

Role of ECMO for Organ donation

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I thank the Editors of JACCR for giving me the opportunity to decode the myth on this very unique, unexplored territory with immense potential in the future of liver and kidney transplantation.

ECMO (extracorporeal membrane oxygenation), also called ECLS (extracorporeal life support), in its actual application is an evolution of the heart-lung machines used in cardiac surgery. Depending on its configuration – venovenous or venoarterial – it is used to support either respiratory function, circulation, or both. Being a bridge therapy, it facilitates the healing of the natural organs or limits further damage to other vital organs such as kidney, liver, brain etc., due to hypoxia and low cardiac output state.

ECMO has now become an extension of critical care armamentarium and also the spectrum of indications are widening, becoming more dependant on the clinical picture of the patient at presentation. With improved technology, the contraindications to ECMO are decreasing. As it is only a bridge to recovery, mortality rate may still be significant if the diseased organ does not heal. The therapy requires cannulation of major blood vessels and anticoagulation to prevent coagulation and support circulation through an external circuit and oxygenator.

India as a country is experiencing an explosion in the use of ECMO and developing ECMO programs. As the infrastructure required to support an ECMO program is the same as that for a transplant program more and more transplant centers will also develop into ECMO centers. Hence it is inevitable that the applications of ECMO will extend to

organ donation and use in post-transplant patients.

Is there a role for ECLS in the Transplant program? The answer is YES.

ECMO may be beneficial in both organ donation to improve the quality of organs retrieved) as well as organ recipients but needs careful deliberation of the technical, ethical, economical and legal aspects. The world over ECMO has been beneficially employed in liver transplantation but the rules pertaining to ethical legal, financial and logistic aspects differ in every country and India is yet to explore this uncharted territory with its huge potential on the transplant program.

Organ donation in India is acceptable only after brain death has been certified as per the Transplantation of Human Organs Act (THOA) 1994 and its amendments of 2014, which defines and legalizes the concept of brain death testing and certification. Donation after circulatory death is still not accepted unless it is in a Maastricht type IV where a brain-dead patient suffers a circulatory collapse in the hospital.

As the topic is very extensive, it would be pertinent to explore the scope of ECMO in organ donation which includes

- **Patients on ECMO who become brain dead**
- **Potential brain-dead donors who become unstable during the waiting period to improve organ quality till retrieval (Organ preserving ECMO)**
- **ECMO assisted DCD (donation after circulatory death) - To decrease warm ischaemia time and ensuing damage to organs.**

Brain death in a patient on ECMO - Consideration for as organ donor?

Intra Cerebral bleeds or thromboembolic infarction are major lurking complications in a patient on ECMO. This may be a reason for the withdrawal of ECMO support if the patient is deemed brain dead on ECMO. Such a patient then would be taken off ECMO but could be considered for organ donation.

The same ethics apply as those regarding withdrawal / continuation of ventilator care on a brain-dead patient for organ donation. Consent for donation is a must from kin or pre-morbid consent of patient from national registry.

Bronchard R et al¹ studied the National registry data of all donors after brain death in France and their organ recipients between 2007 and 2013. 109 kidneys, 37 livers, 7 hearts, and 1 lung were successfully transplanted from donors on ECMO. They concluded that brain dead donors on ECMO

were younger and had more severe intensive care medical conditions (hemodynamic renal biological and liver insults) - but no significant difference in graft survival at 1 year. Hence ECMO patients can be considered suitable for organ procurement.

Declaring brain death on ECMO

Combined with clinical testing Apnoea testing has been the cornerstone in Brain Death testing and declaration as per THOTA 2014. Apnoea testing also is the confirmatory test for brain death testing and certification. This is accomplished in patients on ECMO with certain modifications.

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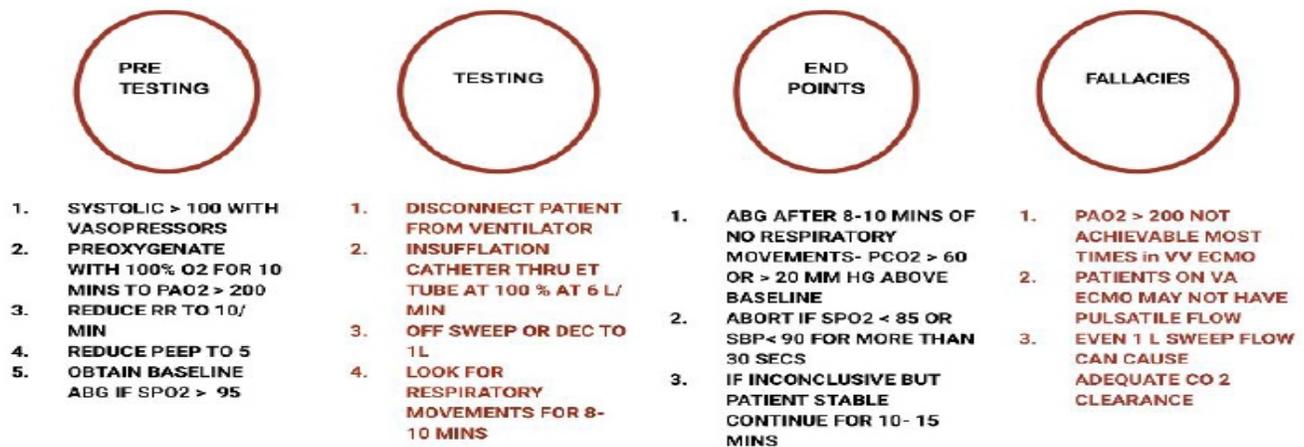


Fig 1. APNOEA Testing process

Kreitler J K et al 2 retrospectively studied variations in practices in brain death declaration, especially in regards to apnea testing, in patients on ECMO. This study represents the largest cohort of patients declared brain dead on ECMO. Their data confirmed the variations in clinical practice and use of ancillary testing such as TCD CBF EEG. Apnoea testing is performed on patients on ECMO by decreasing the sweep gas (oxygen flow to the ECMO machine) to either 1 or zero while giving O2 at 6 liters via a catheter through the ET tube.

This testing can be done only after clinical testing to confirm brain death as laid down by the law. Prior to testing the patient should fulfill all criteria in terms of body temperature, biochemistry etc. as per the THOA act.

Standardization is urgently needed to assure consistent, accurate brain death pronouncement in order to facilitate organ procurement when appropriate. Hence future brain death guidelines must incorporate the ECMO population.

Unstable brain dead potential donors for improving organ quality till retrieval (Organ preserving ECMO).

Brain death is often associated with cardiac failure, lactic acidosis, diabetes insipidus and ARDS which would lead to a need for high inotropes and ventilatory support leading to further hemodynamic instability and finally organ damage/death. The rate of organ donation in India is dismal due to a number of cultural and logistic barriers hence there is a need to get good quality organs once the family agrees for donation as we do not have

the luxury to reject organs. ECMO could play a role in stabilizing unstable donors preserving organ functions and thus decreasing warm ischemia time.

The timing of the institution of ECMO in the donor to decrease organ damage and improve the quality of donation is controversial and crucial.

Organ preserving ECMO - Organ-preserving extracorporeal membrane oxygenation (OP-ECMO) is defined as the use of extracorporeal support for the primary purpose of preserving organs for transplantation, rather than to save the patient's life.

Dalle Ave AL et al 3 in their paper discuss the ethics of using OP-ECMO in donation after determination of brain death (DBDD) to avoid the loss of organs for transplantation.

- ECMO is less invasive than the process of organ retrieval

Families who give consent for donation would support any technique which gives best utilisation of the donated organs. The use of OP-ECMO before the declaration of brain death confirmation, as described in some case reports 4, is problematic and can also be questionable on ethical grounds. ECMO increases the potential risks of intracranial bleeding and therefore could, in a not-yet brain-dead patient, hasten death. Because of the major risks of harm, we do not recommend the implementation of OP-ECMO before brain death has been established.

Hence ideal sequence of events would be the determination of brain death, consent of family for donation, OP ECMO to stabilize till retrieval of organs.

Donation after circulatory death-

ECMO assisted DCD can decrease the warm ischemia time and with normothermic perfusion can be used to reverse the depletion of ATP during the warm ischemia time and assess the organ function before transplanting.

The increasing demand for transplantation has led to a significant explosion in the utilization of donors after circulatory death (DCD). In countries where DCD is permitted, DCD as a percentage of all cadaveric donors has risen in the last decade. In DCD patients are usually taken near OT allowed with family and if death occurs within stipulated time which varies with organ, there is any touch time. Then rushed into theatre, intubated, and incision to clamp aorta.

Organs from DCD donors are subjected to a variable degree of hypotension and hypoxia after the withdrawal of life-supporting therapy (WLST) during the agonal phase (WLST to asystole time) + mandatory period of warm ischemia after asystole ('no-touch time') and a subsequent period of cold ischemia during storage and transportation. The cumulative effects of these insults and the resulting injury to the donor organs are difficult to quantify.

ECMO initiated after the mandatory no touch period (which may vary from 5 mins in most countries to as long as 20 mins in Italy) allows withdrawal of life support in the ICU which in standard DCD is not possible as the retrieval needs to be hurried to limit warm ischaemia time. The donor then taken to OT on ECMO support. During DCD the aorta

organs selectively perfused. In ECMO assisted DCD a retrograde balloon is used in the ascending aorta above the diaphragm to prevent circulation to the heart and brain.

ECMO helps with cold perfusion of organs faster thus reducing warm ischaemia time.

ECMO can use normothermic perfusion to replenish the cellular ATP which is depleted during the warm ischemia time and give time to test the organs in situ with physical and laboratory tests.

Dalle Ave AL, et al 5 considered the ethical issues of ECMO in DCD. These include :

- Use of Premortem Cannulation and Systemic heparinization (timing of ECMO)
- Variable definitions of the standoff times (mandatory no touch period)
- The theoretical possibility of Restoration of cerebral perfusion and Cardiac reanimation during RP (use of retrograde balloon versus clamping of the aorta to prevent cardiac and cerebral circulation as balloon may rupture)
- Ethico Legal framework of each country (every country has different cultural beliefs and definition of death)

- No common worldwide consensus possible

Considerations in the Indian scenario and changes needed to increase the donor pool and organ quality

ECMO in India is new and needs a lot of counseling to convince a family for Organ donation especially so, after failed ECMO it becomes even more challenging. The role of the intensive care team in counselling for same is crucial.

OP- ECMO in brain dead unstable donor needs expertise infrastructure and money, in addition also involves convincing the family of the deceased as well as the recipient, as the organs may still not be good enough to transplant.

DCD in India has been practiced in brain dead donors who pass away in ICU (uncontrolled) and are then rushed to the operating room while performing CPR for retrieval of organs.

As most families would be more open to organ donation after cardiac death, there is an urgent need to legalize controlled DCD (withdrawal of life support in patients who will not recover to normalcy but don't fit brain death criteria). As world experience shows ECMO assisted DCD retrieved organs

are better due to lesser warm ischemia time the legalization of ECMO assisted DCD is also the need of the hour.

Conclusion

India is lagging behind in embracing ECMO as a therapeutic modality into ICU care. Adopting the international experience in all applications of ECMO such as ECPR (ECMO CPR), Transport on ECMO of unstable patients, ECMO for organ donation seems to be the way forward for India also. For organ donation to increase a starting point would be to rewrite and standardise protocols for and add legislation to support

- Apnea testing while on ECMO
- Declaration of brain death on ECMO
- Inclusion of ECMO patients as donors
- ECMO for organ preservation

Also to increase donor pool and improve the retrieved organ quality we will have to go beyond educating public and actually include donation after circulatory death in a controlled setting with ECMO support.

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