

Early Rehabilitation During Extracorporeal Membrane Oxygenation to Prevent ICU-Acquired Weakness: Systematic Review

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Abstract: Extracorporeal membrane oxygenation (ECMO) patients often experience significant muscle weakness and physical impairments during their stay in the critical care unit. This systematic review aims to explore early mobilization to prevent ICU-AW in ECMO survivors. A systematic search of five electronic databases for English language articles reporting on randomized controlled trials or quasi-experimental studies was conducted. Two reviews independently screened selected articles and reported results following the PRISMA guidelines. Of the 168 articles screened, 21 studies were identified for eligible criteria, while two articles were randomized control trials. The finding shows there is no significant data compared to a control group, the patients in the early rehabilitation have the highest level of mobility in the intervention group. Another finding result is the study described that cardiopulmonary rehabilitation was a proven effective method to improve respiratory and cardiovascular diseases. However, the efficiency of weaning ECMO treatment has not been well verified. This method must be conducted in routine clinical practice, even encounters some barriers to applying it.

1 INTRODUCTION

Intensive care units (ICU) treated 13 to 20 million people annually (Haji et al., 2021). The most common complication during an ICU stay is intensive care unit-acquired weakness (ICU-AW) (Witteveen et al., 2020). ICU-AW incidence is 50% of patients (van Wagenberg et al., 2020). Increase up to 67% in critically disease patients with severe cases (Piva et al., 2019). ICU-acquired weakness defines limb symmetry weakness due to neuromuscular, muscle weakness, and skeletal muscle dysfunction in critically conditioned patients (Vanhorebeek et al., 2020; Wang et al., 2018). Many symptoms include 43% of patients having decreased muscle strength (Chen et al., 2021). 40% of patients suffered muscle mass in the 1st week in ICU (Fan et al., 2014). The effects of ICU-AW are prolonged ventilator

(Knudson et al., 2019), physical disability and need rehabilitation (Schweickert et al., 2009), weakness including tetraplegia, reduction or loss of tendon reflex (Fan et al., 2014; Rahiminezhad et al., 2022), increase mortality rate and decrease quality of life (Chen et al., 2016; Christos Kourek et al., 2022). Common causes (of ICU-AW) are metabolic problems, long-term ventilation, and drug use; glucocorticoids, steroids, and neuromuscular blocking drugs (Lin et al., 2022).

ECMO patients frequently use the ventilator and have sedative drugs and neuromuscular blocking agents (Abrams et al., 2014; Singh & Hote, 2021). ECMO plays a significant in ICU-acquired weakness, with a prevalence of 80% of ECMO patients (Chen et al., 2021; Kurniawati et al., 2021). ECMO is very often present (ICU-AW) (Christos Kourek et al., 2022).

Extracorporeal membrane oxygenation (ECMO)

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is an advanced method and standard gold treatment for critical patients (Chen et al., 2022). This lifesaving technology of heart/ lung or combining both for critically ill patient lifesaving in the critical disease patients who failed conventional treatment (Haji et al., 2021; White A Fau - Fan & Fan, 2016). The ECMO principal for respiratory support is venovenous (VV), for cardiovascular or combined cardio-respiratory support placed on veno-arterial support (Chen et al., 2022; Singh & Hote, 2021); even though ECMO is a high standard in the critical patient, there are some complication during ECMO treatment (Christos Kourek et al., 2022; van Dyk, 2018)

Complications receiving ECMO, such as neurologic complications, infection, metabolic problems, and vascular issues (Berger et al., 2022; Bonicolini et al., 2019), influence physical weakness and impairment (Fan et al., 2014). ECMO patients often experience significant muscle weakness and physical impairments during their stay in the ICU (Mayer et al., 2022). One of the significant issues in ECMO during critical illness is physical impairment and ICU-AW (Kurniawati et al., 2021; Wang et al., 2020). Early mobilization effectively prevents ICU-AW (Lacomis, 2022; Luo et al., 2021). Individuals' early mobilization during their stay in the ICU is an important indicator for predicting patient outcomes and discharge from the ICU (Lee et al., 2021) because it can improve mobility for the patient during their recovery phase (Linke et al., 2020; Patel et al., 2018).

Several studies showed that early mobilization reduces weakness (Grant et al., 2018; Li et al., 2020), so Early mobilization improves physical strength in critically ill conditions (Wollersheim et al., 2019). This method will reduce ICU-acquired weakness, increase survival rate, and reduce physical disability (Hodgson et al., 2022). Previous studies examined the recovery phase of physical weakness in ICU survivors (Hodgson et al., 2022; Patel et al., 2014). Physical weakness is more prevalent than mental impairment in ECMO patients (Abrams et al., 2014; Kurniawati et al., 2021). However, it still limited information on the prevalence of early mobilization in the physical weakness of ECMO patients.

This study aims to explore early mobilization to prevent ICU-acquired Weakness in ECMO survivors: Systematic review.

2 METHODS

A systematic review followed the five-step systematic review procedure according to Preferred Reporting

Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.

2.1 Data Sources and Search Strategies

Five databases were searched including Embase, Ovid Medline, CINAHL, Cochrane Library, and Scopus, along with an internet search conducted in February 2023. Databases were searched using keywords following "Extracorporeal membrane oxygenation," "critical care," "intensive care unit," "early ambulation," "mobilization," "physical activity," "physiotherapy," "rehabilitation", "ICU-acquired weakness." Articles were restricted to the English language.

2.2 Study Eligible

The initial search of publications in the database for online learning research yielded over 2000 potential papers. After screening based on inclusion criteria: (1) mention the rehabilitation during ECMO treatment following the definition and scope of concepts, (2) adult population, (3) Studies were designed in RCT or Quasi-experimental, and (4) patients have an intervention group that receives mobilization more than the control group. Studies were excluded if they were not in or available full text. The result used JADAD Quality assessment of appraisal score is 3 which refers to a good quality trial.

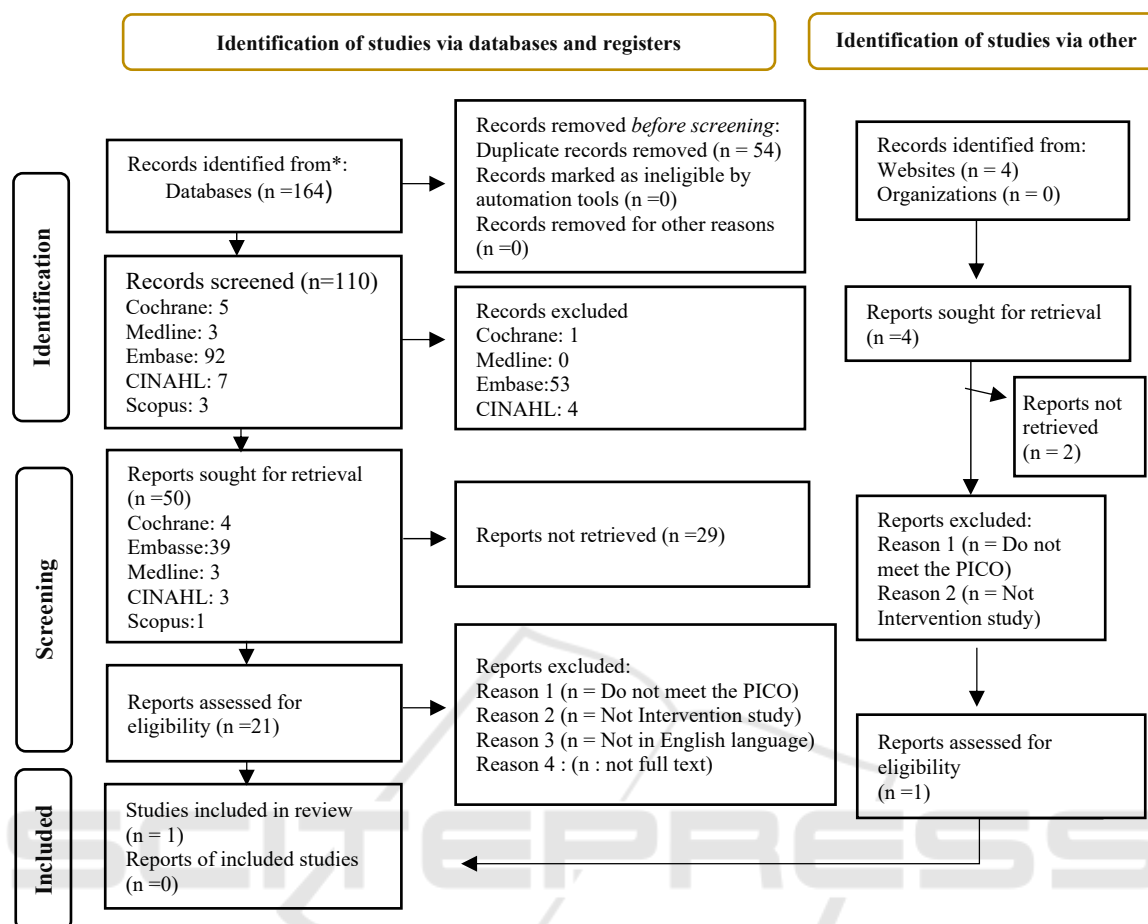
2.3 Process Flow Selection of Articles

Two independent reviewers independently screened and evaluated the abstracts and title. If the abstracts met the criteria, the full-text articles were then separately assessed. A matrix form was utilized to extract information from the selected papers, such as authors and year, design, location, method, interventions, outcomes, and limitations.

3 RESULTS

3.1 Study Selection

The internet search generated 168 articles early initially. Removing duplicates was performed using Endnote 20 and also by manually reviewing the author and title. Furthermore, 54 articles remained after duplicates were removed. The title and abstract were reviewed to exclude 60 articles not subject or incomplete full text. Some articles could not reach inclusion or exclusion criteria; 31 articles were



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

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deleted at this process. The full text for the 23 articles was then retrieved and divided among four researchers. But in the end stage, only one article randomized control trial for quality appraisal using an adapted JBI checklist for RCT appraisal.

The final article was read completely with details collected to analyze: the author and year of publication; problem significance also purpose; research questions and objectives; research design, including theoretical framework and methodology; sample population, participant number, and time frame, data collection, analysis process/es, ethical clearance, and considerations, and the last is the conclusion of appraisal result of JBI checklist result.

3.2 Description of Study

The study we included was a Randomized control

trial; the First article conducted by Hayes et al. (2020) describes how early rehabilitation among extracorporeal membrane oxygenation patients influences psychology. The parameter purpose of this research is to compare the effects of early intensive rehabilitation with standard care physiotherapy over 7 days in patients requiring ECMO. Intensive rehabilitation includes passive and active upper extremity and lower limb exercises. The study outcomes showed no significant result difference between the standard care control and intensive rehabilitation experiment groups. Early rehabilitation among ECMO treatment changes small respiratory and hemodynamics among ECMO patients. Even though there is no significant result with the control group, the patients in the early rehabilitation have the highest level of mobility in the intervention group.

The second article, illustrated by Zheng et al.

(2022b), mentions cardiopulmonary rehabilitation as a facilitator for weaning extracorporeal membrane oxygenation after 7-day rehabilitation. The study purpose of this study is to compare cardiopulmonary rehabilitation (positioning, passive range of motion, respiratory technique, neuromuscular stimulation) with standard care. The study described that cardiopulmonary rehabilitation was a proven effective method to improve cardiovascular and respiratory function among various illnesses. However, the efficacy of weaning ECMO treatment has no significant data. This method must be conducted in routine clinical practice, even encounters some barriers to applying it.

4 DISCUSSIONS

This systematic review was formed based on several studies regarding rehabilitation to prevent ICU weakness (Nydahl et al., 2017; Yang et al., 2022; Zhou et al., 2022). The result of using extracorporeal support for the critically ill increases to prevent further damage lungs and heart (Patel et al., 2018; Singh & Hote, 2021). However, this lifesaving method among ECMO patients often suffers more risk factors of ICU-AW (Chen et al., 2021). Developing and implementing early rehabilitation protocol to mitigate muscle weakness during this method (Chen et al., 2022; Linke et al., 2020). Our systematic review study was carried out with several participants, around 380, who underwent rehabilitation during ECMO treatment. In general, the two studies were not significant on changes in oxygenation and weaning on ECMO. However, there is an interesting finding from the two studies; it was found that in early rehabilitation, the highest level of patient mobility was obtained compared to the control group.

The barrier not significant result of this method is multiple cannulation on the patient's body, which causes limited movement. Active mobilization will interrupt ECMO flow (Aokage et al., 2015), influencing the body's gas exchange impairment (Salna et al., 2020). Certified physiotherapy and specialist equipment are available to conduct this method (Haji et al., 2021; Lang et al., 2020). Another obstacle is early rehabilitation cannot occur among emergency patients and unstable conditions (Hayes et al., 2021; Lugthart et al., 2022).

Some study describes early mobilization safety and reliability among ECMO patients (Lugthart et al., 2022; Rahimi et al., 2013) supported by a professional team and integrated medical device (Abrams et al.,

2014; C. Kourek et al., 2022; Lipshutz & Gropper, 2013). However, early mobilization and physical rehabilitation within 48-78 hours will effectively prevent development weakness (Nydahl et al., 2017; Yang et al., 2018). Zhou et al. (2022) mention that early progressive rehabilitation can develop muscle weakness. Increasing muscle strength (Hayes et al., 2018), and daily basic motion ability enhance the functional status and mitigate ICU-AW risk (George et al., 2022; Labreche et al., 2021).

The general benefit of this method is reduced healthcare utilization (Rahimi et al., 2013). Because it will reduce the length of stay in the hospital (Haji et al., 2021), develop quality of life (Cho et al., 2021). Even though this method is not significant to weaning from ECMO treatment (Zheng et al., 2022a), but enhances the prevalence of weaning from a ventilator (Lugthart et al., 2022).

5 CONCLUSIONS

The data of this study support that influence in early rehabilitation is related with development outcomes. Randomized controlled clinical trials are urgently needed as supporting data that rehabilitation can accommodate the healing and recovery of critical patients on ECMO.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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