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Retrospective Cohort Study

Higher model for end-stage liver disease excluding international normalized ratio scores predict worse kidney graft outcomes in simultaneous heart-kidney transplantation

Marco E Diaz-Cordova, Matthew Rega, Ishani Sharma, Ryosuke Misawa, Abhay Dhand, Seigo Nishida, Kenji Okumura

Marco E Diaz-Cordova, Matthew Rega, Ishani Sharma, Abhay Dhand, Seigo Nishida, Kenji Okumura, Department of Surgery, Westchester Medical Center and New York Medical College, Valhalla, NY 10595, United States

Ryosuke Misawa, Department of Surgery, Westchester Medical Center, Valhalla, NY 10595, United States

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Author contributions: Diaz-Cordova ME and Okumura K contributed to conceptualization, study design, data analysis, data interpretation, and writing-original draft preparation; Rega M contributed to data analysis, data interpretation, and writing-review and editing; Sharma I contributed to data review and manuscript review; Misawa R, Dhand A, and Nishida S contributed to writing-review and editing and critical revisions of the manuscript; all authors reviewed and approved the final version of the manuscript.

Corresponding author: Kenji Okumura, MD, Associate Faculty, Department of Surgery, Westchester Medical Center and New York Medical College, 100 Woods Road, Valhalla, NY 10595, United States. kenji.okumura@wmchealth.org

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Abstract

BACKGROUND

While the model for end-stage liver disease excluding international normalized ratio (MELD-XI) is known to be associated with adverse outcomes following cardiac surgery and heart transplantation, its predictive value in outcomes of simultaneous heart–kidney transplant (SHKT) remains unclear. To identify a reliable pre-transplant risk marker for graft and patient survival among SHKT recipients, we hypothesized that higher MELD-XI scores are linked to worse post-transplant outcomes.

AIM

To determine the association between MELD-XI and post-transplant outcomes in SHKT recipients.

METHODS

We performed a retrospective cohort study in adult SHKT recipients using the United Network for Organ Sharing database from 2014 to 2023. MELD-XI was calculated and categorized into tertiles (high, medium and low). Multivariable Cox proportional hazards models and generalized additive models were used to evaluate the association between MELD-XI and patient mortality and kidney graft failure.

RESULTS

Among the cohort of 2148 SHKT recipients the MELD-XI tertile distribution was: High (11%), medium (56%), and low (36%). Statistically significant differences among recipients in the highest tertile were seen and they were younger, more frequently female, had higher rates of dialysis, and shorter waitlist times. Recipients in the higher MELD-XI tertile also had significant increase in the delayed kidney graft function and longer hospital stays after transplantation. On multivariable analysis, MELD-XI independently predicted increase in 90-day graft failure, and 1-year graft failure and mortality.

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CONCLUSION

Higher MELD-XI is associated with increased early mortality and kidney graft failure in SHKT recipients. MELD-XI can provide an objective risk-stratification tool to help identify candidates who should undergo SHKT *vs* kidney-after-heart transplantation.

Key Words: Simultaneous heart-kidney transplant; Model for end-stage liver disease excluding international normalized ratio; Heart transplant; Kidney transplant; Predictor; Transplant outcomes; Delayed graft dysfunction

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Core Tip: The incidence of simultaneous heart-kidney transplantation (SHKT) has increased substantially in recent years. Early studies suggested benefit, but recent data are conflicting. No reliable prognostic marker exists for this population. The model for end-stage liver disease excluding international normalized ratio (MELD-XI) was previously validated in heart transplantation and cardiac surgery and may serve as a risk-stratification tool. In this study, higher MELD-XI scores were linked to early mortality and kidney graft failure. This supports its potential role in guiding selection between SHKT and kidney-after-heart transplantation under current allocation policies.

INTRODUCTION

Kidney dysfunction can be a common complication of end-stage heart disease and would associate with worse graft and overall survival after heart transplantation[1-5].

In previous studies, perioperative kidney dysfunction was shown to independently associate with worse outcomes after either heart transplant alone or after simultaneous heart–kidney transplantation (SHKT)[1,2,4-7]. Based on patient co-morbidities and close physiological link between heart and kidney dysfunction, the number of simultaneous heart–kidney transplants being performed in the United States has significantly increased over the last decade[4].

Earlier studies found the SHKT conferred survival benefits patients with end-stage renal disease, especially those on prolonged dialysis. Recent literature, however, shows mixed and paradoxical outcomes for patients with moderate or new onset renal dysfunction[4-7]. Because of the combined medical and surgical challenges, SHKT is more complex procedure than heart or kidney transplantation alone. Complicated hemodynamics, severity of medical illness, and higher perioperative instability contribute to higher rates of kidney graft failure and early mortality in SHKT recipients compared to kidney-alone recipients[4-8]. As recipient pool expands to include older patients with higher medical complexity, there is a critical need for robust, objective risk-stratification tools to guide donor organ allocation decisions, especially in the new era of kidney safety net after heart transplantation.

The model for end-stage liver disease (MELD) excluding international normalized ratio (INR)-(MELD-XI) estimates disease severity using only serum creatinine and bilirubin, omitting the INR to avoid misrepresenting severity in patients on anticoagulation. MELD-XI was initially developed for patients with cirrhosis requiring anticoagulation, since the traditional MELD score includes INR and may overestimate severity in these patients[9,10]. MELD-XI performs comparably to the traditional MELD score and has been used to predict the risk of early morbidity and mortality after various surgical procedures, including cardio-thoracic surgeries, in both cirrhotic and non-cirrhotic patients[9,10]. However, its association with outcomes after SHKT remains unknown.

To explore the role of MELD-XI as a potential risk tool, we conducted a retrospective nationwide analysis using the United Network for Organ Sharing (UNOS) database. We

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evaluated the link between MELD-XI and post-transplant outcomes, including kidney graft survival and patient mortality, in SHKT recipients. We hypothesized that higher MELD-XI scores would be associated with greater kidney graft failure and worse early post-transplant outcomes.

MATERIALS AND METHODS

Study population

Adult (age 18 years or older) deceased donor SHKT recipients between January 2014 and December 2023 were analyzed using de-identified data from UNOS. Re-transplant and multi-organ transplant except SHKT were excluded. For this study, the MELD-XI score was calculated using the laboratory values closest to the time of transplantation as reported in the UNOS registry. Patients with missing data for variables required for MELD-XI calculation were also excluded from the final analysis. All variable definitions were based on the Organ Procurement and Transplantation Network policy. This study was considered exempt by our local Institutional Review Board.

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Study endpoints

The primary outcomes were recipient and kidney graft survival, as well as kidney delayed graft function (DGF), defined as the requirement for hemodialysis within the first week after kidney transplant. UNOS defines heart or kidney graft failure as 1 of the following: Removal of the transplanted organ (*e.g.*, retransplant), recipient death, or placement of the recipient on a chronic allograft support system (*e.g.*, hemodialysis for a kidney transplant). The kidney donor profile index (KDPI) was calculated using 10 variables that influence donor organ quality: Age, height, weight, cause of death, last serum creatinine, history of diabetes, hypertension, hepatitis C serostatus, ethnicity, and whether the donation was after circulatory death or after brain death.

Statistical analyses

Baseline characteristics were summarized across MELD-XI categories using medians with interquartile ranges for continuous variables and *n* (%) for categorical variables. Group comparisons were performed using the Kruskal-Wallis test for continuous variables and χ^2 of Fisher's exact tests for categorical variables, as appropriate. First, MELD-XI was assessed using a generalized additive model in a multivariable Cox proportional-hazards regression model. Model fitting was assessed using restricted maximum likelihood and Akaike Information Criterion. Secondly, we compared outcomes among recipients in three tertiles of pre-transplant MELD-XI: High, medium and low.

Post-transplant patient and kidney graft survival were calculated from transplant to event date using the Kaplan-Meier method. Log-rank tests compared survival curves. Cox proportional hazards regression was used to evaluate associations between MELD-XI and other outcome-related factors. Results were hazard ratios with 95%CIs and two-sided *P* values. $P < 0.05$ was significant. All analyses were conducted in RStudio with R Version 4.5.2 (RStudio, Boston, MA, United States).

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RESULTS

Baseline characteristics

Baseline recipient and donor characteristics of the cohort are summarized in Table 1, stratified by MELD-XI tertile. Among the cohort of 2148 SHKT recipients the MELD-XI tertile distribution was: High (11%), medium (56%), and low (36%). Increasing MELD-XI score was associated with younger recipient age [median 55 (interquartile range 47-62) years *vs* 57 (interquartile range 50-63) years *vs* 61 (interquartile range 54-65) years across high, medium and low strata, respectively; $P < 0.001$] and higher proportion of female recipients (89% *vs* 83% *vs* 76%, respectively; $P < 0.001$). Patients with higher MELD-XI score had greater renal dysfunction, including higher creatinine levels at time of transplant (median 3.55 *vs* 3.0 *vs* 1.70, respectively; $P < 0.001$), increased dialysis dependence at transplant (61% *vs* 37% *vs* 0%, respectively; $P < 0.001$), and higher total bilirubin concentrations (median 1.7 mg/dL *vs* 1.0 mg/dL *vs* 1.0 mg/dL, respectively; *P*

< 0.001). Waiting list time differed significantly across MELD-XI strata, with the shortest median waiting time observed in the high MELD-XI group (median 29 days *vs* 52 days *vs* 42 days, respectively; $P < 0.001$). Patients in the higher MELD-XI group were more likely to require preoperative ECMO support (9.2% *vs* 3.2% *vs* 5.4%, respectively; $P < 0.001$). All data are presented from the high MELD-XI tertile to the medium and low tertiles. Donor characteristics were comparable between the groups.

Outcomes

Patients in higher MELD-XI tertiles had longer post-transplant hospital length of stay (median 24 days *vs* 21 days *vs* 21 days, respectively; $P = 0.007$) (Table 2), higher rates of delayed kidney graft function (46% *vs* 32% *vs* 20%; $P < 0.001$), and increased post-transplant dialysis at discharge (47% *vs* 37% *vs* 25%, respectively; $P < 0.001$). Rates of post-transplant stroke and pacemaker requirement did not differ significantly among groups.

Kaplan-Meier survival analysis

Kaplan-Meier analysis demonstrated significant differences in kidney graft survival across MELD-XI strata. Increasing MELD-XI category was associated with progressively worse 1-year kidney survival ($P < 0.001$). At 1-year post-transplant, kidney graft survival among SHKT recipients in various MELD-XI tertiles was 73.1% (95%CI: 62.4-85.7) in the high, 83.4% (95%CI: 81.4-85.5) in the mid, and 87.7% (95%CI: 85.5-89.9) in the low group. Early separation of survival curves was observed within the first 90 days following transplantation and persisted throughout follow-up (Figure 1). Similar patterns were observed with MELD-XI, which was evaluated using alternative categorical definitions, with consistent early divergence and inferior kidney graft survival amongst higher MELD-XI groups.

Continuous modeling of MELD-XI

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After unadjusted spline-based Cox analyses, MELD-XI demonstrated a statistically significant nonlinear association with 1-year kidney survival (P = 0.032) (Figure 2). The estimated hazard function remained relatively flat at lower MELD-XI values, with progressively increasing risk observed at higher values. MELD-XI remained significantly associated with worse kidney graft survival (P < 0.001) at 2-years follow-up, with a similar pattern of increasing hazard with higher MELD-XI values.

Adjusted models

Multivariable Cox regression models were adjusted for clinically relevant recipient, donor, and perioperative variables, including recipient sex, race/ethnicity, peripheral vascular disease, left ventricular assist device (LVAD) support, extracorporeal membrane oxygenation (ECMO) use, infection status, donor age, donor body mass index, kidney pump use, cold ischemia time, and KDPI. In these models, ECMO use and male sex were independently associated with an increased risk of kidney graft failure. To improve transparency regarding covariate adjustment, the full multivariable Cox regression models are provided in Supplementary Tables 1-3. In sensitivity analyses, modeling MELD-XI as tertiles rather than as a continuous variable, higher MELD-XI categories remained significantly associated with increased risk of kidney graft failure (Supplementary Table 4).

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DISCUSSION

In this United States cohort of simultaneous heart–kidney transplant recipients, higher MELD-XI scores were associated with worse early post-transplant outcomes, including 1-year kidney graft survival and patient death. Stratification by MELD-XI tertiles in the UNOS cohort showed early and sustained separation of patient and graft survival curves. This suggests that MELD-XI may predict both early post-transplant complications as well as long-term risk. There is a clear association between MELD-XI scores and kidney graft outcomes in SHKT patients, especially in the early post-transplant period. This confirms the increased vulnerability of the renal allograft

function among higher-risk SHKT recipients. Early studies, using a historical cohort with distinct medical characteristics, showed benefits and good outcomes of SHKT-especially for dialysis-dependent heart transplant recipients-with similar outcomes in heart-alone or kidney-alone transplants[4-7,11-14]. However, contemporary data shows that SHKT recipients have significantly higher rates of kidney graft loss as well as increased risk of post-transplant mortality[5-8]. Our findings align with this trend.

Inferior outcomes among recipients with high MELD-XI scores are likely multifactorial and may reflect the complexity and complications associated with two major surgeries, perioperative hemodynamic fluctuations, and the need for continuous post-operative hemodynamic support[5,6]. The increased risk of hemodynamic instability among current SHKT candidates starts from pre-transplant period reflected by higher need of ECMO and/or LVAD, and then extends into both the perioperative and postoperative periods. One potential explanation is that hepatic dysfunction in SHKT recipients with higher MELD-XI group may contribute to increased bleeding and venous congestion, further impairing perioperative hemodynamics and fluid imbalance, and thereby increasing the need for hemodynamic or continuous renal replacement support. Subsequently, this can increase the risk for ischemia–reperfusion injury and delayed kidney graft function[4-7]. In our cohort, patients with higher MELD-XI scores more frequently required perioperative mechanical circulatory support (ECMO/LVAD) and early post-transplant dialysis-factors that have been previously associated with early kidney graft failure in SHKT recipients[5,6,12]. This creation of a kidney-hostile milieu contributes to higher rates of DGF, renal graft loss, and early mortality in this cohort. Therefore MELD-XI serves as a composite marker of systemic illness severity and the patient's ability to tolerate hemodynamic instability.

In our study, higher MELD-XI was found to predict both immediate perioperative risk and long-term post-transplant outcomes in SHKT recipients. Nearly half of recipients in the highest MELD-XI tertile experienced delayed kidney graft function (46%) and required dialysis at hospital discharge (47%) (Table 1), directly illustrating the association between high MELD-XI and worse early post-transplant outcomes. Two

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main implications emerge from these findings: First, recipients with higher MELD-XI scores are at greatest risk of adverse outcomes during the pre- and perioperative periods, a time of substantial physiological stress. Secondly, although organ dysfunction can be partially reversible, still the recipients in the high MELD-XI group suffer from a disproportionate burden of early complications. Taken together, these findings highlight the importance of early risk stratification and targeted interventions to improve transplant outcomes for high-risk patients.

Similarly, prior studies have demonstrated that MELD-XI is a strong predictor of morbidity and mortality following heart transplantation and other cardiac surgeries[9]. In line with these findings, American Heart Association guidelines advocate the use of MELD-XI for risk stratification in dual-organ heart–liver transplant candidates, particularly among those with perioperative liver dysfunction[2]. Our findings further expand this literature by incorporating MELD-XI into the SHKT population, a group in which patient outcomes have recently evolved and for which no well-established risk stratification tool currently exists[2]. Since recent studies have reported higher rates of kidney graft loss and early mortality among patients undergoing SHKT[4-8], and our study is the first to identify MELD-XI as an independent predictor of these outcomes in this population.

These changing outcomes may partly reflect the changes introduced by 2018 heart allocation policy. This new policy prioritized heart transplant for sicker patients with higher pre-transplant mortality risk and increased the number of candidates on temporary mechanical circulatory support before heart transplant[15-19]. One potential strategy to reduce early kidney graft failure under the 2023 kidney safety-net policy is to use MELD-XI to identify patients with increased risk of worse post-transplant outcomes and therefore help guide patient selection for SHKT *vs* kidney-after-heart (KAH) transplantation[20]. Approaches like KAH have shown better overall and kidney graft survival than SHKT[6]. Kidney graft and patient outcomes in KAH recipients are similar to those of kidney-alone transplants. The new kidney safety-net policy gives an alternative path for expedited kidney transplants in patients who do not recover renal

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function after a heart transplant. Under this approach, the heart transplant recipient can achieve hemodynamic stabilization and mitigation of other risk factors during the immediate post-transplant period. So, a subsequent KAH transplant can be performed under optimal conditions thereby lowering the risk of poor renal outcomes in high–MELD-XI SHKT candidates. This approach also helps with equitable allocation of limited kidney grafts to candidates who are more likely to achieve early graft success.

As a national registry, the UNOS database has inherent limitations that may affect the generalizability of our findings. This was a retrospective study using a single MELD-XI measurement, most likely obtained prior to transplant surgery; however, the exact timing is uncertain, and patient clinical conditions can change daily. Additionally, the registry does not provide detailed information regarding individual causes of mortality for all recipients. The diagnosis of kidney graft failure was not uniformly defined at the time and may vary across transplant programs. Important perioperative variables, including vasopressor use, blood transfusion, and duration of continuous renal replacement therapy, were unavailable.

Despite these limitations, our study clearly demonstrates that higher MELD-XI is consistently associated with increased risk of poor outcomes-including kidney graft loss and mortality-across multiple endpoints in the SHKT cohort.

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CONCLUSION

In conclusion, higher MELD-XI scores were associated with increased early mortality and kidney graft failure among SHKT recipients. As transplant practices continue to evolve in the era of the kidney safety net, MELD-XI may serve as a valuable risk-stratification tool to guide the selection of patients considered for SHKT. Future studies comparing outcomes across the pre- and post-kidney safety-net eras are warranted to further define the role of MELD-XI in optimizing patient and graft outcomes.

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Footnotes

Institutional review board statement: This study was considered exempt by our local Institutional Review Board due to the nature of the study.

Informed consent statement: Informed consent was not required.

Conflict-of-interest statement: All authors declare that they have no conflicts of interest and nothing to disclose.

Data sharing statement: The data used in this study were obtained from the United Network for Organ Sharing (UNOS) registry and are not publicly available due to data use agreements. Data may be obtained directly from UNOS with appropriate permissions. The statistical analysis and analytic code used in this study are available from the corresponding author upon request.

STROBE statement: The authors have read the STROBE Statement-checklist of items, and the manuscript was prepared and revised according to the STROBE Statement-checklist of items.

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Scientific quality: Grade A, Grade B

Novelty: Grade B, Grade B

Creativity or innovation: Grade B, Grade B

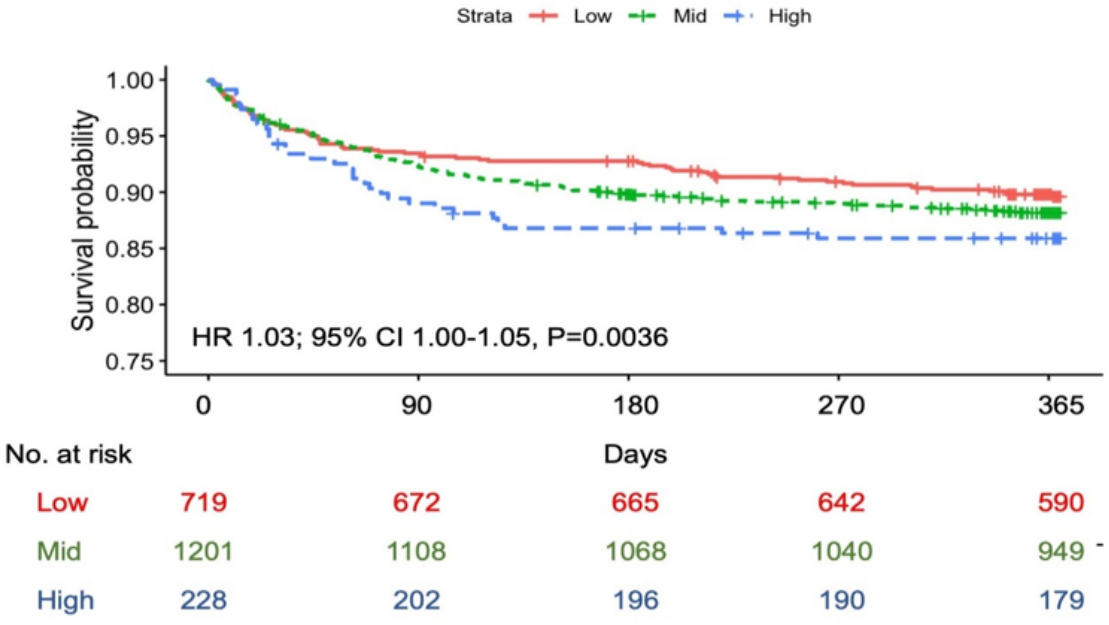
Scientific significance: Grade A, Grade B

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Figures and Tables

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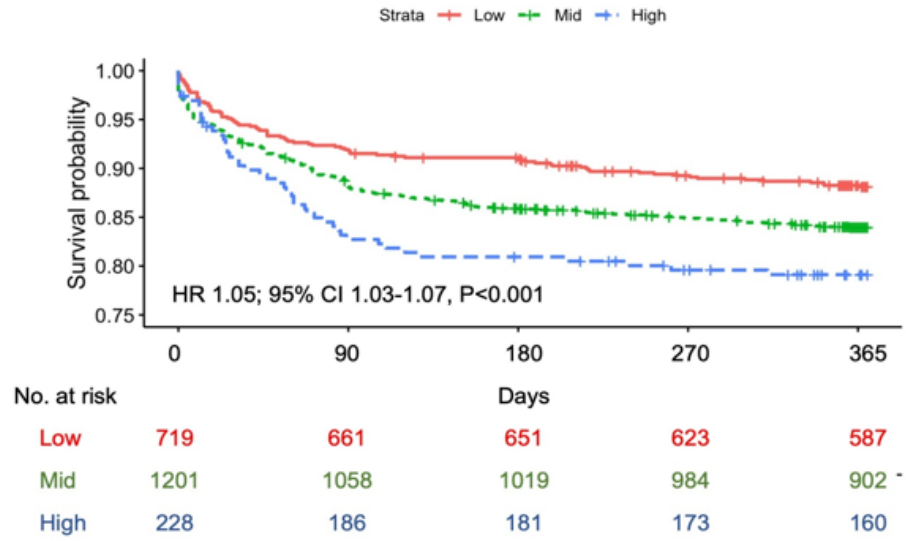


Figure 1 Kaplan–Meier survival curves. A: By model for end-stage liver disease excluding international normalized ratio (MELD-XI) tertiles. Kaplan-Meier curves for 1-year overall survival stratified by MELD-XI tertiles (low, mid, high) among simultaneous heart–kidney transplant recipients. Higher MELD-XI tertiles were associated with lower survival probabilities. Hazard ratio (HR) for MELD-XI (continuous) was 1.03 (95%CI: 1.00-1.05; P = 0.036). Tick marks represent censored observations; B: 1-year kidney graft survival stratified by MELD-XI tertiles. Kaplan–Meier curves demonstrating kidney graft survival among simultaneous heart–kidney transplant recipients stratified by MELD-XI tertiles (low, mid, and high). Patients in higher MELD-XI tertiles exhibited lower graft survival probabilities over time compared with those in lower tertiles. The HR for MELD-XI as a continuous variable was 1.05 (95%CI: 1.03-1.07; P < 0.001). Tick marks indicate censored observations. Numbers at risk at selected time points are shown below the plot. HR: Hazard ratio.

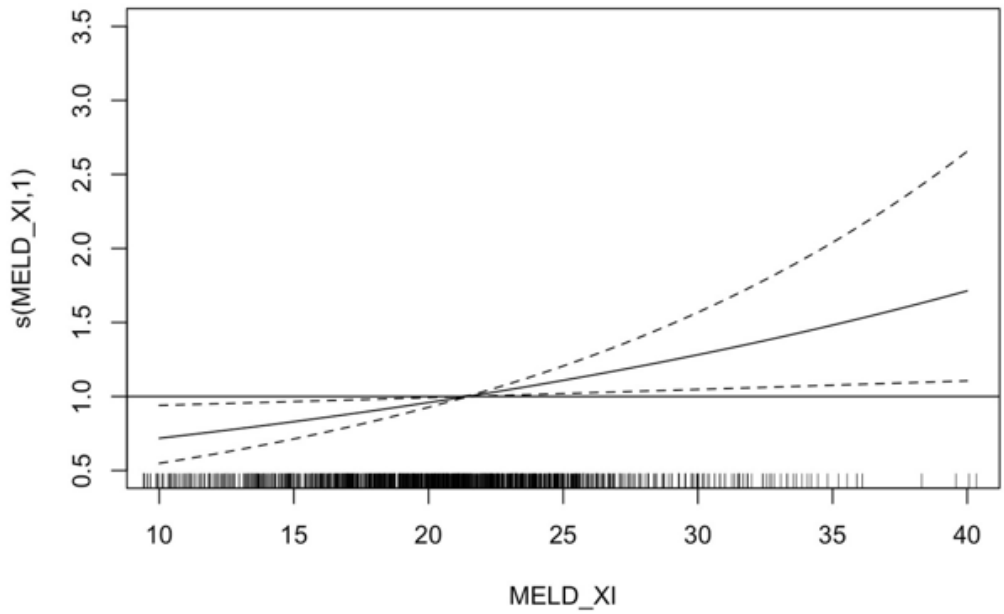


Figure 2 Nonlinear association between model for end-stage liver disease excluding international normalized ratio and risk of 1-year kidney graft failure. Restricted cubic spline demonstrating the association between model for end-stage liver disease excluding international normalized ratio (MELD-XI) and the hazard of 1-year kidney graft failure. The solid line represents the estimated hazard ratio across the range of MELD-XI values, with the reference value centered at approximately MELD-XI = 20. The dashed lines indicate 95%CI. Tick marks along the x-axis represent the distribution of MELD-XI values. A statistically significant nonlinear association was observed (P = 0.032), with relatively flat risk at lower MELD-XI values and progressively increasing risk at higher values. MELD-XI: Model for end-stage liver disease excluding international normalized ratio.

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Table 1 Characteristics of recipients/donors patients with simultaneous heart–kidney transplantation stratified by model for end-stage liver disease excluding international normalized ratio score, *n* (%)/median (interquartile range)

Recipient characteristics	Low, *n* = 719	Medium, *n* = 1201	High, *n* = 228	*P* value
MELD-XI	16.1 (13.6-17.6)	24.8 (21.5-25.7)	27.8 (26.7-30.0)	< 0.001
Age (year)	61.0 (54.0-65.0)	57.0 (50.0-63.0)	55.0 (47.0-62.0)	< 0.001
Sex				< 0.001
Male	173 (24)	209 (17)	26 (11)	
Female	546 (76)	992 (83)	202 (89)	
Race				
White	365 (51)	523 (44)	91 (40)	
Black	237 (33)	482 (40)	95 (42)	
Hispanic	72 (10)	124 (10)	21 (9.2)	
Asian	27 (3.8)	52 (4.3)	13 (5.7)	
Other	18 (2.5)	20 (1.7)	8 (3.5)	
BMI (kg/m²)	27.1 (24.2-30.8)	27.1 (24.0-31.0)	26.6 (23.0-30.1)	0.12
Blood type				0.81
A	271 (38)	430 (36)	78 (34)	
AB	35 (4.9)	72 (6.0)	14 (6.1)	
B	119 (17)	205 (17)	45 (20)	
O	294 (41)	494 (41)	91 (40)	
Waitlist days	42 (14-166)	52 (15-190)	29 (9-79)	< 0.001
Diabetes	340 (47)	578 (48)	96 (42)	0.25
HCV serostatus				
Negative	692 (96)	1,180 (98)	221 (97)	
Positive	27 (3.8)	21 (1.7)	7 (3.1)	
Serum Cr at transplant (mg/dL)	1.70 (1.33-1.98)	3.00 (2.40-4.59)	3.55 (2.22-4.70)	< 0.001

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Serum Cr at admission (mg/dL)	1.17 (0.86-1.60)	1.37 (1.00-2.00)	1.36 (0.93-2.02)	< 0.001
Dialysis at transplant				
No	719 (100)	755 (63)	89 (39)	
Yes	0 (0)	444 (37)	139 (61)	
Total bilirubin (mg/dL)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.70 (1.30-2.80)	< 0.001
Peripheral vascular disease	80 (11)	175 (15)	26 (11)	0.067
Intra-aortic balloon pump	169 (24)	247 (21)	39 (17)	0.088
Left ventricular assist device	272 (38)	374 (31)	72 (32)	0.009
Extracorporeal membrane oxygenation	39 (5.4)	39 (3.2)	21 (9.2)	< 0.001
Location at transplant: ICU	414 (58)	660 (55)	154 (68)	0.002
Inpatient	120 (17)	224 (19)	41 (18)	
Outpatient	185 (26)	317 (26)	33 (14)	
Donor characteristics				
Age (year)	31.0 (23.0-39.0)	32.0 (24.0-39.0)	31.0 (25.0-39.0)	0.48
Race				
White	448 (62)	716 (60)	143 (63)	
Black	93 (13)	174 (14)	32 (14)	
Hispanic	155 (22)	269 (22)	43 (19)	
Asian	7 (1.0)	26 (2.2)	7 (3.1)	
Other	16 (2.2)	16 (1.3)	3 (1.3)	
Blood type				
A	245 (34)	395 (33)	68 (30)	
AB	14 (1.9)	30 (2.5)	5 (2.2)	
B	79 (11)	131 (11)	31 (14)	
O	381 (53)	645 (54)	124 (54)	
BMI (kg/m^2)	27.1 (23.7-30.7)	26.9 (23.5-30.9)	26.5 (23.4-30.6)	0.5

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Creatinine (mg/dL)	0.90 (0.70-1.20)	0.90 (0.70-1.17)	0.90 (0.73-1.20)	0.29
Cause of death				
Anoxia	299 (42)	480 (40)	81 (36)	
Cerebrovascular	93 (13)	157 (13)	32 (14)	
Trauma	314 (44)	530 (44)	109 (48)	
Other	13 (1.8)	27 (2.2)	6 (2.6)	
DCD				0.29
No	682 (95)	1,145 (95)	222 (97)	
Yes	37 (5.1)	56 (4.7)	6 (2.6)	
Kidney pump				
No	409 (57)	657 (55)	134 (59)	
Yes	309 (43)	540 (45)	94 (41)	
Cold ischemia time (hour)	16 (9-22)	16 (10-21)	16 (10-22)	0.88
KDPI	0.14 (0.07-0.28)	0.15 (0.07-0.28)	0.13 (0.06-0.27)	0.67
Distance	192 (47-341)	177 (41-362)	136 (32-309)	0.24

MELD-XI: Model for end-stage liver disease excluding international normalized ratio; BMI: Body mass index; HCV: Hepatitis C virus; ICU: Intensive care unit; KDPI; Kidney donor profile index; DCD: Donation was after circulatory death.

Table 2 Outcomes of simultaneous heart-kidney transplantation stratified by model for end-stage liver disease excluding international normalized ratio scores, *n* (%)/median (interquartile range)

Outcomes	**Low tertile**	**Medium tertile**	**Highest tertile**	***P* value**
Length of stay (days)	21 (15-32)	21 (15-33)	24 (17-36)	< 0.007
Delayed kidney graft function	144 (20)	379 (32)	106 (46)	< 0.001
Dialysis at discharge	179 (25)	449 (37)	108 (47)	< 0.007
Creatine at 6 months (mg/dL)	1.28 (1.02-	1.35 (1.10-	1.37 (1.10-	< 0.001

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	1.57)	1.70)	1.72)	
Creatine at 1 year (mg/dL)	1.26 (1.05-1.54)	1.31(1.10-1.61)	1.37 (1.14-1.70)	< 0.001
Post-transplant stroke	28 (3.9)	43 (3.6)	12 (5.3)	0.48
Post-transplant pacemaker use	11 (1.5)	18 (1.5)	5 (2.2)	0.67
Rejection- kidney prior to discharge	7 (1.0)	11 (0.9)	4 (1.8)	0.13
Rejection-kidney at 1 year	21 (2.9)	41 (3.4)	6 (2.6)	< 0.001

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