



Brano Heart Failure Forum 2022 Conference Proceedings Paper

Quality Assurance in Extracorporeal Membrane Oxygenation Patients

Ruzica Mrkonjic

Department of Cardiac and Transplant Surgery, University Hospital Dubrava, Zagreb, Croatia

*Corresponding author: ruzicam@kbd.hr

Citation: Mrkonjic R. Quality Assurance in ECMO Patients. *The VAD Journal*. 2023;9(1):e2023912. <https://doi.org/10.11589/vad/e2023912>

Editor-in-Chief: Maya Guglin, University of Indiana

Received: September 25, 2022

Accepted: October 25, 2022

Published Online: April 17, 2023

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Funding: Not applicable

Competing interests: None

Abstract

The selection of patients for extracorporeal membrane oxygenation (ECMO) support is a critical component of any perfusion program. Teams must evaluate when to start the support, how long to support the patient, and when is the ideal time to wean. The timing of ECMO support is debated. While some programs emphasize prompt timing, others suggest the conservative approach is better (>7 hours). Delaying ECMO support could increase complications; thus, more evidence has been attained for prompt support. Importantly, complications are common with ECMO support. Despite advances in ECMO support over the last ten years, bleeding remains a high risk.¹ Current guidelines have evolved based on the findings.² One of the newest technologies is Cytosorb (CytoSorbents Inc.); however, the optimization of its use and its true efficacy is unknown. Our institution has recently used the Seraph 1000 Microbind Affinity blood filter, which allows up to a 90% reduction of bloodstream pathogens during a single treatment, and we have found it to be a highly effective approach and a possible advancement in treating septic patients.

Keywords: extracorporeal membrane oxygenation, inotropes



Summary

Statistics show that extracorporeal membrane oxygenation (ECMO) support is effective in certain conditions that previously had high mortality rates.³ The selection of patients certainly influences the results. The COVID pandemic showed how survival differs by applying different algorithms that determine who receives ECMO support. If we are liberal and use ECMO in healthier patients, we will have high survival rates, but some of those patients probably could have survived without ECMO. If we use ECMO as a rescue treatment to avoid death, we will have a high risk of fatal outcomes because the population has few options. Indications for ECMO should be based on the careful assessment of the realistic potential of the patient. For successful implementation of ECMO, the main questions to be answered are:

- When should we start?
- How long should a patient be on ECMO to achieve the desired result?
- What are the strategies to achieve optimal results?

The timing of ECMO support is debated. Over time, two approaches have developed. The conservative approach supports a slightly longer conservative therapy with high doses of inotropes. The prompt approach, or early application, supports the immediate use of ECMO after the high doses of inotropes have been given (within one hour). Analysis of patients who received ECMO due to primary heart transplant dysfunction shows that early implementation is key to favorable clinical outcomes.⁴ It is hard to tell the optimal time to implant the ECMO, but it should happen before multiple organ failure is found. Since complications are common in the technique, ECMO should not be the first-line therapy. Inotropic therapy is a first-line treatment, but only up to certain doses over a certain period of time.

Delaying ECMO support could increase complications.⁵ If the heart is weak without mechanical support, we enter a vicious circle with a bad outcome. The refractory hypotension and the administration of fluids to correct it would lead to hypervolemia, excess fluid accumulated in the extracellular space. Long-term therapy with high doses of inotropes may lead to the deterioration of left ventricular function by accelerating myocardial cell apoptosis.⁶

Another important question when using ECMO is how long it should last. A good definition can be drawn from the conclusion of the analysis conducted by Smith et al., who analyzed 2699 ECMO patients.⁷ The authors concluded that using ECMO support for four days or less is associated with higher mortality, likely reflecting fatal hemorrhage. Survival is highest when patients are weaned on the fourth day of ECMO but likely decreases into the second week as the disease progresses and treatment complications occur. Some conditions require shorter or longer periods of time for the eventual outcome to become clinically apparent.⁷ The survival rate was the highest in the population of post-transplant patients within the first week after the application of ECMO.

Treatment with ECMO is often impeded by complications such as bloodstream infection, coagulopathic bleeding, neurologic injury, catheter-related limb ischemia, recirculation (exclusive to veno-venous ECMO), and left ventricular distention (veno-arterial ECMO).



Successful strategies have been defined as solving the problems of recirculation, distension of the left ventricle, and preventing leg ischemia. However, despite advances in ECMO support over the last ten years, bleeding remains a high risk.^{1,8,9} Current guidelines have evolved based on the findings that hypothermia, anemia, hypofibrinogenemia, thrombocytopenia, GP IIb/IIIa antagonists, and hemodilution can alter the activated clotting time (ACT), but a partial thromboplastin time (PTT) is measured in plasma, and the platelet count or hematocrit does not influence the results. This might be why a PTT, compared to ACT assays, correlates better to heparin concentrations during ECMO support.

In addition to bleeding, systemic response and infection are unresolved issues. Most patients on ECMO are affected by a systemic inflammatory response caused by the underlying disease and the ECMO support itself, contributing to vasoplegia, multi-organ failure, deterioration, and death. The latest innovation in the attempt to reduce the inflammatory response during ECMO is the blood purification technology; however, the optimization of its use and true efficacy is unknown. Our institution has recently used the Seraph 1000 Microbind Affinity blood filter, which allows up to a 90% reduction of bloodstream pathogens during a single treatment, and we have found it to be highly effective in treating septic patients.

References

1. Teruya J, (ed). *Management of Bleeding Patients*. Springer; 2016.
2. Extracorporeal Life Saving Organization. General Guidelines for all ECLS Cases 2017:26.
3. Badulak J, Antonini MV, Stead CM, et al. Extracorporeal Membrane Oxygenation for COVID-19: Updated 2021 Guidelines from the Extracorporeal Life Support Organization. *ASAIO J*. May 1 2021;67(5):485-495. doi:10.1097/MAT.0000000000001422
4. DeRoo SC, Takayama H, Nemeth S, et al. Extracorporeal membrane oxygenation for primary graft dysfunction after heart transplant. *J Thorac Cardiovasc Surg*. Dec 2019;158(6):1576-1584 e3. doi:10.1016/j.jtcvs.2019.02.065
5. Chiu LC, Hu HC, Hung CY, et al. Dynamic driving pressure associated mortality in acute respiratory distress syndrome with extracorporeal membrane oxygenation. *Ann Intensive Care*. Dec 2017;7(1):12. doi:10.1186/s13613-017-0236-y
6. Maack C, Eschenhagen T, Hamdani N, et al. Treatments targeting inotropy. *Eur Heart J*. Nov 21 2019;40(44):3626-3644. doi:10.1093/eurheartj/ehy600
7. Smith M, Vukomanovic A, Brodie D, Thiagarajan R, Rycus P, Buscher H. Duration of veno-arterial extracorporeal life support (VA ECMO) and outcome: an analysis of the Extracorporeal Life Support Organization (ELSO) registry. *Crit Care*. Mar 6 2017;21(1):45. doi:10.1186/s13054-017-1633-1
8. Lafc G, Budak AB, Yener AU, Cicek OF. Use of extracorporeal membrane oxygenation in adults. *Heart Lung Circ*. Jan 2014;23(1):10-23. doi:10.1016/j.hlc.2013.08.009
9. Vakil D, Soto C, D'Costa Z, et al. Short-term and intermediate outcomes of cardiogenic shock and cardiac arrest patients supported by venoarterial extracorporeal membrane oxygenation. *J Cardiothorac Surg*. Oct 9 2021;16(1):290. doi:10.1186/s13019-021-01674-w