



# A Suprainstitutional Network for Remote Extracorporeal Life Support

## A Retrospective Cohort Study

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### ABSTRACT

**OBJECTIVES** This study sought to evaluate patient outcome within the Düsseldorf Extracorporeal Life Support (ECLS) Network, a suprainstitutional network for rapid-response remote ECLS and to define survival-based predictors.

**BACKGROUND** Mobile venoarterial extracorporeal membrane oxygenation (vaECMO) used for ECLS has become a treatment option for a patient population with an otherwise fatal prognosis. However, outcome data remain scarce and institutional standards required to manage these patients are still poorly defined.

**METHODS** This retrospective cohort study analyzes the outcome of 115 patients consecutively treated between July 2011 and October 2014 within the Düsseldorf ECLS Network due to refractory circulatory failure.

**RESULTS** Of the 115 patients ( $56 \pm 15$  years of age, vaECMO initiation under cardiopulmonary resuscitation [CPR] 77%, CPR duration 45 [range 5 to 90] min), 50 patients (44%) survived to primary discharge and 38 patients (33%) were alive after a median follow-up of 1.5 years (95% confidence interval [CI]: 1.2 to 1.7). Thirty-seven (97%) of the long-term survivors showed a favorable neurological outcome. Risk factors associated with mortality during vaECMO were CPR duration (hazard ratio [HR]: 1.006; 95% CI: 1.00 to 1.01) and ischemic stroke (HR: 2.63; 95% CI: 1.52 to 4.56). Risk factors associated with mortality after vaECMO weaning were renal failure (HR: 6.60; 95% CI: 2.72 to 16.01) and sepsis (HR: 3.6; 95% CI: 1.50 to 8.69). Visceral ischemia had a negative impact (HR: 0.30; 95% CI: 0.11 to 0.84) whereas assist device implantation promoted successful vaECMO weaning (HR: 2.95; 95% CI: 1.65 to 5.25). Further, 3 distinct risk groups with significant differences in survival could be identified, demonstrating that in patients with no or short CPR mortality was not conditioned by age, whereas in patients with prolonged CPR young age was associated with increased survival.

**CONCLUSIONS** This study illustrates the implementation of a suprainstitutional ECLS Network. Further, our data suggest that mobile vaECMO is beneficial for a larger patient population than actually expected, especially regarding young patients presenting with prolonged CPR or patients regardless of age with no or short CPR. (J Am Coll Cardiol HF 2016;4:698-708) © 2016 by the American College of Cardiology Foundation.

Venoarterial extracorporeal membrane oxygenation (vaECMO), also referred to as extracorporeal life support (ECLS), has become a valid treatment option for refractory circulatory failure due to a variety of etiologies (1-3), providing temporary circulatory assistance sustaining

vital hemodynamics until completion of diagnostics, full recovery from underlying pathology, or implementation of further therapy.

In the past vaECMO therapy has been restricted to patients on site in selected tertiary care centers (4). Today, miniaturization of circulatory assistance

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systems and incremental clinical experience allow us to provide mobile vaECMO as a rescue therapy in out-of-center emergency situations. However, although registry-derived scores predicting survival for patients receiving vaECMO for refractory cardiogenic shock have already been established (5), decision to treat for out-of-center vaECMO rescue remains challenging, as it has to be taken on the spot by the providing care unit, usually with incomplete information about the patient and his or her condition. Adequate patient selection criteria for such out-of-center emergency situations, that reflect on short- and long-term survival and proportionate cost effectiveness, are still lacking. Further, minimal institutional standards that might be required to manage such patients with all its implications from vaECMO-related complications to complex follow-up therapy still need to be defined.

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Because outcome data from randomized controlled prospective trials will rarely be available in the evaluation of last-resort emergency therapy concepts, we have to rely on cohort analysis to guide our patient selection strategies. Therefore, based on the up-to-date largest patient series, the aim of this study was to evaluate the suprainstitutional network for rapid-response remote vaECMO that was started at our institution in 2011 and to define survival-based predictors in order to identify those patients who did benefit from mobile vaECMO. Further, we hypothesized that in a well-defined setting mobile advanced circulatory support is beneficial for a larger patient population than actually expected, as exemplified by the 2 introductory real-life cases in which mobile vaECMO may seem counterintuitive due to prolonged cardiopulmonary resuscitation (CPR) or advanced age (Online Appendix).

## METHODS

**SETTING.** The Düsseldorf ECLS Network is a supra-institutional network for rapid-response remote ECLS based at the Heart Center of Heinrich Heine University in Düsseldorf (Germany). The ECLS Network was launched in July 2011 by the Department of Cardiovascular Surgery as a suprainstitutional effort to offer 24/7 advanced mobile vaECMO for patients with refractory circulatory failure not related to cardiac surgery at a regional level. Indications for mobile vaECMO are refractory circulatory failure non-manageable on site or cardiac arrest under CPR. vaECMO is declined when life-limiting medical conditions or strong evidence for hypoxic brain damage

after prolonged insufficient CPR are present. Decision to treat is undertaken by the cardiovascular surgeon on duty, immediately sending a trained mobile vaECMO team (cardiovascular surgeon and perfusionist) on site upon emergency call.

On site, mobile peripheral vaECMO system (Sorin Lifebox, Sorin Group, Munich, Germany) implantation is performed as previously described (6). After hemodynamic stabilization the patient is immediately transferred to the Department for Cardiovascular Surgery, where a standardized diagnostic and therapeutic algorithm is started by a specially trained interdisciplinary team, including implantation of a distal leg perfusion cannula, whole-body computer tomographic scan, transesophageal echocardiography, peripheral vessel Doppler sonography, cardiac catheterization, mobile vaECMO switch to a stationary system (SPPSC, Sorin Group), point-of-care blood coagulation management, and optimal left ventricular decompressing management. After completion of diagnostics, customized therapy is started depending on the underlying pathology. In cases where predicted neurological prognosis is favorable and vaECMO weaning is not successful or left ventricular decompression cannot be adequately achieved by other measures a permanent left ventricular assist device (VAD) (HeartWare International, Framingham, Massachusetts) is implanted either as bridge to recovery, bridge to transplant, or destination therapy, adhering to current recommendations (7). Patients are treated at our institution until internal or external referral for further recovery after completion of rescue therapy, hospital discharge after completion of follow-up therapy, or death.

**STUDY DESIGN.** This retrospective cohort study includes 115 patients not related to cardiac surgery consecutively treated with mobile vaECMO rescue therapy for refractory circulatory failure within the ECLS Network between July 2011 and October 2014. Refractory circulatory failure was defined as insufficiency to maintain sufficient mean arterial pressure (60 mm Hg) with evidence of end-organ hypoperfusion despite maximal medical therapy under exhaustion of all on-site available supportive measures and/or ongoing CPR, independent from underlying etiology. vaECMO rescue therapy was defined as mobile when an advanced logistic effort was required to reach the patient, only including patients into the study in whom vaECMO was implanted in facilities spatially separated from the Department of Cardiovascular Surgery. Patients in whom vaECMO implantation was declined on site or patients primarily

## ABBREVIATIONS AND ACRONYMS

**CPR** = cardiopulmonary resuscitation

**ECLS** = extracorporeal life support

**vaECMO** = venoarterial extracorporeal membrane oxygenation

**VAD** = ventricular assist device

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