INNOVATIVE FREE-RANGE RESONANT ELECTRICAL ENERGY DELIVERY SYSTEM (FREE-D SYSTEM) FOR A VENTRICULAR ASSIST DEVICE USING WIRELESS POWER

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Purpose: Percutaneous drivelines limit mobility & freedom, are prone to damage, and need repeated interventions once infected; thus limiting the advantage offered by newer rotary pumps. The Free-range Resonant Electrical Energy Delivery (FREE-D) wireless power system uses magnetically coupled resonators to efficiently transfer power across *meter* distances. **Methods:** Experimental set-up consisted of a transmitter (Tx) and receiver coil (Rx) with close wavelength tuning. Experiments included power delivery with a static, one meter separation distance between Tx and Rx coils, monitoring of temperature of the Rx coil and delivery via relay coils for various Rx coil sizes. **Results:** The power was delivered over a one meter distance without interruptions or fluctuations with coil, rectifier and regulator efficiency over 80% and overall system efficiency of 54%. The axial pump was set at 9400 rpms and worked well throughout the 8 hours of continuous operation. The implantable component in the setup showed a rise of temperature from 71 F to 82 F over first hour and remained static thereafter. **Conclusions:** FREE-D system offers power delivery over an unrestricted space and improved quality of life due to tether free existence. Absence of driveline has the potential to reduce adverse events and prolong survival. **Summary:** Percutaneous drivelines limit mobility & freedom,



are prone to damage, and need repeated interventions once infected; thus limiting the advantage offered by newer rotary pumps. The Free-range Resonant Electrical Energy Delivery (FREE-D) wireless power system uses magnetically coupled resonators to efficiently transfer power across meter distances to a Ventricular Assist Device (VAD) implanted in the human body. An adaptive frequency tracking method refines efficiency upwards of 70% for nearly

any angular orientation over a range of distances. FREE-D system can offer an unrestricted space with tether free operation in a VAD patient and affords advantage over current technology in reducing adverse events and improvement in quality of life.

FLUIDIC PERFORMANCE VIA INTRINSIC PARAMETERS OF A MAGNETICALLY LEVITATED AXIAL FLOW VAD

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Background: We present the methods for real-time measurement of fluidic parameters using the intrinsic pump signals of the LEVitated impeller Ventricular Assist Device (LEV-VAD). Each of these fluidic parameters; heart rate, blood flow rate, and differential pressure across a ventricular assist device may be used clinically to assess patient health or pump status, including flow obstructions. The pump eliminates the need for dedicated sensors to measure the parameters because they are readily calculated from pump magnetic bearing control signals. Methods: The pump was tested in vivo in order to generate a comparative analysis between direct measurement of parameters (pressure, flow, heart rate) and intrinsic measurements using the pump signals. During surgery, Left Ventricular and Arterial pressures were monitored as a means to deduce the actual dP across the pump. Pump flow was measured with an ultrasonic transducer. Measurements of pressure and flow rate based on the intrinsic algorithm were compared to measured rates as the pump rotational speed was adjusted over the anticipated range of operating conditions. Additionally, one flow probe remained on one calf for 1 week. **Results:** The analysis shows a highly significant correlation within the target operating conditions in vitro and in vivo. Additionally, the intrinsic flow and pressure measurements may be used to detect flow obstruction within the pump or poor left ventricle filling.

EMERGENT VERSUS NON-EMERGENT HEARTMATE II LEFT VENTRIC-ULAR ASSIST DEVICE IMPLANTATION

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Purpose: We sought to determine the outcomes of patients (pts) undergoing HeartMate II (HMII) left ventricular assist device (LVAD) implantation under emergent or non-emergent conditions. Methods: We analyzed data from 188 pts who received the HMII from 11/2003 to 9/2010. Pts who were in the intensive care unit (ICU) due to cardiogenic shock, need for additional inotropic therapy, or for an intraaortic balloon pump (IABP) or other short-term assist device, with intractable arrhythmia and need for mechanical ventilation were regarded as emergent. Results: Emergent pts (107 men, 36 women; aged 50±15 y) in comparison to non-emergent pts (37 men, 8 women; aged 53±14 y) required significantly (P<0.04) more IABP support (49% vs 11%); mechanical ventilation (17% vs 0%); had previous open heart surgery (52% vs 25%); were enrolled as destination therapy (45% vs 27%), and were previously on HeartMate XVE support (24% vs 0%). Before LVAD implantation, emergent pts had a lower hemoglobin (11.7±2.0 vs 12.6±2.1 g/dL) and platelet count (197 \pm 79 vs 250 \pm 119 K/ μ L) and a higher white blood cell count (9.6 \pm 4.1 vs 8.2 \pm 3.2 K/ μ L) and partial thromboplastin time $(40\pm16 \text{ vs } 32\pm11 \text{ sec})$ than non-emergent pts. After LVAD receipt, they stayed longer in ICU $(9\pm7 \text{ vs } 6\pm4 \text{ d})$ and had more device-related infections (19% vs 7%). Thirty-day survival was 82% vs 100%, 180-day survival was 68% vs 96%, and 1 year survival was 62% vs 95% in emergent vs non-emergent pts. Conclusion: As expected, outcomes were better in pts who had an LVAD implanted under non-emergent conditions, before deteriorating end-organ function necessitated more emergent LVAD implant. Timely LVAD placement in these patients is recommended.

SINGLE CENTER CLINICAL OUTCOMES OF HEARTMATE II CONTIN-UOUS-FLOW LEFT VENTRICULAR ASSIST DEVICE

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Purpose: We summarize our experience with the HeartMate II (HMII) axial-flow left ventricular assist device (LVAD). Methods: From 11/03 to 6/10, we implanted HMII LVADs in 171 patients (pts) for bridge- totransplant (n=108) or destination therapy (n=63). We analyzed hemodynamic traits, end-organ function, adverse events, mortality, and preversus postoperative laboratory values (Table). Results: Of the 133 men and 38 women (age 51±11 y), 79 pts (46%) had previous open heart surgery, 75 (44%) had ischemic cardiomyopathy, 61 (36%) had diabetes. Thirty-two pts had a former HeartMate XVE (n=30) or Jarvik 2000 (n=2) exchanged for the HMII. The support period was 436±391 d (range 1-1635) for the HMII. Thirty-six pts had a heart transplant and 11 other pts were successfully weaned from the device. Neurologic events occurred in 20 pts (11%), 8 of whom had had an XVE. Twenty-eight pts (16%) had device related infection and 10 pts had gastrointestinal bleeding from an arteriovenous malformation. All discharged pts were in NYHA functional class I. No pump failures occurred. One-year survival, excluding 22 perioperative deaths (<30 d), was 83%.

Table 1.

	Pre-LVAD	3 mo	6 mo	12 mo
Sodium BUN Creatinine SGOT SGPT T bilirubin Albumin	$\begin{array}{c} 136 \pm 5 \\ 29 \pm 17 \\ 1.4 \pm 0.7 \\ 75 \pm 98 \\ 66 \pm 130 \\ 2.4 \pm 4.2 \\ 3.6 \pm 0.8 \end{array}$	$\begin{array}{c} 139 \pm 4^{*} \\ 23 \pm 21^{*} \\ 1.3 \pm 0.8 \\ 35 \pm 26^{*} \\ 30 \pm 23^{*} \\ 1.4 \pm 5.1 \\ 4.0 \pm 0.6^{*} \end{array}$	$139 \pm 3^*$ $23 \pm 15^*$ 1.4 ± 0.8 $37 \pm 25^*$ $33 \pm 28^*$ 0.8 ± 1.5 $4.1 \pm 0.5^*$	$139 \pm 3^*$ $22 \pm 11^*$ 1.3 ± 0.4 $33 \pm 14^*$ $30 \pm 26^*$ $0.7 \pm 0.3^*$ $4.3 \pm 0.4^*$

Conclusions: Because of their reliability, durability, and dependability, axial-flow LVADs. have markedly improved the surgical treatment of terminal heart failure. *Significantly different (P<0.036) from pre-LVAD level.