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Hospital Survival and Financial Metrics in Adults Requiring Veno-Arterial Extra-Corporeal Membrane Oxygenation

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Study: Veno-Arterial Extra-Corporeal Membrane Oxygenation (ECMO) is commonly utilized for cardio-vascular support. The therapy, however, consumes a large amount of hospital resources. Further, with the advent of newer technology, ECMO can safely be continued for longer periods of time. We sought to understand the effect of ECMO support for greater than eight days on survival and hospital financial metrics.
Methods: The outcomes from patients > 18 years of age, who were determined to be unsuitable for a ventricular assist device and were therefore supported using VA-ECMO, were reviewed from 2010–2013. Clinical outcomes were determined from in-patient chart review. Hospital expense and contribution margins were determined from data obtained from hospital finance. Total variable expense was the sum of all variable expenses generated during the patient's hospitalization. Contribution margin was defined as total patient revenue minus total variable expense. Patients were divided into two groups depending upon the duration of ECMO support (Group I: ECMO support for 8 days or less, Group II: ECMO support for greater than 8 days).
Results: A total of 53 adults were supported using ECMO. There was no difference in age or gender between groups. Survival to discharge was not different between groups (Group I: 41% (16/39) Group II: 42% (6/14)). The average total variable expense and contribution margin for ECMO/day was $12,558 ± 9,948 and $58,916 ± 61,355 respectively. Subsequently, the total variable expense was significantly lower within group I ($58,583 ± 59,669 vs. $99,297 ± 63,503; p=0.01), while the contribution margin was significantly greater within group I ($106,493 ± 59,140 vs. $ 51,093 ± 49,459; p=0.01). This suggests that ECMO duration for greater than 8 days does not improve survival, but vastly increases the amount of financial resources required. This becomes more relevant as newer ECMO equipment and techniques have enabled longer duration of support.

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Preservation of High Molecular Weight vWF and Low Hemolysis With the Low Shear TORVAD™ Ventricular Assist Device

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Study: The TORVAD™ is a positive displacement ventricular assist device (VAD) that synchronizes with the cardiac cycle to deliver full support to a failing heart with a 30 ml counterpulse ejection. Pumping is achieved by independently moving two pistons within a toroidal chamber. The gap between the piston and torus wall is controlled using ceramic hydrodynamic bearings. Controlled gaps and low rotational speeds (90–180 rpm) result in low shear (10–50 Pa), an order of magnitude less than the shear in continuous flow (CF) VADs. Preliminary *in vitro* experiments have been conducted to determine the effects of low shear on blood damage.
Methods: Bench top blood damage experiments were conducted with fresh whole human blood in a test circuit. An FDA-approved CF VAD was used as a control. The TORVAD™ was set to operate at 4 L/min, producing a dynamic pressure maximum of 140 mmHg and an average pressure of 60 mmHg. The CF VAD produced a flow rate of 3.8 L/min and pressure of 60 mmHg.
Results: Hemolysis, quantified using the normalized index of hemolysis (NIH), was 0.001 g/100L for the TORVAD™ and 0.013 g/100L for the CF VAD. Von Willebrand Factor (vWF) multimers were analyzed by separation of vWF into its multimeric components using sodium dodecyl sulfate agarose electrophoresis. Densitometry analysis was performed on the multimer band results to determine the ratio of high molecular weight (HMW) multimers (bands > 10 length) with respect to baseline. Shear in a CF VAD was associated with a loss of 70% of the HMW vWF, while the TORVAD lost 1% of the HMW vWF. These initial results demonstrate that blood components experience substantially less trauma with the TORVAD™ as compared to a commercially available CF VAD.