
EFFICACY OF FLOW MONITORING DURING ECMO

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ABSTRACT

Background. To assess whether blood flow monitoring can serve as an effective indicator of oxygenator obstruction during extracorporeal membrane oxygenation (ECMO). Currently, elevated pressure drop across the oxygenator is considered the indicator for oxygenator obstruction. If shown to be as effective, flow monitoring can be safer, hands-free and continuous.

Methods. The ECMO circuit can be easily modified to include a shunt that bifurcates from the main line distal to the cardiac pump but proximal to the oxygenator returning a small amount of blood back to the pump with access points for drug infusions and blood parameter sensors. The underlying principle of the proposed approach is that, distal circuit obstructions (oxygenator and beyond) will result in a slight diversion of flow from the distal line to the shunt. Thus, flow through the shunt quantified as the flow drop between proximal and distal to the shunt bifurcation can serve as a marker for distal circuit obstruction. In this laboratory investigation, an existing ECMO circuit was adapted by including over-the-tube ultrasonic flow sensors at appropriate locations and a resistance chamber that simulates controlled and varying levels of oxygenator obstruction. Upon establishing the reliability of sensors and simulations involved, experiments were conducted under pediatric and adult pump target flow rates (500 mL/min through 5000 mL/min) simulating three different levels of oxygenator obstructions (mild, moderate and severe). Both flow drop and pressure drop were documented under all conditions of pump target flow rates and simulated oxygenator obstructions.

Results. There was clear and measurable elevation in flow drop at all flow rates with increasing obstruction from baseline values. These elevations were statistically significant under Wilcoxon signed rank test ($p < 0.05$) for all levels of obstructions (mild, moderate and severe) and for all pump target flow rates (500, 1000, 1500, 2000, 3000, 4000, 5000 mL/min) as did the conventional marker, pressure drop. Unlike a pressure drop threshold, flow drop threshold needs to be normalized to pump flow rate in order to be effective.

Conclusions. The elevation in flow drop due to oxygenator obstruction in the ECMO circuit is measurable. Because flow monitoring is over the tube, continuous and easy to implement, flow monitoring has the potential to serve as a more effective early indicator of obstruction in the ECMO circuit.