Machine Learning for Prognostication in Patients Undergoing LVAD Implantation

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Purpose
The ability to assess risk in patients undergoing left ventricular assist device (LVAD) implantation would help providers plan management strategy. We recently described MARKER-HF, a novel machine learning based tool developed to predict mortality in heart failure patients. This study evaluated whether MARKER-HF could predict clinically relevant outcomes in patients undergoing LVAD implantation.

Methods
We conducted a single-center observational cohort study of 101 patients implanted with an LVAD as a bridge to transplant or destination therapy from October 2016 to January 2020. The MARKER-HF score was calculated using variables collected on the day of implantation. We assessed the ability of MARKER-HF to predict length of hospitalization post-LVAD implantation, eight patients who received orthotopic heart transplants (OHT) or expired during index hospitalization were excluded from this analysis. In addition, we evaluated the association between MARKER-HF and the total number of hospitalized days during the first year after LVAD implantation, the relationship between MARKER-HF and New York Heart Association (NYHA) functional class one year post-implant, and we compared the prognostic value of MARKER-HF on adverse outcomes to the INTERMACS profile. Patients who expired or underwent (OHT) within a year were excluded from this analysis. The correlation between risk scores and outcomes were analyzed using linear regression, student t-tests, and ANOVA tests. Time to death data was presented as Kaplan Meier estimates and compared using the log-rank test. A significance level of P<0.05 was used, and all tests were performed 2-sided.

Results
Patient demographics and baseline characteristics are reported in Table 1. Individual components of the MARKER-HF score were not associated with outcomes. However, linear regression demonstrated a positive correlation between higher MARKER-HF score and longer LOS after LVAD implantation (p < 0.05) (Figure 1A). When divided into quartiles for MARKER-HF score, each quartile had a statistically significant difference in LOS post-implantation (p= 0.014). Patients in the highest quartile had a mean post-implant LOS of 51 days, compared to 30 days for patients in the lowest quartile (p = 0.001) (Figure 1B). Patients with the highest quartile MARKER-HF scores also spent significantly more days hospitalized within the first year of LVAD implantation (80 vs 43 days, p = 0.02) (Figure 1B). There was significant difference in NYHA functional class one year after LVAD implantation (p=0.005) (Figure 1C). A lower MARKER-HF score was associated with a significant improvement in NYHA class (r = 0.37, p=0.006). While four patients in the top quartile MARKER-HF score died compared to one patient in the bottom quartile, the association between MARKER-HF score and mortality did not reach statistical significance on survival analysis (p = 0.15) (Figure 2). To compare the prognostic value of MARKER-HF and INTERMACS profile, we separately assessed the association between the INTERMACS profile at LVAD implantation and outcomes. Univariate regression did not demonstrate a significant
association between INTERMACS profiles and LOS post LVAD implantation, \( p = 0.07 \). There was also no statistically significant difference between INTERMACS profiles (1-2, 3, 4-5) and post-implant LOS \( (p = 0.41) \) or total hospitalized days one year post-implant \( (p = 0.32) \), (Figure 1D).

**Conclusion**

Using readily available clinical data, the MARKER-HF score is associated with LOS post LVAD implantation, total numbers of days hospitalized in year after implantation, and improvement in NYHA class after one year. MARKER-HF could improve risk stratification prior to LVAD implantation for more informed discussions between providers and patients. Future studies are needed to validate these findings.