The minimum skills necessary for the nursing professional working with ECMO are: identifying the type of ECMO VV or VA, knowing the components of the ECMO circuit, defining and demonstrating how to remove the patient from ECMO in an emergency, identify potential emergencies and how to deal with with them, identify the necessary equipment at the bedside, present problem solving techniques, identify and describe decannulation, verbalize the understanding of when to notify the ECMO specialist. 19

When defining the indication for therapy, the medical team makes contact with the pediatric surgeon responsible for cannulation and with the team of perfusionists. The nurse provides material and notifies the blood bank to provide the blood products prescribed by the medical team to fill the system. As ideal logistics, a bed will already be defined in the unit where the ECMO will be performed. If the patient is not in this bed, the nurse arranges for the transfer to this bed and certifies that all material, previously listed, is accessible for immediate use. Nursing is present throughout the process involving therapy, providing complex care that requires physical structure, equipment, monitoring and continuous attention to

the patient's clinical conditions. 22 The standardization of equipment locations is part of the organization of the patient unit and ensures the safety of the entire process. Observation is constant in the circuit to identify thrombus formation, with the aid of a light spot. Another important aspect is the prevention of skin lesions, glycemic, water, thermal and level of consciousness control. 15 The nurse is privately responsible for direct care to the patient undergoing this intervention. 23 As the patient improves, ECMO support is gradually reduced. Patients are decannulated when they cannot tolerate minimal ECMO support with low-to-moderate mechanical ventilation parameters. ECMO treatment typically lasts between five and ten days for neonatal patients with respiratory disease and longer in cases of congenital diaphragmatic hernia (10 to 12 days on average). 1

### Complications

By far the most common complication of ECMO is the need for vasoactive drugs during extracorporeal support, followed by bleeding from the surgical site. 6

The most common mechanical (circuit-related) complications are clots in the circuit, consumptive coagulopathy, and embolisms. Cannulation can damage the jugular vein, which can lead to massive mediastinal hemorrhage and damage to the carotid artery that can lead to aortic dissection. 13,24,25 The circuit failures that can occur are with the oxygen source and oxygen mixers, failure of monitoring equipment, cracks in connectors, tube rupture and pump malfunction, which may just be an inadequate venous return. 22

Clinical complications are usually consequences of anticoagulation, blood interactions with artificial surfaces in the circuit, and changes in the blood flow pattern. Neurological, hemorrhagic, cardiac, pulmonary and renal complications can occur. 26,27,28

Although much progress has been made in this field and despite the different models studied, there is still a need to develop new scientific productions on the subject, to show that cardiopulmonary capacity is protected and continues to mature during ECMO support

Intracranial hemorrhage is the leading cause of death during ECMO and the appearance of seizures is a sign of poor prognosis. There are also complications from failure of the oxygenator circuit or other ECMO equipment. 1

## CONCLUSION

Although much progress has been made in this field and despite the different models studied, there is still a need to develop new scientific productions on the subject, to show that cardiopulmonary capacity is protected and continues to mature during ECMO support.

A limitation for the construction of this article is that most of the articles researched on the topic contain studies and bibliographic reviews that involve older articles that are more than 20 years old, corroborating what we previously stated about intellectual productions on ECMO, especially in neonatal patients.

Despite the scarcity of material, the importance of nurses in using this technique is noticeable, which tends to grow strongly in Brazil. Scientific knowledge and professional training are seen as determining factors for the successful implementation and maintenance of extracorporeal membrane oxygenation.

We can conclude that knowledge on the subject is still a barrier to be overcome by the care team, but in addition, technical skills are extremely important for the team, so it is safe to say that these are the main obstacles to be faced by the nursing team when it comes to a care proposal as innovative and challenging as ECMO.

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