Is there a benefit of ECMO in traumatically injured patients?

Publication – May 20, 2017

Christopher Lam, M.D.
-Resident

Mary Herman, M.D., Ph.D.
-Associate

Michael Murray, M.D. Ph.D.
-Associate

Department of Anesthesiology

Geisinger Commonwealth School of Medicine

Danville, PA

KEY POINTS

- ECMO may be indicated in patients with acute severe heart/lung failure associated with a high mortality despite optimal conventional therapy
- Relative contraindications include conditions incompatible for normal life if the patient recovers, pre-existing conditions affecting quality of life, patient size/age, and patients who are too sick or have a fatal diagnosis
- Advances in ECMO have facilitated the feasibility of use in trauma patients

When reviewing text books like Barash or Faust, a quick glance of the indexes in the back would redirect you to either the pediatric chapters discussing the use of extracorporeal membrane oxygenation (ECMO) for neonatal respiratory failure, or use after repair of congenital heart defects.1 They may quote the CESAR trial in support of using ECMO in patients with "severe but potentially reversible respiratory failure whose Murray score exceeds 3.0 or who have a pH of less than 7.20 on optimum conventional management."2 Trauma patients are some of the sickest patients in the hospital, so why not routinely place trauma patients on ECMO as well?

Such an innocent question is a controversial one. ECMO was first pioneered in the 1970's with mixed results when it was used because of a survival rate of only 10-15%.3 Originally used as a way for oxygenation only, in the mid 1980's CO2 removal was incorporated into the technology. With the advent of CO2 removal, the lung could be rested, and survival rates improved to 48%, though hemorrhage (a major complication related to the need to anti-coagulate the circuit) remains a major problem. The efficacy of ECMO has improved with modern advances including: heparin coated tubing to reduce device malfunction because of clotting, magnetic centrifugal impeller systems as opposed to traditional roller pumps, and percutaneous access compared to open vascular access, as well as, increased clinical expertise gained during the 2009 H1N1 epidemic.

One of the major indications for ECMO use is in patients with acute severe heart/lung failure associated with a high mortality despite optimal conventional therapy; the decision to use ECMO however, is specific to each patient.4 Generally, ECMO is considered as a treatment modality when the predicted mortality is >50% and is indicated in most circumstances when mortality is predicted to be 80% or higher.4 Most contraindications for ECMO are relative with the need for clinical decision making for risk versus benefit assessment on an individual patient basis. Relative contraindications include conditions incompatible for normal life if the patient recovers, pre-existing conditions affecting quality of life, patient size/age, and patients who are too sick or have a

fatal diagnosis.4 These guidelines offer a wide spectrum of interpretation, placing the decision for ECMO use in the hands of the clinician.

Vascular access for ECMO is determined by the therapeutic goal. When cardiac support is required, venoarterial access is necessary, due to the need for flow rates of 3 L/M^2/min or higher (neonates 100 ml/kg/min, pediatrics 80 ml/kg/min, adults 60 ml/kg/min). If respiratory support is needed, venoarterial or venovenous access is sufficient though venovenous access is preferred as there are more complications with arterial cannulation, including potential systemic emboli. If CO2 removal is required, arteriovenous access is preferred (typical blood flow approximately 25% of cardiac output).4 Often, vascular access sites are limited in trauma patients due to their mechanism of injury and injury profile.

Several retrospective studies have evaluated the use of ECMO in trauma patients. Ahmad et al performed a 9-year single center retrospective chart review of 39 patients that underwent venovenous cannulation with ECMO. Of those patients, 44% survived to discharge. Of the survivors, 71% sustained non-penetrating injuries and 29% sustained penetrating injuries with a median age of 28 for the entire cohort. The median age was 35 in the survivor cohort with median BMI of 25.4 kg/M^2 compared to BMI of 27.3 kg/M^2 in the non-survivors.5

Ull et al performed a similar retrospective single center study evaluating the outcomes of ECMO use in trauma versus non-trauma patients. Overall 99 patients were evaluated (venoarterial and venovenous cannulations), 49 in the trauma cohort and 50 in the non-trauma cohort. The median age of the trauma cohort was 49.9 with median BMI 27.7 kg/M^2 while in the non-trauma cohort the median age was 57.1 with median BMI 32.5 kg/M^2. Interestingly, the ICU survival rate (69.4% v. 26%) and the hospital survivor rate (65.3% v. 26%) were higher for the trauma patients (along with a greater ICU length of stay (24 days v. 11.3 days) and hospital length of stay (46.6 days v. 21 days)). The authors suggested that the main reason for this difference might be the median patient age. The trauma patients had more nosocomial infections though there was no difference in the incidence of primary and nosocomial infections in the lower respiratory tract between either group. Bleeding was not a major complication for either cohort.6

In the past, trauma patients have not been considered candidates for ECMO because of the risks of bleeding; however, with modern advances, these risks have been reduced. Robba et al presented a case series with a systemic review of the literature of trauma patients receiving venovenous ECMO in the neuro critical care unit evaluating different anticoagulation therapies.7 Overall 39 patients were

evaluated; 16 received heparin boluses of which 3 developed major bleeding complications when given heparin to a target goal of ACT > 150. Four patients evaluated in this series died but death was never directly or indirectly related to ECMO use. One of the patients was treated with heparin free ECMO tubing but subsequently developed clots in the inferior vena cava and was started on heparin without subsequent cardiac or pulmonary thromboembolic events. The authors concluded that ECMO is safe in trauma patients. In trauma patients at high risk of bleeding, heparin free ECMO systems should be initially used while moderate risk patients should be given heparin with goal ACTs >120 but < 1407.

Though definitive use of ECMO in trauma patients remains controversial, it is a useful mode of treatment for acute severely sick patients. Decision for use needs to be individualized but studies have shown, with modern advances, ECMO can be a viable option for patients refractory to optimal conventional treatments. Though not without risks, sometimes ECMO may be the only remaining viable option, and has been associated with good outcomes in trauma patients.

References

1. Edited by Michael J. Murray; associate editors, Steven H. Rose, Denise J. Wedel, C. Thomas Wass, Barry A. Harrison, Jeff T. Mueller. Faust's Anesthesiology Review. Philadelphia, PA: Saunders, 2015. Print: p 539.
2. Peek GJ, Mugford M, Tiruvoipati R, Wilson A, Allen E, Thalanany MM, Hibbert CL, Truesdale A, Clemens F, Cooper N, Firmin RK, Elbourne D. "Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial." Lancet 2009, 374:1351-1363. [1].
3. Zonies D. "ECLS in trauma: Practical application and a review of current status." World J Surg 2016: 1-6.
4. Extracorporeal Life Support Organization. "General Guidelines for all ECLS Cases, Version 1.3." Nov 2013. https://www.elso.org/Portals/0/IGD/Archive/FileManager/929122ae88cusersshyerdocumentselsoguidelinesgeneralalleclsversion1.3.pdf. Accessed 23 Mar 2017.
5. Ahmad SB, Menaker J, Kufera J, O'Connor J, Scalea TM, Stein DM. "Extracorporeal membrane oxygenation after traumatic injury." J Trauma Acute Care Surg 2016, 82(3): 587-591.

6. Ull C, Schildhauer TA, Strauch JT, Swol J. "Outcome measures of extracorporeal life support (ECLS) in trauma patients versus patients without trauma: a 7-year single-center retrospective cohort study." J Artif Organs 2016, 1-8.
7. Robba C, Ortu A, Bilotta F, Lombardo A, Sekhon MS, Gallo F, Matta BF. "Extracorporeal membrane oxygenation for adult respiratory distress syndrome in trauma patients: A case series and systematic literature review." J Trauma Acute Care Surg 2016, 82(1): 165-173.