

# Veno-arterial extracorporeal membrane oxygenation for acute myocardial infarction-associated cardiogenic shock: can we predict survival before decision of implantation?

Nicolas Persico<sup>1,2</sup>, Jeremy Bourenne<sup>3</sup>, Antoine Roch<sup>1,2</sup>

<sup>1</sup>Aix-Marseille Univ, APHM, URMITE UMR CNRS 7278, Hôpital Nord, Réanimation des Détresses Respiratoires et Infections Sévères, Marseille, France; <sup>2</sup>Emergency Department, APHM, CHU Nord, Marseille, France; <sup>3</sup>APHM, CHU Timone, Réanimation, Marseille, France

Correspondence to: Prof. Antoine Roch, MD, PhD. Réanimation, CHU Nord, Chemin des Bourrely, 13015 Marseille, France.

Email: antoine.roch@ap-hm.fr.

Submitted Jul 12, 2016. Accepted for publication Jul 18, 2016.

doi: 10.21037/jtd.2016.08.91

View this article at: <http://dx.doi.org/10.21037/jtd.2016.08.91>

Acute myocardial infarction (AMI) with subsequent ventricular dysfunction is the most frequent cause of cardiogenic shock (CS) accounting for about 80% of cases (1). CS remains the leading cause of death in AMI with mortality rates still approaching 40–50% (2,3). The treatment of AMI-induced CS principally consists of early revascularization and intensive care treatment with inotropes, vasopressors, sedation and mechanical ventilation. The most severe cases of CS can be treated with mechanical circulatory support, as a bridge to recovery of cardiac function, or sometimes as a bridge to heart transplantation. According to Guidelines of the European Society of Cardiology (4), short-term mechanical circulatory support should be considered (as a ‘bridge to recovery’) in patients remaining severely hypoperfused despite inotropic therapy and with a potentially reversible cause (e.g., viral myocarditis) or a potentially surgically correctable cause (e.g., acute interventricular septal rupture) (class IIa/level C recommendation) and may be considered (as a ‘bridge to decision’) in patients deteriorating rapidly before a full diagnostic and clinical evaluation can be made (class IIb/level C recommendation). Among available devices, veno-arterial (VA)-Extracorporeal Membrane Oxygenation (ECMO) technique, also called Extracorporeal Life Support (ECLS), has been increasingly used (5) since it is easy to implant in referring centers and has an acceptable cost. Main limitations of these devices are large cannula sizes potentially causing lower limb ischaemia and bleeding complications, lack of direct left-ventricular unloading, rise in afterload, and a limited support time.

In a recent meta-analysis including 20 studies and 1,866 patients, complications were frequent with lower extremity ischaemia (16.9%), compartment syndrome (10.3%), amputation (4.7%), stroke (5.9%), major bleeding (40.8%), and significant infection (30.4%) (6). To date, there are no randomized controlled trials comparing ECMO with other mechanical support systems in AMI-associated CS, but several nonrandomized studies suggest a survival advantage from the early use of ECMO in such circumstances. In a previous observational study conducted in 81 patients given ECMO support for medical (n=55), postcardiotomy (n=16), or posttransplantation (n=10) CS, Combes *et al.* (7) found that independent predictors of intensive care unit (ICU) death were device insertion under cardiac massage [odds ratio (OR) =20.68], 24 h urine output <500 mL (OR =6.52), prothrombin activity <50% (OR =3.93), and female sex (OR =3.89); myocarditis was associated with better outcomes (OR =0.13) and long term survival was 36%. In a retrospective study comparing two periods in one center (before the use of ECMO, 115 patients and a period with ECMO, 219 patients), Sheu *et al.* (8) found a dramatically lower mortality during the ECMO period (39.1% vs. 72%), although the older period started in 1993, i.e., before the use of percutaneous coronary intervention. However, timing and appropriate patient selection need to be further investigated since benefits of early implantation on organ failure occurrence may be counter-balanced by device-related complications.

In this sense, Muller *et al.* (9) recently published the results of an observational bicenter study which identified

factors associated with in-ICU death for VA-ECMO-treated AMI patients. All consecutive AMI patients who received VA-ECMO for refractory CS in two adult ICUs in French university hospitals between May 2008 and May 2013 were included. VA-ECMO was indicated for acute refractory cardiovascular failure defined as evidence of tissue hypoxia (e.g., extensive skin mottling or elevated blood lactate); left ventricular ejection fraction (<25%); low cardiac index (<2.2 L/min/m<sup>2</sup>); and sustained hypotension despite infusion of very high-dose catecholamines (epinephrine >1 µg/kg/min or dobutamine >20 µg/kg/min and norepinephrine >1 µg/kg/min). VA-ECMO exclusion criteria were severe underlying condition with life expectancy <1 year, prolonged cardiac arrest (>60 min) pre-ECMO, and irreversible neurological pathology (e.g., massive intracranial bleeding or flat EEG). The main outcome variable was survival to ICU discharge. A practical ICU mortality risk score (ENCOURAGE score) was developed using multivariable regression analysis. To note regarding statistics, all continuous variables were transformed into categorical variables, whereas the following variables were forced in the model: mobile ECMO retrieval, pre-ECMO cardiac arrest, ECMO under cardiopulmonary resuscitation, AMI location, intra-aortic balloon pump associated with ECMO, and post-percutaneous coronary intervention thrombolysis in myocardial infarction. The authors included 138 consecutive patients with a median (25th–75th percentile) age of 55 (46–63) years old, a SAPS II score of 66 (48–82), a pre-ECMO lactate level of 4.1 (2.1–8.2) mmol/L and a troponin IC level at the admission of 45 (10–188 µg/L). Forty-five (33%) of patients were retrieved using mobile ECMO unit, 79 (57%) had presented pre-ECMO cardiac arrest, 112 (81%) were submitted to percutaneous coronary intervention, and 134 (97%) were mechanically ventilated before ECMO initiation. Sixty-five (47%) patients survived to ICU discharge. Six months post-ICU admission, 57 patients were still alive (41%). Median (25th–75th percentile) ECMO support was 7 (4–10) days. ECMO complications occurred in 39 % of the patients. ECMO served as a bridge to left or biventricular assist device for 18 patients and 13 were transplanted. After multivariable analysis, independent pre-ECMO institution predictors of in-ICU death were pre-ECMO age >60 years (5 points in the ENCOURAGE score), female sex (7 points), body mass index >25 kg/m<sup>2</sup> (6 points), Glasgow coma score <6 (the last value recorded when the patient was assessable before intubation or when the patient was still awake, 6 points), creatinemia >150 µmol/L (5 points), elevated serum lactate (8 points if between 2

and 8 mmol/L, 11 points if >8 mmol/L), and prothrombin activity <50% (5 points). Interestingly, mobile ECMO unit retrieval was not associated with poorer prognosis, what emphasizes the interest for implementing these teams. Cumulative probabilities of respective 30-day and 6-month survival post-ECMO initiation were 92, 70, 35, 28, and 17% and 80, 58, 25, 20, and 7% for ENCOURAGE score classes 0–12, 13–18, 19–22, 23–27, and ≥28, respectively. The ENCOURAGE score had significantly better discrimination properties than other usual survival scores. Survivors' health-related quality of life and anxiety, depression, and posttraumatic stress disorder (PTSD)-related symptoms were assessed a median of 32 (18–54) months post-ICU discharge in 41 (77%) longterm survivors and revealed satisfactory mental health but persistent physical and emotional-related difficulties, with 34% (95% CI, 20–49%) anxiety, 20% (95% CI, 8–32%) depression, and 5% (95% CI, 0–12%) PTSD symptoms reported.

The results of this observational study are important since they may help clinicians in better selecting AMI patients for VA-ECMO implantation. It is crucial to benefit from this type of score since decision has to be taken very promptly and most often by phone. Therefore, it is useful to determine with accuracy which patients would benefit from this very expensive treatment. The ENCOURAGE score was constructed with demographic, clinical and biological parameters which are constantly recorded in these patients and can consequently be easily determined on site or on phone. To note, the only parameter which may be difficult to interpret is prothrombin activity in patients previously treated with anticoagulant drugs. Moreover, all parameters have to be very cautiously recorded in this score since the addition of only one criteria may move the patient from one category with 70% survival to a category with 28%. This study was conducted in two university hospitals with extensive experience of ECMO and equipped with an ECMO mobile unit, accounting for a relatively low 30-day mortality rate of 53%. Therefore, the generalizability of the results may be limited and requires external validation. Indeed, since the decision of ECMO implantation has to be taken very promptly, the validity of parameters which are used for indicating ECMO initiation have to be robustly confirmed before their extension. As acknowledged by the authors, another limitation is that this study has been performed in patients who were all treated with ECMO, whereas it may less accurately reflect mortality in a larger population of patients considered for ECMO implantation.

For the clinical practice, the results of the study by

Muller *et al.* (9) will help clinicians in communicating objective prognostic informations to families and colleagues from referring centers, and in avoiding the use of ECMO in two severe patients in whom even the best device available will not be able to change clinical outcome. The optimal mechanical support has also not been determined and several other devices than ECMO are currently under investigation.

### Acknowledgements

None.

### Footnote

*Provenance:* This is an invited Editorial commissioned by the Section Editor Lei Huang (Cardiac Center of Tianjin Third-Central Hospital, Tianjin, China).

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

*Comment on:* Muller G, Flecher E, Lebreton G, *et al.* The ENCOURAGE mortality risk score and analysis of long-term outcomes after VA-ECMO for acute myocardial infarction with cardiogenic shock. *Intensive Care Med* 2016;42:370-8.

### References

1. Werdan K, Gielen S, Ebelt H, *et al.* Mechanical circulatory support in cardiogenic shock. *Eur Heart J* 2014;35:156-67.
2. Thiele H, Zeymer U, Neumann FJ, *et al.* Intraaortic balloon support for myocardial infarction with cardiogenic shock. *N Engl J Med* 2012;367:1287-96.
3. Katz JN, Stebbins AL, Alexander JH, *et al.* Predictors of 30-day mortality in patients with refractory cardiogenic shock following acute myocardial infarction despite a patent infarct artery. *Am Heart J* 2009;158:680-7.
4. McMurray JJ, Adamopoulos S, Anker SD, *et al.* ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012: The Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC. *Eur Heart J* 2012;33:1787-847.
5. Stretch R, Sauer CM, Yuh DD, *et al.* National trends in the utilization of short-term mechanical circulatory support: incidence, outcomes, and cost analysis. *J Am Coll Cardiol* 2014;64:1407-15.
6. Cheng R, Hachamovitch R, Kittleston M, *et al.* Complications of extracorporeal membrane oxygenation for treatment of cardiogenic shock and cardiac arrest: a meta-analysis of 1,866 adult patients. *Ann Thorac Surg* 2014;97:610-6.
7. Combes A, Leprince P, Luyt CE, *et al.* Outcomes and long-term quality-of-life of patients supported by extracorporeal membrane oxygenation for refractory cardiogenic shock. *Crit Care Med* 2008;36:1404-11.
8. Sheu JJ, Tsai TH, Lee FY, *et al.* Early extracorporeal membrane oxygenator-assisted primary percutaneous coronary intervention improved 30-day clinical outcomes in patients with ST-segment elevation myocardial infarction complicated with profound cardiogenic shock. *Crit Care Med* 2010;38:1810-7.
9. Muller G, Flecher E, Lebreton G, *et al.* The ENCOURAGE mortality risk score and analysis of long-term outcomes after VA-ECMO for acute myocardial infarction with cardiogenic shock. *Intensive Care Med* 2016;42:370-8.

**Cite this article as:** Persico N, Bourenne J, Roch A. Venous-arterial extracorporeal membrane oxygenation for acute myocardial infarction-associated cardiogenic shock: can we predict survival before decision of implantation? *J Thorac Dis* 2016;8(9):2331-2333. doi: 10.21037/jtd.2016.08.91