Acute In Vivo Performance Of A Pediatric Ambulatory Artificial Lung

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Study: Respiratory failure is a significant source of pediatric morbidity and mortality. Current means of respiratory support typically render patients bedridden which can worsen long term patient outcomes. Our Pittsburgh Pediatric Ambulatory Lung (P-PAL), and second generation Pediatric Modular Extracorporeal Lung Assist System (P-ModELAS), are integrated pediatric pump-oxygenators that enable ambulation. Our device is intended for long-term use and designed to provide up to 90% of respiratory support for 5–25 kg children. This study aims to characterize the device performance in an acute ovine model.

Methods: The functional difference between the two devices is a shortened blood flow channel connecting the pump and bundle in the P-ModELAS. Both prototypes use a centrifugal pump and a cylindrical, stacked fiber bundle (0.3 m2). In vivo device performance was evaluated in 6 acute (4.5 - 6 hrs) studies using 23 - 32 kg sheep. A thoracotomy was performed to place a venous cannula in the right atrium and an arterial cannula in the pulmonary artery. The cannulas used varied in the first 4 studies as we refined our implant strategy. Trials 1 - 4 used the P-PAL and trials 5 - 6 used the P-ModELAS. Oxygen transfer rates were measured at blood flows from 1 to 2.5 L/min. Bundle resistance, plasma free hemoglobin and animal hemodynamics were measured throughout the study. ACT was maintained between 1.2 - 4.1 times baseline.

Results: There was no statistical difference between the P-PAL and P-ModELAS performance. Oxygen transfer rates ranged from 39.9 - 83.4 mL/min (Hb = 6.2 ± 0.3 g/dL) at blood flows of 1 - 2.5 L/min. Blood flow in one study was limited due to a venous cannula occlusion. Changes in the implant strategy remedied this. The plasma free hemoglobin remained low and ranged from 5.8 - 10.4 mg/dL. Macroscopic evaluation of the bundle post study showed small thrombi in four studies. One device failed due to poor priming. Based on our successful acute studies, we will move to chronic studies to further evaluate device hemocompatibility