Clinical Predictors of Graft Loss After Living Donor Kidney Transplantation

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Background

As of late 2019, there were nearly 800,000 people with end-stage kidney disease in the United States. Living donor kidney transplantation (LDKT) is the treatment of choice for such individuals, as it is associated with significantly improved long-term survival and quality of life compared to other renal replacement strategies. We sought to develop a novel risk model to facilitate the matching of potential living kidney donors to recipients so as to maximize transplanted organ (graft) survival.

Approach and Methods

We developed predictive models of graft loss using Cox regression, random forest (RF), and XGBoost (XGB) algorithms.

Input Data: Demographic, clinical, and immunological features of 31,822 adult LDKT donor-recipient pairs from the Scientific Registry of Transplant Recipients

Predicted Outcome: 1) Graft loss versus graft survival after LDKT, and 2) time to graft loss (or duration of graft survival, if no loss occurred)
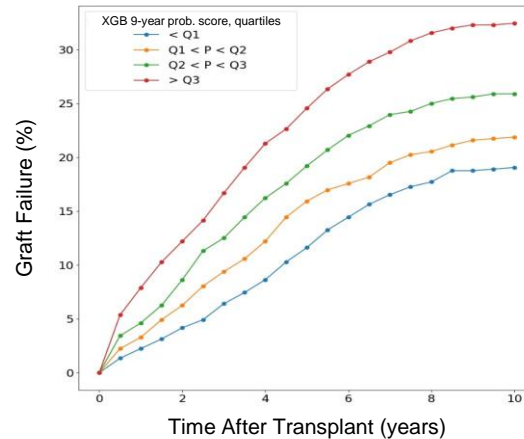
Results
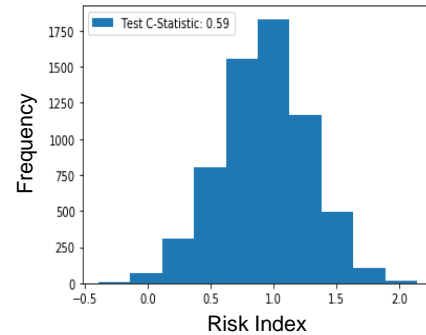
Figure 1: Our Cox regression model performs similarly to the LKDPI, the gold standard regression model for quantifying LDKT graft loss risk.
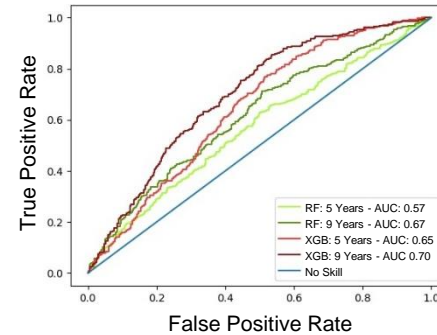
Figure 2: Our RF and XGB models outperform the LKDPI and our Cox regression model for predicting graft loss within 9 years. Compare the AUCs above to the C-statistic in Figure 1.

Figure 3: For XGB, predicted probability of graft loss within 9 years post-transplant can be extrapolated to meaningful trajectories of graft loss risk over time, indicating how this risk changes within those 9 years.

Feature	Regression Coefficient	P value
Recipient age at transplant	0.01	<0.005
Donor age >50	0.03	<0.005
Recipient is Asian	-0.57	<0.005
Left kidney used for transplant	-0.18	<0.005
Number of HLA-B mismatches	0.11	0.01

Table 1: Top 5 features associated with graft loss per Cox regression

Conclusions

- Our Cox regression model for graft loss risk performs comparably to the gold standard LKDPI
- Our novel RF and XGB classifiers demonstrate overall superior performance at predicting graft loss within 9 years after LDKT
- XGB graft loss probability score extrapolates to predicted trajectories of graft loss risk over time, which could be used to compare potential donor-recipient matches against each other

Future Directions

1. Investigate feature importance and interactions in RF and XGB models to better understand why these approaches outperform traditional regression
2. Rescale model output to that of existing clinically interpretable risk indices such as the LKDPI