



ECMO in the Modern ICU: Patient Selection, Timing, and the Challenge of Predicting Benefit

Fosterb A^{1*} and Siddiqui P²

¹Department of Cardiothoracic Anaesthesia and Critical Care, Northbridge University Hospital, United States

²Department of Intensive Care Medicine, Gulf International Medical University, United Arab Emirates

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***Corresponding author:** Andrew Fosterb, Department of Cardiothoracic Anaesthesia and Critical Care, Northbridge University Hospital, United States

Abstract

Extracorporeal membrane oxygenation (ECMO) has become an important rescue therapy for selected patients with severe respiratory or cardiac failure. However, determining which patients will benefit from ECMO and identifying the appropriate timing for initiation remain challenging. Clinical severity, comorbidities, duration of organ dysfunction, reversibility of disease, and institutional expertise all influence decision-making. Artificial intelligence and predictive analytics may eventually support ECMO referral, initiation, and prognostic assessment by integrating large numbers of physiological and clinical variables. This short communication discusses the potential role of predictive technologies while emphasizing that ECMO decisions require multidisciplinary clinical judgment.

Keywords: ECMO; Extracorporeal Membrane Oxygenation; Critical Care; Respiratory Failure; Cardiogenic Shock; Artificial Intelligence; Prognosis

Introduction

ECMO represents one of the most resource-intensive interventions available in critical care. It can provide temporary respiratory and/or circulatory support while the underlying disease is treated. However, ECMO is not appropriate for every critically ill patient. The central clinical question is whether the expected benefit justifies the risks and resources associated with extracorporeal support.

The Timing Problem

ECMO may be initiated too late, after irreversible organ injury has developed.

Conversely, initiating ECMO too early may expose patients to significant complications without sufficient expected benefit. Timing is therefore critical. Clinicians must integrate respiratory or cardiovascular failure severity, disease trajectory, response to conventional therapy, and reversibility. Patient Selection Potential selection variables include:

- ❖ age;
- ❖ comorbidity;
- ❖ duration of mechanical ventilation;
- ❖ oxygenation;
- ❖ carbon dioxide levels;
- ❖ hemodynamic status;
- ❖ lactate;
- ❖ renal function;

- ❖ neurological status;
- ❖ underlying diagnosis.

The challenge is that these factors interact.

A single threshold rarely provides a complete answer.

Could AI Help?

AI could potentially integrate multiple variables to estimate the probability of survival with and without ECMO. A prediction model could support referral decisions and identify patients whose condition is deteriorating despite maximal conventional management. Recent research has begun examining AI and machine-learning approaches for ECMO initiation and prognosis [1].

However, an algorithm should not become an automatic ECMO gatekeeper.

Why Human Judgment Remains Essential

ECMO decisions often involve uncertainty.

A patient may have a high predicted mortality but still have a reversible disease process.

Another patient may have apparently moderate physiological abnormalities but severe irreversible underlying pathology. Clinical teams must therefore consider information that may not be captured by an algorithm.

Resource Considerations ECMO availability differs significantly between healthcare systems.

An AI system developed in a high-resource tertiary ECMO center may not be directly applicable to hospitals with limited access to extracorporeal services.

Prediction models must therefore be evaluated within their intended clinical environment.

- ❖ Clinical Implications
- ❖ Predictive technologies could potentially assist with:
- ❖ early referral;
- ❖ patient selection;
- ❖ timing of cannulation;
- ❖ prognostic assessment;

- ❖ resource planning;
- ❖ identification of deterioration.

Their greatest benefit may be helping clinicians recognize when an ECMO consultation should occur.

Future Directions

Future studies should compare AI-assisted ECMO referral with conventional decision-making. Important outcomes include survival to discharge, neurological outcome, complications, duration of ECMO, and time from eligibility to cannulation. Multicenter validation is essential [2].

Conclusion

ECMO represents a complex decision rather than a simple treatment choice. AI may eventually help clinicians process the large amount of information required to make these decisions, but it should remain a decision-support tool rather than an autonomous decision-maker. The future of ECMO may depend not only on better machines, but also on better methods for identifying the patients most likely to benefit from them.

References

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