QMJ
A peer reviewed journal
QATAR MEDICAL JOURNAL

4th Annual ELSO-SWAC Conference Proceedings

The small circuit pump, oxygenator, and surface coating

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http://dx.doi.org/10.5339/qmj.2017.swacelso.77

Cite this article as: Ogino MT. The small circuit pump, oxygenator, and surface coating, Qatar Medical Journal, 4th Annual ELSO-SWAC Conference Proceedings 2017:77 http://dx.doi.org/10.5339/qmj.2017.swacelso.77

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Dr Robert Bartlett is the pioneer surgeon credited for moving extracorporeal life support (ECLS) from the operating room to the intensive care unit (ICU), where the therapy has given hope for survival to thousands of neonates, children, and adults with respiratory and/or cardiac failure. Dr Bartlett describes the ECMO timeline as ECMO 1 (1990 – 2008) and ECMO 2 (2008 – present).[1] The first phase of ECMO utilized individual components, designed for other uses, assembled together to provide ECLS at the bedside. Circuit monitoring used equipment engineered for other functions, and hence, the need for clinical personnel to oversee the delivery of this technologically complex therapy was extensive. ECMO 2, the second phase in which we are currently practicing has been revolutionized by low-resistance oxygenators, centrifugal technology, and bicaval catheters that can be placed using the Seldinger technique.[2] ECMO systems are now integrated, simplified, self-monitoring, and self-regulating, and have allowed for changes in the bedside model of care. A remaining challenge in providing ECLS is the systemic inflammatory response (SIR) induced by blood exposure to the artificial circuitry. The renal, pulmonary, and neurologic dysfunction seen after cardiopulmonary bypass (CPB) has been attributed to the SIR.[3] The development of miniaturized extracorporeal circuits (MECC) with reduced tubing length, smaller oxygenators, biocompatible coatings, and fewer components are hypothesized to reduce the blood – foreign surface contact area, and hence, reduce the SIR. A possible breakthrough in the reduction of a SIR may allow transition into the next era of ECMO care. Published reports have shown laboratory evidence that MECC application in CPB blunts the systemic inflammatory response with decreases in C-reactive protein (CRP), leukocytes, and cytokines (IL-6, IL-8, TNF), SC5b-9 (an inflammation complement complex), and activated neutrophil factors.[4] In studies evaluating the clinical outcome of patients who have undergone ECLS with MECC, the benefit remains debatable with respect to 30-day mortality, neuro-cognitive disturbance, cerebrovascular events, renal failure, and myocardial infarction. In the outcome criteria of ventilation period, hospital stay, and ICU stay, MECC showed benefit.[5] In the meta-analysis report by Harling *et al*., the authors found other clinical benefits with MECC, which included the reduction in blood production transfusions.[6]

The use of MECC for prolonged ECLS has not been extensively reported in the literature, and may be related to the functional longevity of the oxygenator. A small number of case reports have been published and a conclusion cannot be made from the current level of MECC experience for its use as an alternative equipment option in ECMO. Further research in this area will be necessary before MECC can be clinically adapted for ECMO.

Keywords: miniature extracorporeal circuits, systemic inflammatory response, cardiopulmonary bypass, surface coatings, heparin

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