







Early mobilization in adult patients using extracorporeal membrane oxygenation

Mobilização precoce em pacientes adultos sob o uso de oxigenação por membrana extracorpórea

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ABSTRACT

Introduction: Extracorporeal membrane oxygenation is used in patients with respiratory failure and severe cardiovascular complications with a prognosis of reversal. Early mobilization in these patients can prevent the complications of immobility, such as decreased functional capacity, delirium, physical deficits, respiratory and psychological. A well-trained multidisciplinary team with extensive knowledge about extracorporeal membrane oxygenation is essential to optimize patient care. **Objective:** The objective of this narrative literature review is to relate the repercussions of early mobilization in these patients, to optimize care and reduce unfavorable events related to immobility. **Methods:** It is an integrative literature review, with research through analysis of articles on the Pubmed platform, from the years 2014 to 2022, applying the terms: ECMO Rehabilitation, Mobilization ECMO, ECMO and physiotherapy and ECMO Physiotherapy. **Results:** 26 articles were found, 09 selected for the study, in a total of 1390 patients on extracorporeal membrane oxygenation who received at least one physiotherapy session, from activities in bed to walking. There was no change in relevant hemodynamic parameters, regardless of the location of the cannula, making early mobilization feasible. **Conclusion:** Early mobilization in patients undergoing extracorporeal membrane oxygenation is beneficial for a better clinical outcome within institutions, which requires the involvement of the entire aligned and engaged multidisciplinary team.

Keywords: extracorporeal membrane oxygenation, early ambulation; physical therapy.

RESUMO

Introdução: A oxigenação por membrana extracorpórea é utilizada em pacientes com falência respiratória e complicações cardiovasculares graves com prognóstico de reversão. A mobilização precoce nesses pacientes pode evitar as complicações do imobilismo, como diminuição da capacidade funcional, delirium, déficits físicos, respiratórios e psicológicos. É fundamental uma equipe multidisciplinar bem treinada e com conhecimentos amplos sobre a oxigenação por membrana extracorpórea para otimizar a assistência ao paciente. **Objetivo:** O objetivo desta revisão narrativa de literatura é relacionar as repercussões da mobilização precoce nestes pacientes, a fim de otimizar a assistência e diminuir os eventos desfavoráveis relacionados ao imobilismo. **Métodos:** É uma revisão integrativa de literatura, com pesquisas por meio de análises de artigos na plataforma Pubmed, dos anos 2014 a 2022, aplicando os termos: ECMO Rehabilitation, Mobilization ECMO, ECMO and physiotherapy e ECMO Physiotherapy. **Resultados:** Foram encontrados 26 artigos, 09 selecionados para o estudo, totalizando 1390 pacientes em oxigenação por membrana extracorpórea que receberam ao menos uma sessão de fisioterapia, desde atividades no leito à deambulação. Não houve alteração de parâmetros hemodinâmicos relevantes, independentemente da localização da cânula, tornando viável a mobilização precoce. **Conclusão:** A mobilização precoce em pacientes submetidos a oxigenação por membrana extracorpórea se mostra benéfica para melhor desfecho clínico dentro das instituições, o que exige o envolvimento de toda equipe multidisciplinar alinhada e engajada.

Palavras-chave: oxigenação por membrana extracorpórea; deambulação precoce; fisioterapia.

Introduction

In recent years, early mobilization has been explored as a way to accelerate the recovery of critically ill patients and reduce risk factors that develop muscle weakness acquired in the intensive care unit (ICU) [1].

There is a strong association between weakness and prolonged ventilator dependence, which is a fundamental result in patient survival after acute respiratory failure, lasting for months or indefinitely [2].

Functional decline is directly related to the harmful effects of immobility in the ICU, leading to increased care costs, decreased quality of life and post-discharge survival [3]. The patient admitted to the ICU using mechanical ventilation has about a 25% chance of developing muscle atrophy upon awakening and may even progress to post-intensive care syndrome (PICS) [4,5].

With technological advances, extracorporeal life support modalities are adopted in patients with cardiovascular and pulmonary failures, such as extracorporeal membrane oxygenation (ECMO). ECMO consists of a closed extracorporeal circuit system, which works based on adequate oxygenation and temperature modulation. Before reperfusion occurs, it is necessary for the blood to be heated by the machine to body temperature and, soon after, this blood will be pumped and return to the arterial and venous circulatory system [6]. It is important to mention that among the types of ECMO there are Venous-Arterial (VA) cannulation, guaranteeing cardiac support with preserved lung function or not. The drainage cannula is inserted into a venous access and the return cannula into an arterial one, being classified in two ways: central or peripheral. In the central one, the drainage cannula is connected directly to the right atrium and the return cannula to the ascending portion of the aorta artery. In the peripheral, the blood can be drained through the femoral or jugular veins and returns to the patient through the carotid, axillary or femoral artery. Venovenous (VV) cannulation is appropriate to support oxygenation in respiratory failure with preserved cardiac function. In this case, the drainage cannula is usually inserted into the right femoral vein and the return cannula into the right internal jugular vein. Another alternative is the drainage cannula inserted in the jugular vein and the return cannula in the femoral vein [7].

In case of ECMO failure by VV cannulation, the patient can undergo a new hybrid or VA configuration. Different hybrid cannulations can be used depending on the clinical picture. This category is called veno-arterial veno-venous ECMO (VAVV) [8].

Patients on ECMO are often under bed rest, immobile, and in most cases under sedation. When treatment lasts for a long time, the complications generated by immobility can prolong hospitalization and increase the need for additional health care [9].

Currently, it is increasingly common for patients to wake up on ECMO for food, communication, active participation in treatment and rehabilitation programs, promoting the maintenance of muscle strength and function [8]. In the possibility

of physical activity during ECMO, the improvement in gas exchange after physical exercise and walking was confirmed. Thus, physical therapy, simultaneously with the multidisciplinary team, aims to promote functional recovery through human movement [3,9]. Given the above, it is known that it is essential to reduce the negative impacts generated by immobility, hospital and psychosocial costs in patients using ECMO. The present study aims to list the repercussions of mobilization in patients on ECMO to optimize care and reduce unfavorable outcomes related to immobility in bed.

Methods

This study consists of a narrative review of the literature, carried out through the analysis of articles searched on the Pubmed platform, from the years 2014 to 2022, applying the terms: ECMO Rehabilitation, Mobilization ECMO, ECMO and physiotherapy and ECMO Physiotherapy.

This work included randomized clinical trials, retrospective investigations, case studies, systematic literature review and cross-sectional observational studies that could demonstrate the effectiveness of early mobilization in patients using ECMO. The use of articles that enabled mobilization in adult patients using ECMO was established as an inclusion criterion.

Results

The results were displayed in Table I, where the authors of the various studies, objectives, types of accesses and conclusions that discuss the theme analyzed are described. The search resulted in 26 articles, after critical reading 25 were selected, among them 06 excluded, 19 evaluated for eligibility and 09 included for the present study. One thousand three hundred and ninety (1390) patients on extracorporeal membrane oxygenation received at least one physiotherapy session, from activities in bed to walking. There was no change in relevant hemodynamic parameters, regardless of the location of the cannula, making early mobilization feasible. The article selection flowchart is shown in figure 1.

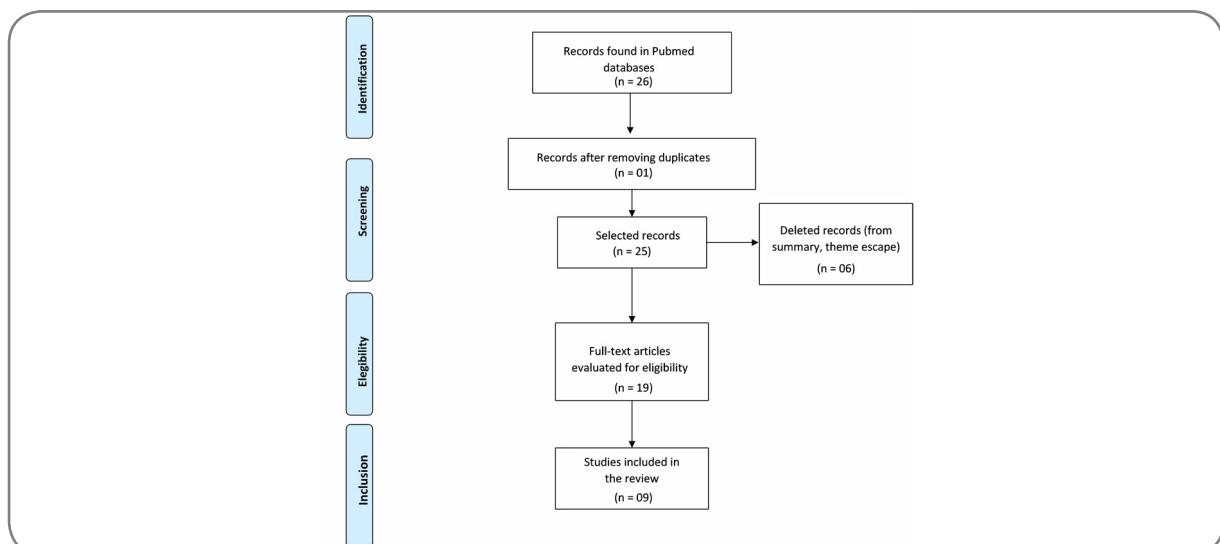


Figure 1 - Flowchart for selection and inclusion of articles in this study

Chart 1 - Results of the search for articles that addressed exercises/mobilization in patients with ECMO

Article	Author	Objective	Types of access / vessels	Conclusion
Early rehabilitation during extracorporeal membrane oxygenation has minimal impact on physiological parameters: A pilot randomized controlled trial	Hayes <i>et al.</i> 2020 [10]	To describe the respiratory and hemodynamic effects of early intensive rehabilitation compared to standard care physiotherapy over a 7-day period in patients requiring ECMO.	Veno-venous and Veno-arterial / not informed	Early intensive rehabilitation of ECMO patients had minimal effect on respiratory and hemodynamic parameters, or ECMO settings, when compared between groups. In addition to not observing significant changes in the two groups after the physiotherapy sessions in the period of 24 hours during the 7 days.
Early mobilization of patients receiving extracorporeal membrane oxygenation: a retrospective cohort study	Abrams <i>et al.</i> 2014 [11]	Feasibility and impact of active physical therapy in patients with ECMO.	Veno-arterial / subclavian artery and jugular vein veno-venous / double-lumen catheter	Active physiotherapy, including ambulation, can be safely and reliably achieved in ECMO patients when an experienced multidisciplinary team is utilized. More research is needed to define physical therapy barriers and impact on survival and long-term functional neurocognitive outcomes in this population.
Early mobilization during extracorporeal membrane oxygenation for cardiopulmonary failure in adults: factors associated with intensity of treatment	Abrams <i>et al.</i> 2021 [12]	To determine if there are factors associated with obtaining out-of-bed versus in-bed physiotherapy in ECMO-supported patients, and whether mobilization with femoral cannulation is safe and feasible.	Veno-venous / femoro-jugular Veno-arterial / right atrium and ascending aorta	In this large retrospective cohort study, factors such as ECMO indication, configuration, and reliance on invasive mechanical ventilation during physiotherapy were significantly associated with the intensity of early mobilization during ECMO support. In addition, the safety and feasibility of femoral cannulation were observed, due to the ease of placement.
Feasibility and safety of early physical therapy and active mobilization for patients on extracorporeal membrane oxygenation	Ko <i>et al.</i> 2015 [13]	The aim of this study was to review the terms of safety and feasibility of early passive physical therapy for ECMO patients.	Veno-venous / femoro-jugular veno-arterial / right atrium-ascending aorta.	It is feasible and safe to perform passive physiotherapy and mobilization for patients on ECMO. However, its survival benefit should be investigated in a larger prospective study in the future.
Intensive care physiotherapy during extracorporeal membrane oxygenation for acute respiratory distress syndrome [14]	Munshi <i>et al.</i> 2017 [14]	The aim of the study was to evaluate the association between physical therapy and mortality in patients with ARDS on ECMO in the intensive care unit.	Veno-venous / jugular vein with double lumen bicaval catheter / jugular-femoral vein	Physiotherapy during ECMO is feasible and safe when performed by an experienced team and performed in stages. However, further study is needed to identify possible barriers, exercise dosage and classify a safety profile.
Safety and feasibility of early physical therapy for patients on extracorporeal membrane oxygenator: university of maryland medical center experience	Wells <i>et al.</i> 2018 [15]	Examine the feasibility and safety of mobilizing patients during ECMO support.	Veno-venous / Bi-femoral and double lumen catheter Venoarterial / Bi-femoral	It is feasible and safe to offer early rehabilitation, including orthostatism and ambulation, for patients on ECMO support, regardless of the cannulation site.

Chart I - continuation

Article	Author	Objective	Types of access/ vessels	Conclusion
Mobility levels with physical rehabilitation delivered during and after extracorporeal membrane oxygenation: a marker of illness severity or an indication of recovery	Mayer <i>et al.</i> 2022 [16]	The objectives of this study were to determine whether the physical rehabilitation intervention for individuals on ECMO is associated with clinical outcomes and to assess whether the mobility response during physiotherapy sessions in the ICU is associated with survival, length of stay, willingness to discharge and readmissions within 30 days.	Veno-venous; Double lumen Veno-venous; Veno-arterial VV-VA (hybrid) / Bifemoral, internal jugular vein, aorta and subclavian artery, and atria	The findings of this study demonstrate that early physical rehabilitation is associated with greater survival of patients on ECMO and discharged home, regardless of the mobility level of the applied scale.
Awake extracorporeal life support and physiotherapy in adult patients: A systematic review of the literature	Cucchi <i>et al.</i> 2022 [17]	The primary objective of this work was to investigate survival after hospital discharge in adult patients who underwent ECMO. The study was carried out from the analysis of four databases from 2002 to February 2015. Together, one can observe safety results, physiotherapy feasibility, length of stay in the ICU and hospital stay, ECMO cannulation strategies and scales of assessment	Veno-venous / Femoro-femoral Veno-arterial / jugular-axillary	Survival after hospital discharge was found in 80% of patients who were not intubated during the ECMO period. Physical therapy was safe and feasible, regardless of the cannulation approach, with different target therapies achieved through ambulation and weaning from invasive mechanical ventilation support. However, a more comprehensive and consistent evaluation protocol for mobilization, sedation, delirium and pain score is strongly recommended and necessary for future multicenter randomized controlled trials, in addition to the involvement of a multidisciplinary team.
Sedation and mobilization during venovenous extracorporeal membrane oxygenation for acute respiratory failure: an international survey. [18]	Marhong <i>et al.</i> 2017 [18]	To characterize sedation, analgesia, delirium and mobilization practices in patients with ECMO support by venovenous cannulation for severe acute respiratory failure.	Veno-venous / Femoro-femoral	Most centers reported targeting moderate to profound sedation using continuous midazolam infusions. A minority of respondents reported mobilizing these patients out of bed, with the severity of the illness being the most frequently perceived barrier to mobilization. The most significant barriers to physical therapy during venovenous cannulation ECMO were hemo-dynamic instability in 72% of respondents, level of dependence in 49% and hypoxemia in 48%. Delirium was a reported barrier to mobilization for 20% of respondents. Future investigations in this population should focus on minimizing sedation, safe mobilization, and developing objective criteria to help guide the transition from deep sedation to more awake states after cannulation.

ECMO = Extracorporeal Membrane Oxygenation; ARDS = Acute Respiratory Distress Syndrome; ICU = Intensive Care Unit

Discussion

Patients with prolonged stay in ICUs may develop physical and psychological complications and generalized muscle weakness, caused by the association of muscle and/or nerve injury, according to Needham [19]. Early rehabilitation has been identified as a viable intervention in the ICU environment, with a positive response in the physical function and muscle strength of critically ill patients. However, it is a strategy that seems to be far from reality in many institutions, says Adler *et al.* [20].

According to Cucchi *et al.*, there is a growing practice of physical therapy in awake patients on ECMO. Despite the limitations, walking is performed in almost half of the cases examined. The awake ECMO approach aims to reduce cases of delirium after sedation and analgesia, muscle weakness, deficits in muscle and respiratory conditioning. This consists of weaning from sedation and invasive mechanical ventilation, so that the patient actively participates in decision-making and rehabilitation [17].

In general, the main challenges observed by professionals at the time of care are: patient agitation, respiratory discomfort, positioning and malfunction of the cannula during mobilization, trauma and local bleeding [17].

Early mobilization in patients using ECMO may present some adverse events, such as risks related to walking, which include device and catheter displacement, circuit interruption, activity intolerance, and others. In addition, there may be abrupt desaturation, a drop in heart rate and blood pressure, which will culminate in the use of vasoactive drugs, increased sedation and even neuromuscular blockers, according to Rickelmann *et al.* [21]. In contrast, another randomized controlled study by Hodgson *et al.* carried out in three intensive care units of the main ECMO centers in Australia, observed that patients started early mobilization within 72 hours, maintaining ECMO for 7 days, improved functional independence in activities of daily living and were discharged from hospital. The authors also highlighted that this type of mobilization was performed by a trained multidisciplinary team, with more than 15 years of experience in specialized centers. Thus, it was possible to state that early mobilization is safe and feasible [22].

According to Lange *et al.*, there is a percentage (10-36%) of patients using ECMO that evolve with bleeding complications, bleeding at the cannulation site (VV-ECMO), bleeding at the surgery site (VA-ECMO), and even intracranial hemorrhage in 6% of these patients [23]. On the other hand, Wells *et al.* in a study carried out, also in a specialized ECMO center, they demonstrated safety in the mobilization of such patients [15]. Once again, it was mentioned that an important item for such progress was having a very well-prepared multidisciplinary team to assess, for example, the mental, hemodynamic, respiratory state and the possible accidents that this patient may suffer, as well as bringing the study by Cucchi *et al.* [15,17].

Considering Brazil, due to organic instability and vascular cannulation, patients tend to remain permanently sedated and immobile during ECMO treatment.

It should be noted that it has been widely demonstrated in the literature that deep sedation and immobilization are related to adverse effects and worse results [18].

ECMO support is attributed to an inflammatory state due to the patient's clinical condition, which increases oxygen demand and blood flow. Given this, according to Munshi *et al.*, there are more suitable cannulas for mobilization, the bicaval double lumen, has its maximum flow capacity reached and greater oxygen supply [14]. According to Ko *et al.*, with the technology of cannulas and extracorporeal circuits, ECMO therapy has become safer to support patients for long periods. From therapy with the physiotherapy team, it is possible to perform sitting, strengthening, orthostatism, stationary gait and ambulation, without the occurrence of any serious adverse event [13].

Patients using low-dose vasopressors were fully capable of performing active physical therapy, without the need for changes in ECMO configuration. However, not all patients using ECMO are suitable for such mobilization, as is the case of patients who come to present hemodynamic instability, high-dose vasopressors, deep sedation, neuromuscular blockade or severe hypoxemic, as described by Abrams *et al.* [11].

ICU-acquired muscle weakness is associated with physical and cognitive deficits, which can last for years after ICU admission. Thus, there has been a need to keep these patients awake, with active participation and walking during ECMO. However, as described by Hayes *et al.* this practice is not carried out considering that most patients on ECMO remain in bed and receive passive exercises. Thus, rehabilitation is established late [10].

The need to conduct more studies is highlighted for better practical guidance, such as defining protocols, minimizing possible barriers, and identifying the quality of life after the intensive care unit.

Conclusion

Scientific evidence indicates in clinical practice that early ECMO mobilization is feasible within institutions, which requires the involvement of the entire aligned and engaged multidisciplinary team. Physical therapy associated with reduced sedation minimizes the occurrence of muscle weakness, delirium, physical, respiratory and psychological deficits, in addition to optimizing patient mobility. It is extremely important that this mobilization be performed to generate a better clinical outcome.

Academic affiliation

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Interest conflicts

The authors declare that they have no conflicts of interest related to this publication.

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