Risk Scores For VAD Implantation

Katherine Lietz, M.D., Ph.D.

From the Cardiovascular Divisions,
Columbia-University Medical Center, New York, NY

February 8, 2009

Katherine Lietz, M.D. Ph.D.
Center for Advanced Cardiac Care
Columbia-Presbyterian Medical Center
PH12 Stem Rm 134
622nd West 168th Street
New York, NY 10032
Phone: 212-342-0730
Fax: 212-305-9264
Email: KL2384@columbia.edu

Introduction

Since there are very few prospective trials in patients who undergo LVAD placement as bridge to transplantation (BTT) and very little data on the long-term use of MCS as a permanent alternative to heart transplantation (HT), or destination therapy (DT), most of the patient selection criteria for LVAD therapy, including the criteria for DT published by the U.S. Centers for Medicare and Medicaid Services are very broad and based on clinical experiences of single centers and data collected by large multi-institutional registries.

Over the years, various VAD scores have been developed to improve selection of device candidates. The utility of these risk scales are reviewed in this talk, including the INTERMACS stratification, Heart Failure Survival Score (HFSS), the Seattle Heart Failure Risk Score, Right Ventricular Risk Score, Columbia-Cleveland Clinic Risk Score, APACHE II score (Acute Physiology and Chronic Health Evaluation) and Destination Therapy Risk Score. We place special emphasis on the DT Risk Score, which has been increasingly used in the recent years.

Selection of Candidates for LVAD Implantation

It is recommended that all patients undergo comprehensive evaluation prior to LVAD placement, which includes the following areas: (1) clinical assessment of severity of heart failure (clinical presentation, cardiopulmonary stress testing, hemodynamic studies), (2) cardiac and anatomic considerations (right ventricular function, arrhythmia,
anatomic and body size considerations), (3) non-cardiac considerations (coexisting life-limiting illnesses, psychosocial and age-related considerations), (4) assessment of transplant candidacy, and (5) assessment of LVAD operative risk.

The risk scales for VAD implantation are used to define the optimum timing for device implantation, as shown in the slide beneath, and are part of the above 5-step candidate evaluation, and in particular the assessment of severity of heart failure, right ventricular function and operative risk. We will, therefore, focus on these areas of candidate evaluation next.

Clinical Assessment of Severity of Heart Failure

Seven INTERMACS levels have been proposed to classify the different degrees of clinical severity of stage D heart failure, in patients with New York Heart Association class IV symptoms [13]. The INTERMACS levels and their corresponding survival and potential benefit from MCS as shown on the slide [10]. The INTERMACS stratification is one of the most helpful clinically indices to stratify the severity of heart failure in patients who reach the end-stages of pump failure.

The two most common indications for LVAD placement include: cardiogenic shock (INTERMACS level 1 – “crash and burn”) and worsening of symptoms in inotrope-dependent patients (INTERMACS level 2 -“sliding down on inotropes”), accounting for 60% of all MCS implantations. It is recommended that LVAD implantations in INTERMACS level 1 and 2 are primarily used to rescue potential HT candidates, whereas DT should be reserved for only stable patients as an elective surgery.

Inotrope-dependence is assessed either clinically by demonstrating improvement of heart failure symptoms, vital signs and end-organ function with the use of intravenous inotropic agents and/or hemodynamically by demonstrating improvement of pulmonary artery saturation and/or cardiac output at time of drug infusion (INTERMACS level 3 – “stable dependent”). Inotrope-dependence is associated with less than 50% 6-months survival and urgent cardiac replacement therapy should be sought for these patients. Both, HT and LVAD implantation have shown to provide the greatest survival benefit at this stage of heart failure. The criteria for elective LVAD implantation in HT candidates
have not been established. Consideration for LVAD implantation as DT in non-transplant candidates who reached inotrope-dependence should not be deferred.

Although the quality of life of patients in INTERMACS levels 4 through 6 is severely compromised, the right timing of LVAD implantation remains an area of controversy. Post-hoc analyzes of DT recipients in the REMATCH trial and the post-REMATCH cohort showed no survival benefit with LVAD implantation; and early HT in ambulatory candidates provided little improvement of 1-year survival (94% 1-year survival with HT versus 89% 1-year survival without HT). Consideration for cardiac replacement, however, should not be delayed in these patients. In non-inotrope dependent patients with class IV heart failure cardiopulmonary testing is considered to be the best prognostic of long-term outcomes. However, in the current era of medical and device therapy, the cardiopulmonary test in isolation from other predictors of survival may not be sufficient and composite risk scores may be more helpful, such as the Heart Failure Survival Score (HFSS) or the Seattle Heart Failure Risk Score.

**Cardiac and Anatomic Considerations**

Candidates for permanent LVAD implantation should be evaluated for the cardiac and anatomic conditions, which can influence successful LVAD support. This includes right ventricular dysfunction, arrhythmia, anatomic and body size considerations. Some of these patients may be more appropriate candidates for biventricular support or total artificial heart. In this talk, we will review assessment of the RV function.

In some patients with advanced heart failure, increased cardiac output and venous return at time of LVAD placement may “unmask” the severity of native RV dysfunction and lead to severe RV failure, resulting in congestive renal and hepatic dysfunction or even cardiogenic shock due to underfilling of the pump. It is estimated that 20-35% of patients who undergo LVAD implant develop RV failure, which significantly contributes to postoperative mortality. The assessment of RV function prior to LVAD implantation, therefore, is of critical importance.

Although there have been several clinical predictors of postoperative RV failure identified in single center series, prospective identification of patients at risk of postoperative RV failure remains challenging. In general, elevated right atrial pressure > 20 mmHg, low mean pulmonary artery pressure < 25 mmHg, low right ventricular stroke work index, large and hypokinetic RV (> 200 mL), severe tricuspid regurgitation and markers of renal and hepatic dysfunction are all poor prognostics for isolated LV support. Some patients, such as those of smaller body size, females and those with non-ischemic cardiomyopathy may be at higher risk. There is some data suggesting that an attempt to optimize RV function with medical therapy and intraaortic balloon pump can reduce the need for RV assist device insertion. If these attempts fails to correct elevated right sided pressures, such patients should be considered for/or anticipated to require biventricular support. RV Risk score has been developed by the University of Michigan group and is reviewed on the following slide.
Assessment of LVAD Operative Risk

Throughout all clinical trials of DT the operative mortality has been strikingly high, often exceeding several times that seen in patients “bridged” to HT. The probability of death within 3-month after LVAD surgery was 30% in the REMATCH trial, 50% in the INTREPID trial and as much as 60% in the CUBS trial. In all of the above clinical trials, as well as in the recipients of DT in the post-REMATCH era in the U.S., nearly all early deaths occurred with a functional device were due to the consequences of operative complications, including sepsis, multiorgan failure, bleeding, right ventricular failure and stroke. As many as two-thirds of deaths reported in the post-REMATCH cohort occurred prior to hospital discharge (76 of 120 deaths)!

Since the primary goal of elective device implantation as DT is to be able to discharge patients home in better condition than they were before LVAD surgery, the appropriate assessment of the candidate operative risk is of paramount importance.

The tremendous impact of patient selection on the outcomes of LVAD surgery has been recognized since the first devices were used as a “bridge” to transplantation. Regardless of the type of device, the later in the disease course LVAD surgery was performed, the poorer were the outcomes, as shown in the diagram in the slide. Implantations performed in patients with severe functional impairment, end-organ dysfunction, right ventricular failure, malnutrition or infection had been consistently associated with adverse outcomes. Recognizing that no one variable can accurately predict survival in these patients, composite risk scores have been used to risk stratify the severity of multi-organ impairment, including classic risk scores used in critically ill patients, such as the Heart Failure Survival Score and the APACHE score, closely correlated with outcomes of LVAD surgery.

In the analysis of 222 patients in post-REMATCH era in the U.S., who approved use of their clinical data for the study, we reconfirmed again the same risk factors for in-hospital mortality after LVAD surgery, as have been previously described. We showed one more time that, as heart failure progressed and end-organ and right ventricular function worsened, the operative risk increased substantially, often rendering such implantations futile. To help clinicians identify patients who may be at prohibitive operative risk for LVAD insertion, we proposed a composite DT Risk Score, which could be calculated from 9 preoperative parameters, as shown in the following slide. Malnutrition is common in heart failure patients and the DT Risk Score was the first to call attention to the importance of malnutrition as being correlated with mortality with LVAD use. One important observation from the data was the very strong correlation with the abnormal variable in the pre-op risk assessment and the eventual cause of death, e.g. malnutrition and death from infection, and prolonged INR and low-platelet count and death related to bleeding and right ventricular failure.

The proposed DT Risk score calculates 90-days probability of in-hospital mortality after LVAD surgery and thus, is able to assess patients’ odds of being discharge home with DT. Patients who have acceptable operative risk (cumulative DT Risk Score > 16), were more likely to survive surgery, be discharged home and had better long-term survival outcomes (1-year survival ranging between 71% and 80%), than high risk
operative candidates whose prognosis was very poor (1-year survival < 15%), or even inferior to the outcomes of patients enrolled in the medical arm of the REMATCH trial (1-year survival 26%), as illustrated.

The proposed DT Risk Score, however, had many limitations. First, the risk score was derived from a population of mostly older patients. Previous studies have shown that advanced age by itself may account for nearly 3-fold increase of the operative risk of LVAD surgery, thus rendering this a high risk population. In older patients even slight abnormalities of some of the risk factors might have posed significant risk of operative death, such as slightly lower platelet count or elevation of liver enzymes, etc. Second, the prevalence of mechanical ventilation, intra-aortic balloon pump support and small patient size in this study was too small to enter the risk stratification model, and thus patients with the above risk factors should be treated as higher risk candidates than estimated by the described DT Risk Score. Third, the DT Risk Score could not account for the clinical severity of heart failure as defined by the INTERMACS levels, the definitions of which were formulated after 2005, when the study was closed for analysis.

Because of the relatively small number of DT implants performed nationally at the time when the DT Risk Score was calculated and because of the voluntary nature of the Thoratec Destination Therapy Registry database, from which the above DT Risk Score was derived, this model will require prospective validation. The recent HeartMate II DT trial, which enrolled over 500 patients, and should be reported out within the next two years when all patients will have met the two year follow up end point will be sufficient to validate this model. Hopefully, by then we will be able to derive more sophisticated risk stratification models from the data collected by the newly established INTERMACS Registry. It should also be noted, that the DT Risk Score may not be applicable to patients “bridged” to HT, as they are often younger patients who undergo emergent or semi-emergent implantations for cardiogenic shock and majority of whom are bailed out with HT within the first 6 months of LVAD support, the parameters and outcomes for which the above DT Risk Score does not account for.

Limitations of current selection criteria

Most of these recommendations are derived from the experiences with the pusher-plate pumps, but these considerations are likely applicable also to the recipients of new generation axial flow devices. Since classification of chronic MCS based on the original intent is largely artificial, the described in this talk risk scores will apply to both patients who receive devices as BTT and DT.

REFERENCES


Matthews JC, Koelling TM, Pagani FD, Aaronson KD. The right ventricular failure risk score a pre-operative tool for assessing the risk of right ventricular failure in left ventricular assist device candidates. J Am Coll Cardiol. 2008 Jun 3;51(22):2163-72.


Lietz K, Miller LW. Destination therapy: current results and future promise. Seminars of Thoracic and Cardiovascular Surgery, 2009