VA ECMO weaning using continuous hemodynamic transesophageal echocardiography

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Background: Venoarterial extracorporeal membrane oxygenation (VA ECMO) has been used for profound cardiogenic shock to bridge to decision, ventricular assist device(s) (VADs), or transplant. To assess ventricular function and volume status along with hemodynamics during ECMO weaning, we developed a standardized weaning protocol, guided by a miniaturized transesophageal echocardiography probe designed for continuous hemodynamic monitoring (hemodynamic transesophageal echocardiography [hTEE]). We reviewed our experience with this weaning protocol with hTEE guidance to assess if we could predict patient outcomes.

Methods: During the academic year of 2011, hTEE-guided ECMO weaning was performed in 21 patients on VA ECMO. Left and right ventricular function and volume status were assessed by continuous hTEE, while attempting to wean ECMO after a standardized protocol. The clinical outcomes, management, and positive predictive value of the device were investigated and analyzed for this cohort of patients.

Results: Of the 21 patients, six (29%) had left and right ventricular recovery and underwent optimal medical therapy or revascularization for underlying coronary artery disease; seven (33%) had non recoverable left and right ventricular function; and eight (38%) had right ventricular recovery without improvement of the left ventricular function. These eight patients underwent left VAD placement; none subsequently developed profound right ventricular failure. The positive predictive value for ventricular recovery by hTEE was 100% using our standardized ECMO weaning protocol (95% confidence interval, 73%-100%).

Conclusions: The hTEE-guided ECMO weaning protocol accurately predicted the ability to wean ECMO to decision. This protocol can be applied by cardiac intensivists as a part of standard bedside intensive care unit assessment.

Note: In this study, "hTEE" refers to hemodynamic ultrasound.

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VA ECMO weaning protocol using hTEE

STAGE	ACTIONS
Before weaning **Insert hTEE probe**	• Patient euvolemic and afebrile, chest x-ray film clear, end organ injury resolved. Increase heparinization for PTT goal of 60-70 seconds.
Stage 1	• Baseline assessment of right and left ventricular function with full ECMO flow.
Stage 2	• Decrease flow from full to half flow in increments of 0.5L/min. • Assess LV and RV function by hTEE over at least 30 minutes after each decrease. • If distention occurs, return to full flow and abort trial.
Stage 3	• Volume load (10 mL/kg) over 20 minutes, with half flow, and assess RV and LV function by hTEE over at least 1 hour.
Stage 4	• Load inotrope (dobutamine and/or milrinone), • Decrease flow to minimum (1-1.5/min), and assess LV and RV function for at least 1 hour.
After weaning assessment	• If biventricular failure persists, consider evaluation for total artificial heart placement end-of-life discussion. • If LV dysfunction persists but RV function is recovered, consider LVAD insertion. • If RV dysfunction persists but LV function is recovered, consider external RVAD. • If LV and RV functions are recovered, consider ECMO de-cannulation.
After weaning	• Return to full flow and discuss timing of surgical intervention.

VA, Venoaerterial; ***ECMO***, extracorporeal membrane oxygenation; ***hTEE***, hemodynamic transesophageal echocardiography; ***PTT***, partial thromboplastin time; ***LV***, left ventricle; ***RV***, right ventricle; ***LVAD***, left ventricular assist device; ***RVAD***, right ventricular assist device.

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