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The ECMO Retrieval Team

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The extra-corporeal membrane oxygenation (ECMO) retrieval team initiating ECMO in remote institutions followed by stabilisation and transfer to tertiary centres under ECMO might allow markedly improved survival to the sickest patients with refractory respiratory or cardiac failure.

Introduction

ECMO is a high risk and complex therapy that can be offered to the sickest patients with refractory respiratory or cardiac failure. It has been successfully used as a bridge to myocardial recovery, cardiac transplantation or the implantation of a ventricular assist device in patients with overt cardiac failure of various aetiologies (Bakhtiary et al. 2008; Combes et al. 2008), e.g., acute myocardial infarction (Combes et al. 2008; Chen et al. 2006), end-stage dilated cardiomyopathy (Schwarz et al. 2003), viral or toxic myocarditis (Asaumi et al. 2005; Mirabel et al. 2011), complications of cardiac surgery (Rastan et al. 2010) or cardiac arrest (Chen et al. 2008). Alternatively, the current potential indications for the use of ECMO in cases of severe acute respiratory failure (ARF) include: severe acute respiratory distress syndrome (ARDS), status asthmaticus, bridge to lung transplantation, as well as diffuse alveolar haemorrhage, pulmonary hypertensive crisis, pulmonary embolism, severe bronchopleural fistula and other forms of severe ARF (Schmidt et al. 2013; Pham et al. 2013; Noah et al. 2011; Australia and New Zealand Extracorporeal Membrane Oxygenation (ANZ ECMO) Influenza Investigators et al. 2009; Peek et al. 2009).

Transfer of medically unstable patients to tertiary centres without extracorporeal support may be associated with markedly increased risks. In the CESAR trial (Peek et al. 2009) where retrieval under ECMO was not possible, 6% of the patients randomised to the ECMO group died before or during transport to the ECMO centre. Therefore, initiating ECMO in remote institutions followed by stabilisation and transfer to tertiary centres under ECMO might allow significant improved survival. The first report of a patient retrieval under ECMO was made by Cornish in 1986 (Cornish et al. 1986). Since then successful transportation of patients on cardiopulmonary support has been described for short and long distances by ambulance, helicopter, and aeroplane (Beurtheret et al. 2013; Foley et al. 2002; Forrest et al. 2011; Lebreton et al. 2012; Linden et al. 2001; Javidfar et al. 2011; Isgro et al. 2011).

ECMO Retrieval Network Organisation

A policy directive should be established at the regional or national level for critically ill patients and patients at risk of critical deterioration requiring referral and transfer to a tertiary centre. Specifically, networks of hospitals should be created around ECMO centres located in tertiary referral hospitals. Hospitals in these networks should adhere to written standardised protocols detailing criteria for both the initiation of ECMO (indications and exclusions) (Extracorporeal Life Support Organization 2010), as well as optimisation of conventional treatments to be undertaken prior to the consideration of ECMO.

In Australia, the New South Wales Critical Care Tertiary Referral Networks was established in 2006, and is currently utilised across the state to guide the process of appropriate critical care adult tertiary networking, referral and patient transfer. It has defined indications for emergent ECMO retrieval of cardiac and respiratory failure patients (NSW Health 2010), and has established the links between primary care hospitals and tertiary referral hospitals for functional clinical referral relationships. It was extensively used during the 2009 influenza A(H1N1) pandemic, and contributed to the remarkably good results obtained in that state for the treatment of the most severe forms of influenza A(H1N1)-associated ARDS (Australia and New Zealand Extracorporeal Membrane Oxygenation (ANZ ECMO) Influenza Investigators et al. 2009). Such formalised networks have also been successfully organised in the United Kingdom (National Institute for Healthcare and Clinical Excellence 2011), Italy (Patroniti et al. 2011) and the French West Indies (Lebreton et al. 2012).

Logistics for ECMO Retrieval

The safe management of an ECMO retrieval patient requires a coordinated response by the referring and receiving hospitals, ECMO team, ambulance and the medical retrieval services. Written criteria for early notification of a patient potentially requiring referral ECMO should be available at each referral hospital, and referrals should be restricted to severe, but potentially reversible acute respiratory or cardiac failure refractory to maximal conventional therapy. Potential ECMO referrals should be discussed between physicians at the referral centre and intensivists, anaesthetists, cardiologists, cardiac surgeons and respiratory physicians at the ECMO centre (Figure 1). Telephone, email and web conference can be used to communicate and discuss patient details (such as Doppler-echocardiography, ventilator settings, blood results and imaging) and medical management.

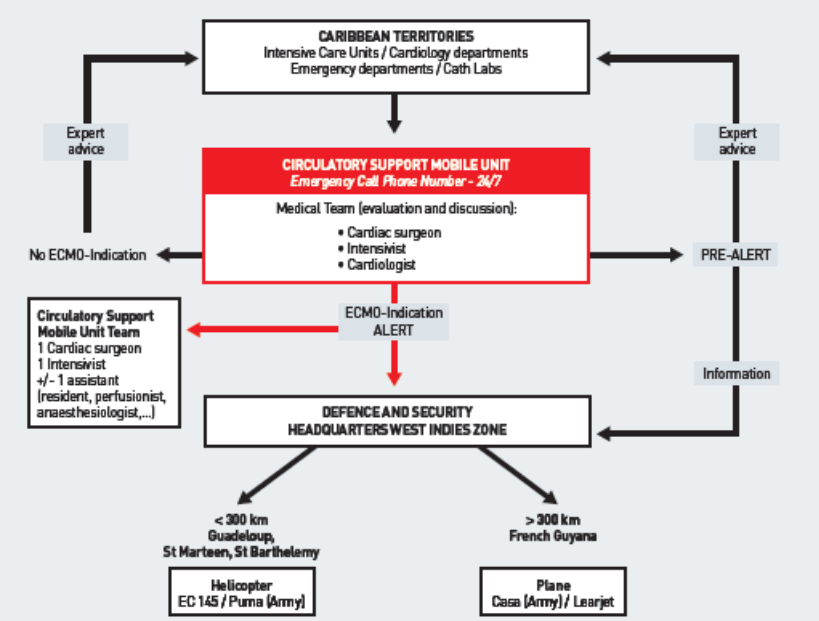

Figure 1. Airbridge Procedure for Circulatory Support in the French Carribean

Figure 2. The Mobile Team Prepacked ECMO Equipment and Car for Emergent Transport of the Team to Referral Hospitals

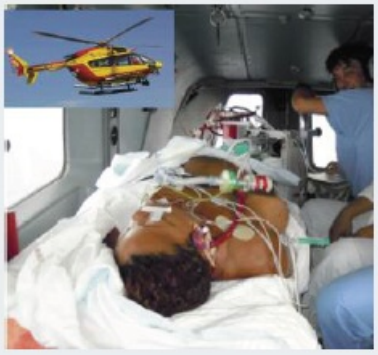

Figure 3. Helicopter Retrieval of an ECMO Patient

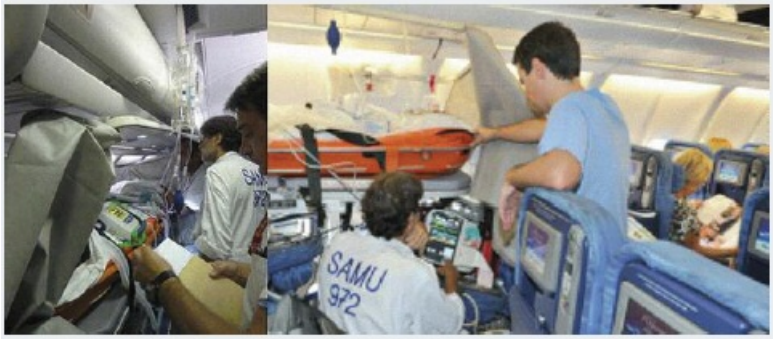

Figure 4. Transatlantic Transfer in a Commercial Plane to La Pitié Hospital in Paris of an ECMO Patient

The mobile ECMO team should be available 24 hours a day, 7 days a week, and employ experienced personnel trained in the transport of critically ill patients, insertion of ECMO cannulas, as well as circuit and patient management. All the equipment required for cannulation, circuit set-up, and transportation should be pre-packed (Figure 2) and immediately available. The team will usually include a mix of physicians, transport specialists, nurses, perfusionists or other ECMO specialists. Imaging requirements at the referring hospital should be considered and a clinician trained in echocardiography should also be considered for some transfers. Portable ultrasound equipment should also be considered. The transport to the referring hospital to bring the personnel and equipment should be as quick as possible (Figure 2). Upon arrival of the transport team at the referral hospital, the patient should be carefully re-evaluated, ECMO indication confirmed and optimal mode of mechanical support (venoarterial, venovenous, cannulation sites) determined. The choice of transport vehicle for retrieval (ambulance, helicopter, or fixed-wing aircraft) should be based on transport distance, crew and and 4). Miniaturised newest generation portable ECMO machines (Philipp et al. 2011) might allow easier and more rapid patient transportation, particularly in small helicopters. Transport vehicles should be equipped with adequate electrical power supply, an oxygen tank, a high performance ICU ventilator, an ICU portable monitor, infusion pumps and suction equipment.

Return on Experience

The University of Michigan Medical Centre reported the first large experience of 100 patients retrieved on bulky first generation ECMO devices in the 1990s. Of the patients, 53 were supported with venovenous bypass and 47 with venoarterial bypass. Patients were transported by ground ambulance (80%), helicopter (5%), or fixed-wing aircraft (15%). The median transport distance was 44 miles (two to 790 miles), and the median transport time was 5 hours and 30 minutes (1 hour 33 min, to 16 hours 6 min.). Complications that occurred during transport included 10 cases of electrical failure, three cases of circuit tubing leakage, and one case each of circuit rupture, membrane lung thrombosis, and membrane lung leakage. However, none of the complications occurring during transport had an adverse effect on outcome.

Our group reported more recently on a large series of 75 refractory cardiogenic shock patients who were retrieved under the newest generation venoarterial ECMO systems from hospitals without ECMO facilities throughout the Greater Paris area between 2005 and 2009. Time from phone call to circulatory support ranged from 64 to 254 minutes depending on the distance to remote centre. No technical incident or adverse event occurred during transport, except one ECMO pump dysfunction requiring temporary manual assistance. Interestingly, after adjusting for other confounding factors, inhospital survival (37%) of these patients was not statistically different from that of 123 consecutive patients who received ECMO at our institution during the same period. Very good results have also been reported after retrievals under venovenous ECMO of patients suffering serious H1N1-induced ARDS (Forrest et al. 2011; Isgro et al. 2011; Ciapetti et al. 2011). Lastly, safe transcontinental transport of several ECMO patients referred to our centre for ventricular assist devices (VAD) implantation of heart transplantation using regular commercial flights have been performed between French Caribbean Islands, La Réunion Island and La Pitié Hospital in Paris in the last three years (Figure 4).

Conclusion

Mobile ECMO retrieval teams for the provision of ECMO support to critically ill patients should be created as part of critical care tertiary referral networks of hospitals covering regional or national areas. A policy directive should be established within the network allowing standardisation of referral indications and adequate 24 hours a day, 7 days a week staffing, equipment and transport. This strategy might allow safe transportation

under cardiopulmonary support to experienced tertiary centres and might ultimately improve survival of the sickest respiratory or cardiac failure patients initially treated in centres where ECMO is not possible.

Conflict of Interest Statement

Dr. Combes reports receiving lecture honoraria from Maquet Cardiovascular. He is the primary investigator of the EOLIA trial (NCT01470703) for which MAQUET provides the CardioHelp devices and ECMO cannulas. Dr Lebreton has no conflict of interest to declare.

For full references, please send a request to editorial@icu-management.org

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