FOCUS EDITORIAL

Focus on veno-venous ECMO in adults with severe ARDS

Laurent Papazian^{1,2*}, Margaret Herridge³ and Alain Combes⁴

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Veno-venous extracorporeal membrane oxygenation (vvECMO) improves oxygenation and promotes carbon dioxide (CO₂) removal [1, 2]. In the most severe form of ARDS, ECMO rapidly facilitates the correction of severe derangement in gas exchange and saves time, which allows one to treat the cause of lung injury. Recent advances in ECMO technology have improved safety and promoted its use [3–5].

Knowledge of the gas exchange performance of membrane oxygenators is important to help choose the optimal system for patients suffering from acute respiratory failure. In an in vivo study of 317 vvECMO patients supported with four different ECMO systems, Lehle et al. [6] showed that CO₂ transfer was dependent on sweep gas flow and blood flow, while O₂ transfer was only dependent on blood flow when it was above 3 L/min.

The association between ECMO use and the development of thrombocytopenia secondary to circuit-induced platelet activation and aggregation has been suggested, although never carefully evaluated. In a retrospective cohort study of 100 adults who received vvECMO for acute respiratory failure, Abrams et al. [7] demonstrated that the severity of critical illness and platelet count at the time of cannulation were independently associated with the development of severe thrombocytopenia, while the duration of ECMO support was not.

A position paper [8] from an international group of experts described the optimal approach to organizing programs and delivering safe and proficient ECMO for acute respiratory failure. They encouraged restraint in the widespread use of ECMO until a better appreciation

of both the potential clinical applications and the optimal techniques for performing ECMO are available. They also underlined the need for further randomized controlled trials assessing this technique.

Using hospital ECMO volumes from 290 international centers, a retrospective study of more than 55,000 ECMO patients [9] found an association between higher adult ECMO hospital volume and lower ECMO mortality rates. Patients receiving ECMO at hospitals with more than 30 adult annual ECMO cases had significantly lower odds of mortality (adjusted odds ratio, 0.61; 95 % confidence interval 0.46–0.80) compared with those receiving ECMO at hospitals with fewer than six cases annually.

In a review paper, Levy et al. [10] proposed a multistep therapeutic approach with optimization of ECMO blood flow, red blood cell transfusion, moderate hypothermia, and short-action beta-blockers for the management of persistent severe hypoxemia under vvECMO. Important technical considerations for the care of ECMO patients by nurses [11] and physicians were also detailed in a review.

The optimal ventilatory strategy for ARDS patients under ECMO remains unclear. Controlled mechanical ventilation is recommended in the first few days [12]. While the ventilator settings should be as low as possible to reduce ventilator-induced lung injury (VILI), there is an increased risk of derecruitment. In a recent international study [13] it was suggested that higher PEEP is associated with a better outcome. Indeed, independent predictors of ICU death included lower PEEP during the first 3 days on ECMO support and duration between ICU admission and ECMO initiation, whereas plateau pressure was not increased in patients who died. Despite the use of optimized ECMO and ventilator settings, some ARDS patients remain severely hypoxemic. It is suggested to use prone positioning in these patients [10],

*Correspondence: laurent.papazian@ap-hm.fr

¹ Assistance Publique–Hôpitaux de Marseille, Hôpital Nord, Réanimation des Détresses Respiratoires et des Infections Sévères, 13015 Marseille, France

Full author information is available at the end of the article

which is safe and associated with improved oxygenation status when performed by well-trained teams [14]. Moreover, prone positioning is also able to decrease VILI by a reduction in atelectrauma (repeated opening and closing of terminal respiratory units), tidal hyperinflation, and by modulating biotrauma [14]. Fluid balance is also associated with oxygenation alterations. It was recently shown [15] that a positive fluid balance on ECMO day 3 was associated with a higher hospital mortality, while there was no difference among survivors and patients who died during the first 2 days. This result strongly confirms that it is difficult to minimize fluid administration during the very early phase of ARDS. However, it is clearly feasible after 2 days and is able to improve the outcome.

The mortality associated with ARDS remains unacceptably high, reaching 46 % in patients with severe disease [16, 17]. The burgeoning outcomes literature on complex and high-risk ARDS patients has evolved to increasingly embrace patient- and family-centered outcome measures. No longer is it adequate to report survival in isolation to understand the impact of new interventions on patient outcome [18–20].

ECMO represents a scarce and costly resource, and there has been a significant further contribution to the outcomes literature over this past year on risk stratification and outcomes to better inform the decision-making surrounding this new technology [4]. This work began with the seminal PRESERVE study [21] that graded mortality risk but also linked this to longer-term outcome using patient and mechanical ventilation-related parameters. Similar to the previously published RESP score [5], Barbaro and colleagues [22] recently sought to develop a risk prognostication model for children being considered for ECMO treatment and noted that physiologic derangement (blood gas data), diagnosis, and duration of mechanical ventilation were the main determinants of hospital mortality. The exclusion of acute renal dysfunction and hypoxemia in this novel pediatric model were consistent with findings from the RESP score. A novel ICU mortality risk prognostication model for patients needing veno-arterial (va) ECMO—the ENCOURAGE score—was developed using age greater than 60 years, female sex, body mass index greater than 25 kg/m², Glasgow coma score less than 6, creatinine greater than 150 µmol/L, lactate (<2, 2–8, or >8 mmol/L), and prothrombin activity less than 50 % [23]. Similar to prior ARDS outcomes data, these authors showed that patients had persistent functional disability and mood disorders at 6-month follow-up. Of interest, recent data from Luyt and colleagues [24] showed that intracranial bleeding on ECMO was frequent, occurred early, and was associated with mortality. It is possible that these sequelae may increase the risk of neuropsychological dysfunction, and this requires further study.

ECMO technology is still under study, and we continue to strive to use this novel intervention in the safest and most optimal way. The future challenge will be to identify its niche and identify optimal risk strata for those with severe ARDS who have failed other treatment modalities.

Author details

¹ Assistance Publique–Hôpitaux de Marseille, Hôpital Nord, Réanimation des Détresses Respiratoires et des Infections Sévères, 13015 Marseille, France.

² Faculté de Médecine, Aix-Marseille Université, URMITE UMR CNRS 7278, 13005 Marseille, France. ³ Critical Care and Respiratory Medicine, Toronto General Research Institute, University Health Network, University of Toronto, Munk Building 11 PMB 127, 585 University Avenue, Toronto, ON M5G 2N2, Canada.

⁴ Service de Réanimation Médicale, INSERM, UMRS-1166, iCAN, Institute of Cardiometabolism and Nutrition, Université Pierre et Marie Curie, Paris 6, Hôpital de la Pitié-Salpêtrière, Assistance Publique–Hôpitaux de Paris, 47, bd de l'Hôpital, 75651 Paris Cedex 13, France.

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