

A Novel Weighted Psychosocial Assessment Scoring System for Kidney Transplant Evaluation

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Introduction

Over the years the supply of available organs for transplant has not increased in accordance with demand. While medical requirements for transplantation have consequently become more standardized and rigorous across institutions, the same cannot be said for psychosocial assessment criteria. There is limited research on psychosocial factors and clinical outcomes, leading to difficulty in the accurate assessment of a candidate's suitability for transplant from this standpoint. Additionally, the qualitative nature of these risk factors introduces bias during the evaluation process. To avoid this major limitation, assessment tools are available that score psychosocial factors to assist assessors with maintaining objectivity during the evaluation process. Three such tools have been developed: the Psychosocial Assessment of Candidates for Transplant (PACT), the Transplant Evaluation Rating Scale (TERS), and the Stanford Integrated Psychosocial Assessment for Transplant (SIPAT). The PACT weighs each psychosocial variable equally during scoring, possibly leading to bias against patients that score high on variables that are not strongly associated with undesirable post-transplant outcomes. Similar calculations are also used for the TERS and SIPAT tools. A major limitation of all these tools is their failure to account for organ-specific psychosocial issues such as substance abuse and chronic disease management. In this study we assessed psychosocial risk factors that influence 1-year clinical outcomes for adult kidney transplant patients to develop an assessment tool that best captures that relationship between these factors and kidney transplant outcomes.

Methods

Data Collection

Features used in this study included clinical, transplant-related, and psychosocial factors. The patient cohort comprised of 106 kidney transplant candidates that were evaluated and either waitlisted or denied for transplant in 2016. Exclusion criteria included diagnosis of a congenital etiology (type I diabetes, Wegener's granulomatosis, and SLE), dual transplant candidates, and patients younger than 18 years old and over 65 years old.

Psychosocial factors were collected from psychosocial evaluations conducted by a social worker. Clinical control variables included comorbidities, medications, donor liver parameters such as KDPI and perioperative factors (intraoperative or post-transplant hospital stay complications) and were collected from discharge summaries.

Poor outcomes were defined as clinical events within the first year after transplant that are known to pose greater risk of poorer long-term outcomes and included number of hospitalizations subcategorized by primary diagnosis at admission (transplant incision-related, sepsis, AKI, or UTI), total hospitalization days, and acute rejection episodes within 1 year.

Dimensionality Reduction

Factor Analysis of Mixed Data (FAMD) was performed on the psychosocial factors to create a lower dimension representation that explained the most variance in the original factors. Twenty psychosocial variables were identified for the entire cohort that contributed most to overall variation. FAMD was repeated for the denied and waitlisted subpopulations.

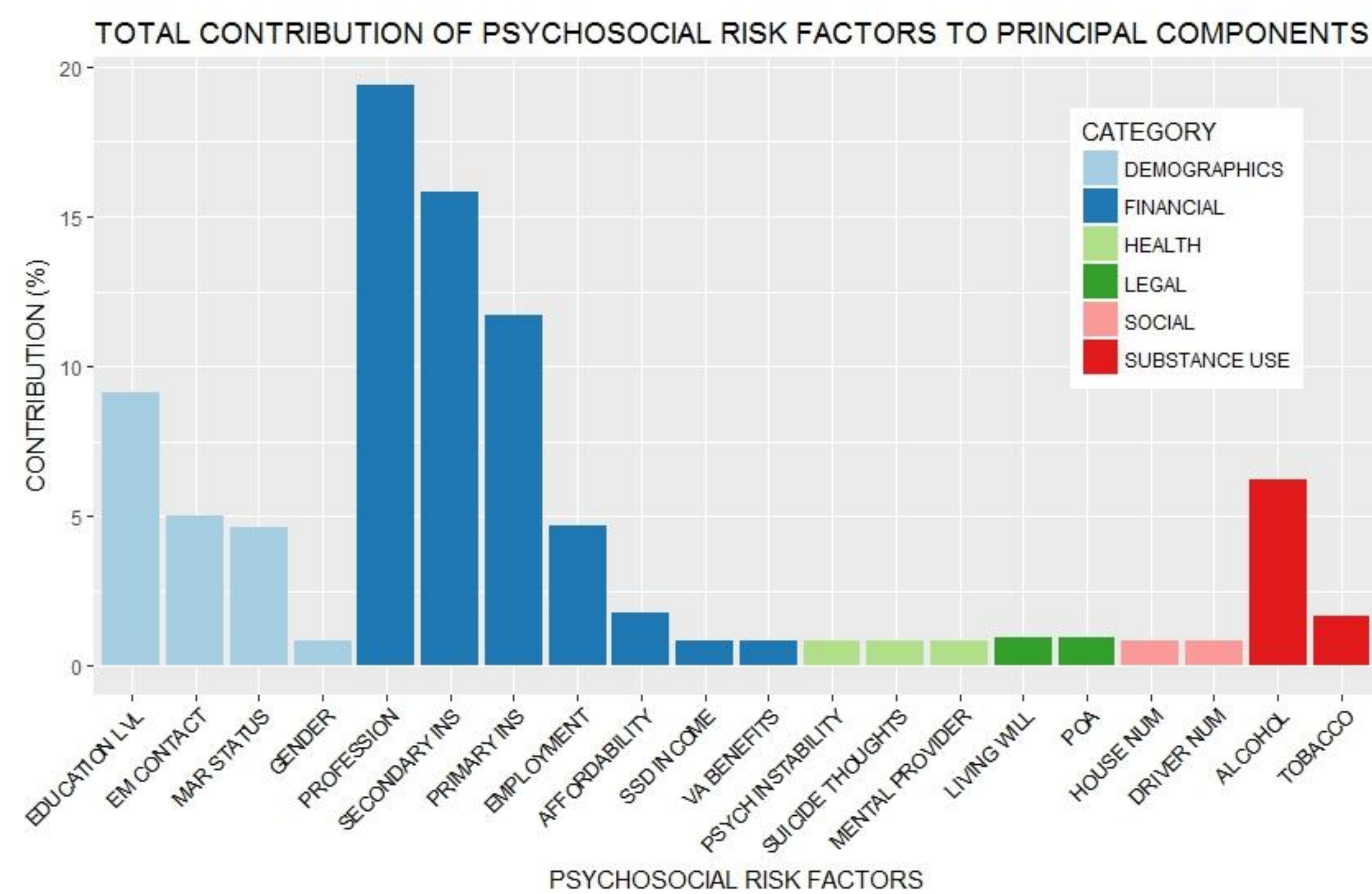
Data Analysis

Chi-square, Fisher's exact, and Wald test were performed to calculate the relative risk with a 95% confidence interval of each feature and the probability of waitlist placement. The test was repeated to evaluate the same features and the probability of each poor outcome of the waitlisted patients.

Score Calculation

Clinical and Transplant factors were controlled for by adding points equivalent to the midpoint relative risk and subtracting midpoint relative risk reduction to serve as a baseline value for each patient. Statistical significance of each psychosocial factor was assessed using Wald test ($\alpha = 0.5$). Each statistically significant psychosocial factor was then assigned a range of points derived from the 95% confidence interval in single digit increments resulting in approximately 8×10^8 possible scores for each patient. Receiver operator curve and area under curve (ROC/AUC) were calculated for each set of scores to identify the scoring values that categorized each patient to a degree greater than random chance ($AUC > 0.5$). The final scoring system was selected based on the maximum possible AUC value of 0.802.

Results



Dimensionality Reduction

FAMD revealed the psychosocial factors that accounted for approximately 80% of the variability in the entire cohort belonged to the demographic, financial, health (specifically mental health), legal, social support, and substance use categories. These results suggest that a greater degree of attention may be placed on these factors during evaluation since they are the most highly variable between patients.

CATEGORY	PSYCHOSOCIAL FACTOR	POINTS
Financial	Medicare primary insurance	1
	On disability	1
	On disability for ESRD	2
	Monthly income <\$820	2
	Concerned with affording medication	1
Substance Use	Tobacco	3
	Marijuana	1
	Cocaine	1
Self-Care	Difficulties with medications	3
	Difficulties walking	1
	Difficulties driving	1
TOTAL		17
Total >8 suggests higher risk for poor outcomes		

Scoring Assessment Tool

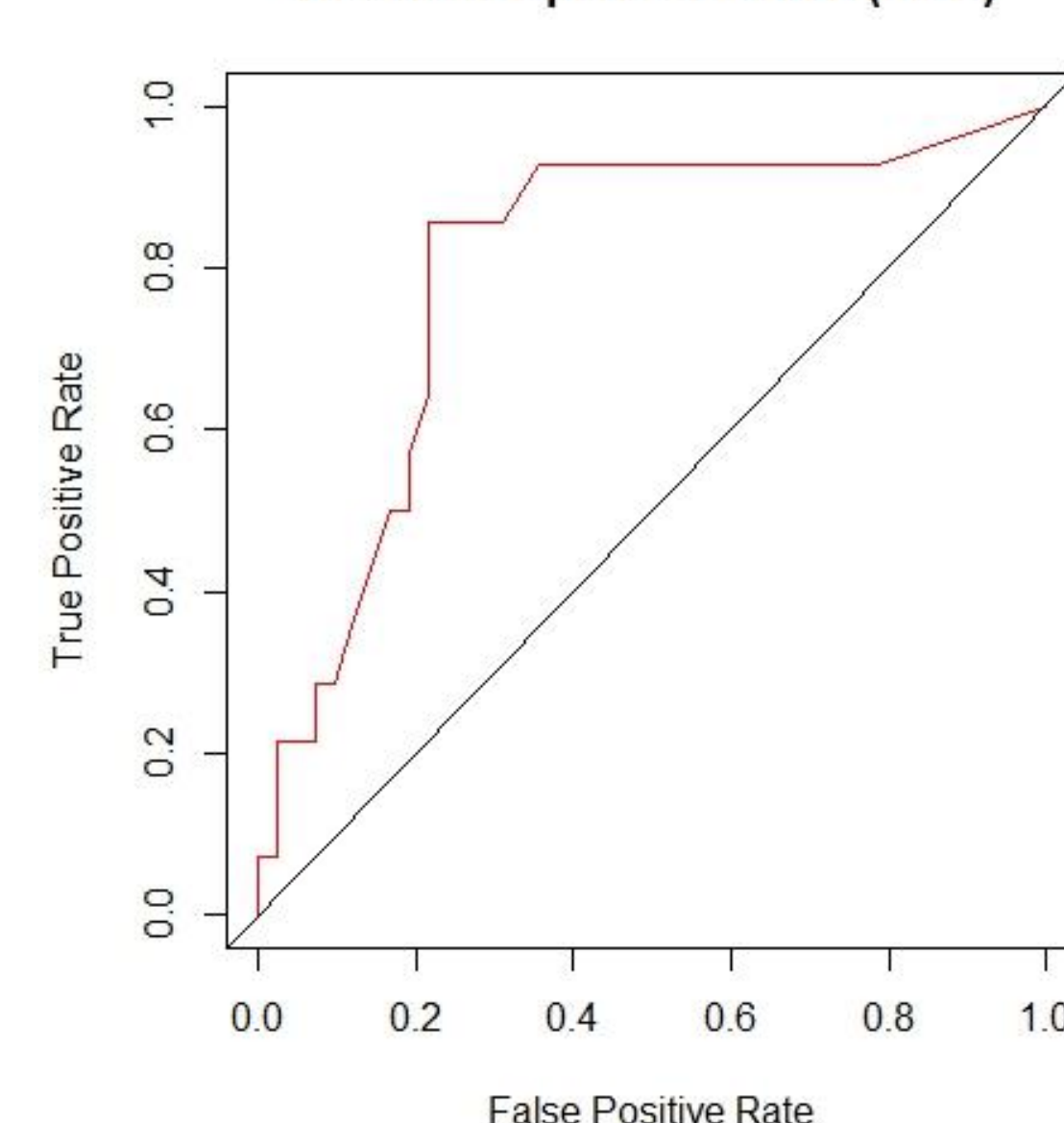
For the financial category, the relative risk of Medicare as primary insurance, being on disability, a monthly income less than \$820, and concerns for affording medication were 4.3 (95% CI[1.5-12.6]), 3.9 (95% CI[1.1-14.6]) or 3.7 (95% CI[1.6-8.8]) if for ESRD, 3.6 (95% CI[2.0-6.4]), and 1.4 (95% CI[1.0-2.1]).

Current or past use of tobacco was associated with a relative risk of 9.6 (95% CI[2.1-44.7]), illegal drugs such as marijuana and cocaine were associated with a relative risk of 4.5 (95% CI[2.0-10.1]) and 2.4 (95% CI[1.8-3.2]) for poor outcomes.

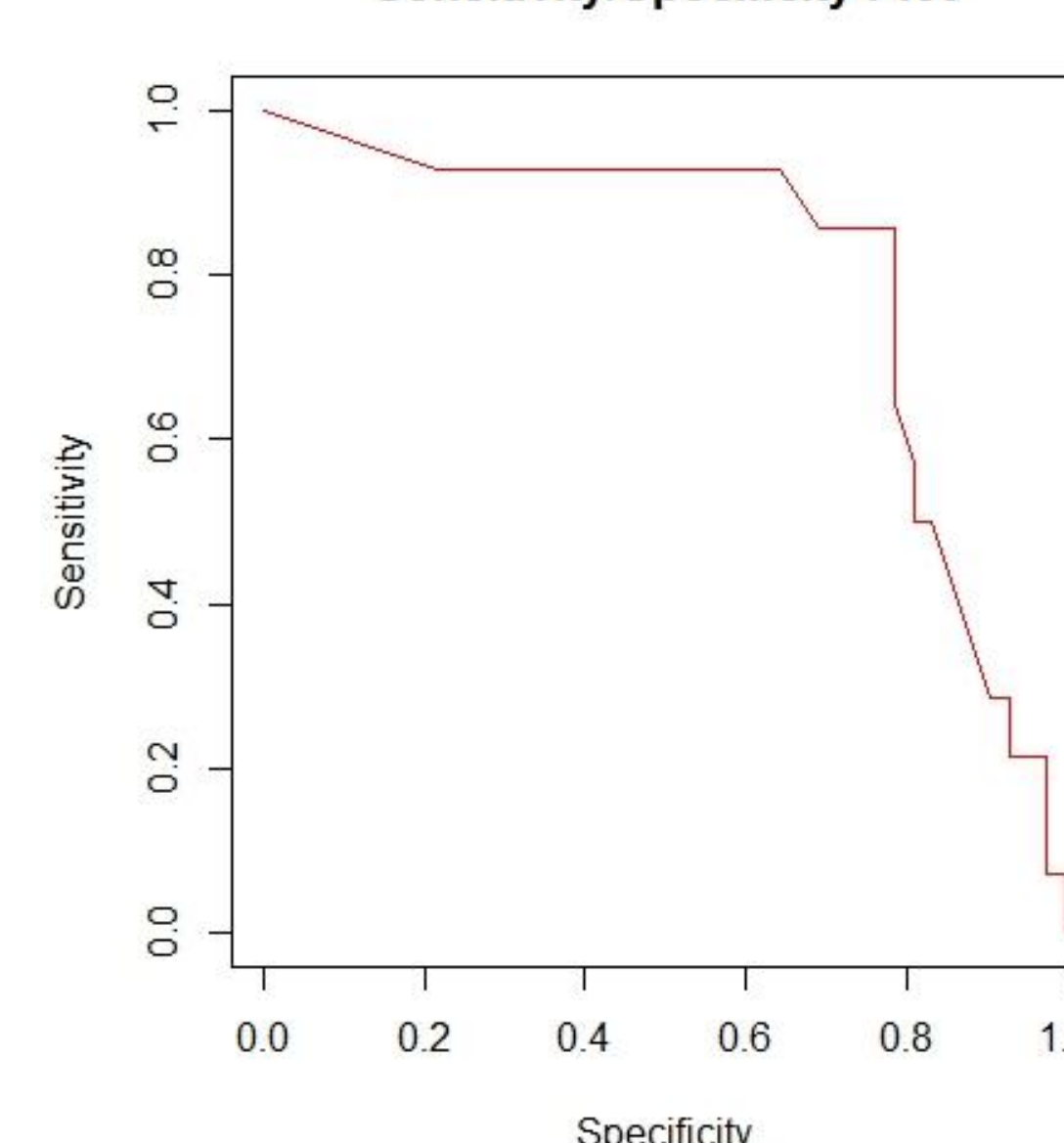
Of the other psychosocial factors collected, the factors linked to completing activities of daily living were most strongly associated with poor outcomes. Self-reported difficulties with medication adherence, walking, and driving were associated with a relative risk with 95% confidence interval of 2.2 [1.6-3.0], 2.0 [1.4-2.9], and 1.7[1.2-2.5], respectively.

Performance of the scoring system was assessed by plotting receiver operator curve and sensitivity/specificity. Overall global performance metrics of diagnostic accuracy include AUC = 0.802 at a cut-off value of 8, 0.857 sensitivity, 0.786 specificity, 0.571 positive predictive value, 0.943 negative predictive value, 0.803 accuracy, 4.00 likelihood ratio for positive result, 0.182 likelihood ratio for negative result, and 22.0 diagnostic odds ratio.

Receiver Operator Curve (ROC)



Sensitivity/Specificity Plot



Discussion

The United Network for Organ Sharing bylaws require every transplant program to have professionals whose primary responsibility is to conduct psychosocial evaluations, highlighting the importance of a thorough and accurate psychosocial assessment in the transplant evaluation process. This study explored the psychosocial factors that are associated with listing status for adult kidney patients at our institution and analyzed the correlation between these same factors and the incidence of a poor clinical outcome within 1 year of transplant.

Although this study was limited to retrospective chart review and by a small sample size, the assessment tool that we have developed will serve as a prototype for further research in the relationships between psychosocial factors and outcomes. Applying this assessment tool in an observational setting would assess for the practicality of using such a scoring system in a real-world setting, assess for interobserver variability, allow for more accurate psychosocial data capture, and increase total sample size that can allow for better model fitting and statistical results. A more precise model would also allow for the assessment of other indices of suboptimal transplant outcomes such as immunosuppression levels, elevated creatinine or potassium levels in the post-transplant period, and long-term transplant outcomes.

Conclusions

In order to create an assessment tool that stratifies risk during psychosocial evaluation of organ transplant candidates, both the variability and correlations of the psychosocial factors with poor outcomes were analyzed using dimensionality reduction and categorical statistical analysis. Our final scoring system demonstrates optimal performance based on the measurements of diagnostic accuracy.

This study also allowed for us to note the psychosocial factors that are strongly correlated with poor clinical outcomes that may also be modified to optimize candidacy and resource allocation from the psychosocial perspective. For example, substance use can be targeted with appropriate cessation and counseling programs to reduce risk as well as improve candidacy.

The category that is most influential on outcomes in this study was financial. Modifiable factors under this category include medication affordability, suggesting a point of intervention that may improve overall outcomes of these patients.

There is additionally an overarching theme of difficulties with performing the activities of daily living. However, the underlying relationship between these activities and poor 1-year outcomes remains to be known and may be related to poor hygiene, low mobility, or reduced functional status.

Limitations and Future Research

Our study utilized a retrospective approach due to wait time length for most adult kidney transplant patients and the desire to compare psychosocial risk factors to outcomes 1-year post-transplant. Reliance on the electronic medical record could potentially lead to information bias, based on the accuracy of the notes. Potential selection bias is noted as only transplanted patients were included in the study; outcome information for patients deemed to not be appropriate transplant candidates was not available. Additionally, the reliance of psychosocial assessments on patient self-report may also introduce bias in the information gathered. Prospective research in this area is needed to address the limitations of the current study. Future research should utilize a standardized collection method for psychosocial risk factors.

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