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Reviews:

[Blood Pressure Control in Continuous Flow Left Ventricular Assist Devices: Efficacy and Impact on Adverse Events.](#)

Lampert BC, Eckert C, Weaver S, Scanlon A, Lockard K, Allen C, Kunz N, Bermudez C, Bhamra JK, Shullo MA, Kormos RL, Dew MA, Teuteberg, JJ. *Ann Thorac Surg.* 2014 Jan;97(1):139-46.

This study investigates patients implanted with continuous flow LVADs at a single institution to assess the effects of an outpatient blood pressure control protocol. Retrospective data on 96 patients supported at least 30 days was analyzed. Blood pressure was monitored by Doppler probe. Outpatient management of blood pressure was conducted in accordance with an institutional protocol with a goal mean arterial pressure (MAP) of 80 mm Hg. The opening pressure on Doppler assessment was defined as the MAP for the purposes of the study. Patients with both axial flow and centrifugal flow devices implanted for both bridge and destination therapy were included. Adverse events were defined by the Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS) criteria. Progression of aortic insufficiency (AI) was determined by the Echo closest to implantation and the echo closest to last follow up.

On monthly assessment, blood pressure was near goal, with no significant difference between axial and centrifugal flow pumps. 74% of patients required anti-hypertensives after implantation with 54% requiring 1 medication, 35% 2 medications, 10% 3 medications, and 3% 4 or more medications. 36% of patients not on anti-hypertensives died, compared to 12% of patients on medication. 31 neurological events in 23 patients were recorded. Patients on no anti-hypertensives had a significantly higher rate of neurological events. In patients on anti-hypertensives, the number of medications was not associated with a difference in neurological events. With utilization of this blood pressure protocol there was a very low rate of development of AI or progression of existing AI. The two-year freedom from more than mild AI was lowest in the group not on anti-hypertensives, who illustrated a lower MAP pressure overall when compared to the group on medication.

As we support patients longer with LVADs medical management to reduce adverse events becomes more important. The ISHLT guidelines recommend management of blood pressure in patients with mechanical circulatory support. This study shows successful control of blood pressure and a low rate of progression of AI with an outpatient protocol. Blood pressure in the majority of patients was well controlled with 1-2 medications. Interestingly, death and adverse neurological events were higher in patients who did not require antihypertensive therapy. This suggests that low mean arterial pressure after continuous flow LVAD, may be a surrogate for higher risk patients. Varying goal blood pressures were not evaluated and further study should be conducted to determine the lowest risk goal MAP.

[An Analysis of Pump Thrombus Events in Patients in the HeartWare ADVANCE Bridge to Transplant and Continued Access Protocol Trial.](#)

Najjar SS, Slaughter MS, Pagani FD, Starling RC, McGee EC, Eckman P, Tatroles AJ, Moazami N, Kormos RL, Hathaway DR, Najarian KB, Bhat G, Aaronson KD, Boyce SW. *J Heart Lung Transplant.* 2014 Jan;33(1):23-34.

This study is an investigation of pump thrombus events in the combined Heartware ADVANCE bridge to transplant (BTT) trial and continued access protocol (CAP) cohorts. This study excludes peri-operative events related to implant, examining events occurring > 72 hours after surgery. Thrombus was defined by alterations in pump

parameters, increased lactate dehydrogenase or plasma free hemoglobin, visualized thrombus after pump exchange, and abnormal pump sounds on auscultation. 382 patients were implanted with the HVAD as BTT in the trial and CAP at 30 centers. During the trial, the device was modified to include sintering of a portion of the VAD inlet cannula to limit the panus formation. 71.2% of patients had non-sintered devices and 28.8% received sintered pumps. 34 pump thrombus events occurred in 31 patients. The overall rate of pump thrombus was 8.1% or 0.08 events per patient year. 4.2% of patients required pump exchange. The incidence of pump thrombus events was similar for the initial trial and CAP. Multivariate analysis identified MAP > 90 mm Hg, ASA dose \leq 81 mg, INR \leq 2.0, and INTERMACS score \geq 3 at time of implant as significant risk factors for pump thrombus. Average pump speed <2750 rpms and non-sintered pumps were borderline covariates but not statistically significant.

Medical therapy was the initial treatment in the majority of thrombus events (30/34) and was successful in resolving the thrombus event in 50% of cases. All 4 patients treated with initial pump exchange survived. Medical treatment varied and included single and multi-drug treatment including heparin, glycoprotein 2b/3a antagonist, and tPA given peripherally or catheter-directed. Regimens including tPA were 82% successful and regimens with 2b/3a antagonists without tPA were 50% successful. Heparin alone was found to be ineffective. Of the 15 patients who failed medical therapy 2 were transplanted, 12 went on to pump exchange with 4 deaths, and 1 died without exchange. Overall 30% of failed medical therapy patients died.

This study illustrates several interesting points regarding the on-going problem of pump thrombus. It supports the recognized importance of adequate anti-platelet therapy in VAD patients. Elevated MAP is an intuitive risk factor for stroke, but is less so for pump thrombus formation. Perhaps the increased MAP in an afterload-sensitive centrifugal pump results in less effective flow through the pump and decreased washing of the pump and inlet cannula. Regardless, as the authors suggest, this finding supports the recommendations of the ISHLT for blood pressure management in VAD patients. We will see whether the tighter control of blood pressure in the second phase of the Endurance trial decreases thrombus events, although this will be in a different population. Medical therapy was successful in 50% of patients with thrombus, but the mortality was 30% when it failed. There is growing support for aggressive VAD exchange in patients with pump malfunction and this study's discussion of medical management is an interesting contrast. Pump exchange in the HVAD is an easier option early after implantation when scar tissue has not formed. The increasingly popular sub-costal approach many centers, including our own, are employing for exchange of Heartmate II is a less likely option without a VAD pocket and a median sternotomy is needed for exchange. Please refer to Dr. Silvestry's report of eptifibatid for medical management of thrombus and Dr. Naka's report on VAD exchange in the bibliography below for further discussion.

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