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I, Audrey E Ertel , hereby submit this original work as part of the requirements for the degree of Master of Science in Clinical and Translational Research _____.

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Hospital Utilization of Nationally Shared Liver Allografts from 2009-2012

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Hospital Utilization of Nationally Shared Liver Allografts from 2009-2012

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by

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Abstract

Due to the current geographic disparities in liver allocation the Organ procurement and transplantation network has developed and proposed a regional redistricting policy which includes two potential redistricting plans, that would reduce the number of UNOS regions from the current 11 regions to 8 or 4 much larger regions. The measure of potential success of these proposed redistricting plans have been based upon regional median MELD scores and reductions in waitlist mortality. While these are important measures, no research has been done to assess the affects of such a policy change on recipient outcomes. We investigated the potential implications of this policy change on perioperative outcomes and resource utilization following liver transplantation (LT). Analysis was based on 12,282 deceased donor liver transplants performed between 2007-2012 using the Scientific Registry of Transplant Recipients linked to the University HealthSystem Consortium database. Univariate and multivariate analysis were used to determine how patient characteristics and hospital outcomes were associated with national sharing. Compared to locally distributed livers, nationally shared livers have a donor risk index >1.8 (64.3% vs. 11.6%), are more likely to be classified as expanded criteria donors (44.6% vs. 24.8%), and are transplanted into healthier recipients. Nationally shared LTs were more likely to be performed at high volume centers (49.1% vs. 30.6%), resulted in longer overall length of stay (11 vs. 9 days), and higher in-hospital mortality (6.6% vs. 3.3%). In addition, nationally shared allografts were independent predictors of in-hospital mortality (OR 1.64, 95% CI 1.13-2.39) and length of stay (OR 1.12, 95% CI 1.02-1.21). These data suggest that increased national sharing of livers will likely result inferior patient outcomes, such as increased in-hospital mortality, length of stay, readmission rate, and increased hospital resource utilization.

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Introduction

Since the advent of an organized system of organ allocation, waitlist mortality has been a highly publicized topic within the field of liver transplantation (LT). Arguably the most influential change in liver allocation came in 2002 when the Model for End-stage Liver Disease (MELD) score was introduced as a means of prioritizing waitlist patients based on mortality risk. With a more standardized method of organ allocation in place, focus was shifted to the geographic disparities in access to LT that existed within the United States. Efforts to reduce regional variation were introduced with the “Regional Share 15” and “Regional Share 35” policies, which were implemented in 2005 and 2013 respectively. While available data has shown an improvement in waitlist mortality (1, 2), significant geographic variability that still exists at the national level(3-6).

Under the current allocation policy, differences in MELD score at transplant may vary by more than 7 points depending upon the region in which the candidate resides. In addition, waitlist mortality varies up to 2-fold between the 11 United Network for Organ Sharing (UNOS) regions(4). To address this issue, the Organ Procurement and Transplantation Network (OPTN) has proposed a redistricting plan to improve waitlist time and mortality in those regions most severely affected (7). The implementation of this policy would significantly broaden the sharing of donor organs across large distances and potentially have significant negative effects on patient outcomes and resource utilization.

Currently, no research has been done to assess the impact of broader sharing, and therefore increased travel and cold ischemia times will have on clinical outcomes of the recipients. The goal of this study was to identify potential ramifications of the proposed policy on health? outcomes using data from nationally shared livers.

Methods

Study Population

A retrospective cohort study was performed for all LT recipients transplanted in the United States between January 1, 2007 and December 31, 2012. Data for this analysis was acquired from two separate sources. First, clinical data for recipient and donor characteristics were obtained from the Scientific Registry of Transplant Recipients (SRTR) Standard Analysis File. SRTR is a nation-wide database established in 1987 by the OPTN (8).

These data were then linked to recipient clinical and hospital encounter specific data obtained from the University HealthSystem Consortium (UHC) Clinical Data Base/Resource Manager (CDB/RM). UHC is an alliance of 118 academic medical centers and 298 of their affiliated hospitals representing approximately 95% of the nation's major not-for-profit academic medical centers. The CDB/RM is an administrative database wherein patient demographic, financial, ICD-9 diagnosis and procedure data are provided by the member medical centers. Hospital charges are reported for each patient encounter and are converted to cost estimates using institution specific Medicare cost-to-charge ratios and federally reported area wage indexes to normalize regional variation in labor cost (9-11). All costs were adjusted to 2012 dollars using the overall Consumer Price Index to account for inflation, as previously described (12).

From January 2007 to December 2012, 34,611 LTs from 135 centers were identified from the SRTR database. Over the same time period, 21,868 LTs from 67 centers were identified from the UHC CDB/RM database (13, 14). A linkage of patients within the 2 datasets was performed using recipient age, date of procedure, gender, zip code, and transplant center. Recipient age less than eighteen years ($n = 1,433$), living donor transplants ($n=715$), and repeat-LT within the same hospitalization ($n = 396$) were excluded from this dataset. The final matched

cohort consisted of 14,282 deceased donor LT recipients from 62 transplant centers representing 43% of the LTs performed nationally over the six-year period. This dataset was found to be similar to the overall SRTR LT cohort with regards to donor and recipient characteristics as well as liver disease etiology, severity of disease, and survival following LT. From these parameters we identified 10,690 locally distributed, 2,790 regionally distributed, and 802 nationally shared liver allografts. Nationally shared allografts are defined as those livers that cross regional boundaries and will be referred to as “shared” livers for the remainder of this manuscript. Through the linkage of these 2 independent datasets we were able to assess transplant-specific outcomes including patient and graft survival, as well as hospital-level outcomes including in-hospital mortality, 30-day readmission, discharge disposition, length of stay (LOS), and cost.

Study Variables

Allograft distribution categories (local, regional, and national) were defined according to the OPTN definitions based on the geographic relationship between the hospital where the organ is recovered and the transplant hospital where the candidate is listed (7).

Recipient and donor race were categorized into 4 groups: white, Black, Hispanic and other. Pre-transplant Model for End Stage Liver Disease (MELD) score was calculated for each recipient as previously described (15). MELD exception scores were not used. Donor type was categorized as standard criteria donor (SCD), expanded criteria donor (ECD), or donation after cardiac death (DCD). Expanded criteria donation was based on the United Network for Organ Sharing kidney definition in regards to kidney donors. Donor risk index (DRI) was calculated as previously described (16, 17) and was stratified into quartiles. Centers were ranked based on annual case volume and stratified into tertiles, representing low volume centers (lower third of

centers based on annual case volume ranging from 5 to 56 ± 4 transplantations/year), medium volume centers (middle third of centers based on case volume of 62 ± 6 to 99 ± 10 transplantations/year), and high volume centers (upper third of centers based on case volume of 102 ± 9 to 172 transplantations/year) (10, 18, 19). Centers performing fewer than five procedures per year were excluded from the center volume analysis.

Statistical Analysis

Statistical Analysis was performed using SAS 9.4 statistical software (SAS Institute, Cary, NC). Univariate analysis was performed using the Pearson's chi-squared test for categorical variables and Wilcoxon rank-sum test for continuous variables. Statistical significance was determined by a p-value less than 0.05. Multivariable analysis was performed analyzing total length of stay and discharge status. Variables that were found to be significant on univariate analysis were included in the covariate selection process in the multivariable analysis.

Odds ratio (OR) of mortality and discharge status after LT was estimated using logistic regression techniques while Poisson regression techniques were used for OR of overall length of stay. Models were adjusted for donor, recipient and center variables as noted in Tables 3a-c. Graft and patient survival were estimated using Kaplan-Meier survival curves. Log rank test was used to determine significant differences ($p < 0.05$) between cohorts.

The University of Cincinnati's Institutional Review Board approved this study. The linkage of these two databases was approved by the University HealthSystems Consortium, the SRTR and the HRSA. This study used data from the Scientific Registry of Transplant Recipients (SRTR). The SRTR data system includes data on all donor, wait-listed candidates, and transplant recipients in the US, submitted by the members of the OPTN, and has been described elsewhere.

The Health Resources and Services Administration, U.S. Department of Health and Human Services provides oversight to the activities of the OPTN and SRTR contractors.

Results

Donor characteristics are outlined in Table 1. Shared donors were older at 50 years of age versus 42 and 43 for local and regional donors. Shared donors were also more likely to be classified as ECD (44.6%) as compared to locally and regionally placed donors (24.8 & 27.2%) and were more likely to be positive for HCV antibody. Shared donors cause of death was more often due to cerebrovascular accidents, they had a longer cold ischemia times, and were more likely to have DRIs >1.8.

Table 2 demonstrates recipient characteristics from the overall cohort. Recipients of local, regional, and shared liver allografts were similarly more often male, white, and did not differ clinically in age. With regard to their health and pre-transplant status, recipients of shared liver allografts were more likely to be independent as compared to recipients of locally and regionally placed liver allografts, less likely to be severely limited, on hemodialysis prior to transplant, or in the ICU. They also tended to have a lower MELD score and were less likely to qualify for MELD exception points.

Liver transplantations for shared allografts were more likely performed at high volume centers, had higher in-hospital mortality, longer total LOS, and were less likely to be discharged to home. 30-day readmissions were no different across the 3 groups and direct cost was found to be statistically significantly higher for locally distributed organs as compared to regional and shared organs. Our unadjusted analysis of patient and graft survival supported that seen in the literature (20) which demonstrated that, with a median follow-up of 3 years, shared livers had lower patient ($p=0.003$) and graft survival ($p<0.001$) according to the Kaplan-Meier analysis.

Results of the final logistic regression model are shown in Table 3. After adjusting for recipient, donor and center characteristics, shared allografts remained independent predictors of in-hospital mortality (Table 3a) and length of stay (Table 3b). Patients receiving shared livers were also less likely to be discharged to home (Table 3c). Additional factors that were independently associated with increased mortality included recipient factors including age, extreme severity of illness, and use of DCD allografts. Undergoing transplantation at medium and high-volume centers was protective against mortality.

Discussion

Compared with locally and regionally distributed liver allografts, shared donor livers were of poorer quality as they were more often from elderly donors, positive for HCV-antibody, and had higher DRIs. In addition, shared liver allografts were transplanted into healthier recipients more likely to be classified as independent, with lower MELD scores, and less likely to be hospitalized or in the ICU prior to transplant. After controlling for donor and recipient specific characteristics shared allografts were independent predictors of in-hospital mortality, total length of stay, and failure to discharge patient to home. This study identifies the changes in outcomes the field of transplantation would see should the proposed policies for broader sharing be implemented.

The current OPTN redistricting plan for liver allocation regions is just one of many proposals that have been studied since the Health Resources and Services Administration (HRSA) Final Rule, established in 2000. (21) Most recently, Gentry et al.(22) published a simulation study using the Liver Simulated Allocation Model (LSAM) to demonstrate a potential redistribution of the 11 regions such that all regions have a similar allograft supply. The proposed model resulted in a relative reduction of 77 total deaths per year and 385 total deaths over a 5-year period. This figure is 69% of the total death reduction proposed in the 5-year simulation model of the OPTN 4 region plan and 100.2 % of the 8 region plan.(7, 23) These data suggest that such a drastic change in geographic boundaries is not necessary to achieve similar results in total waitlist death reduction. Furthermore, Axelrod et al. demonstrated that the cost of transplant admission was positively associated with DRI >1.7 and increasing MELD score with an exponential increase in cost noted with MELD scores greater than 25. (21) Registry studies and modeling analyses cannot adjust for recipient selection and transplant center behavior in a

prospective fashion. While cost was not significantly higher for shared livers in our analysis, the \$2,228 difference suggests that as liver allografts are increasingly shared they will incur the costs associated with increasing recipient MELD scores, donor DRI, and transportation. After adjusting for donor, recipient, and center characteristics Lai et al. demonstrated no increased risk of long-term patient and/or graft loss with nationally shared livers as compared to locally placed livers. However in that study, only six of 113 transplant centers (all classified as high-volume) utilized 64% of nationally shared allografts. (20)

Measures of potential success of the current redistricting proposals have been based upon regional median MELD score equalization and reductions in waitlist mortality. This is the first analysis to assess the potential effects of such a policy change on recipient outcomes. As stated in the Final Rule, allocation of organs “shall not be based on the candidates place of residence or place of listing.” It similarly emphasizes that we “shall seek to achieve the best use of donated organs.” In our study, in-hospital mortality was twice as high for recipients of shared allografts as compared to those who received locally distributed livers. After adjusting for donor, recipient and center factors, shared allografts were still independent predictors of increased in-hospital mortality, total length of stay, and decreased routine discharge to home. Inferior outcomes were seen with shared allografts despite their being transplanted into healthier recipients. Should the proposed policies be implemented similar donors will be prioritized and transplanted into severely debilitated recipients who lack the reserve of those patients encountered in this analysis. As more severely ill patients with higher MELD scores receive broadly shared livers we are likely to experience even worse recipient outcomes than the current analysis suggests.

Interestingly, cost was found to be higher for recipients of locally distributed liver allografts as compared to recipients of shared livers. This finding may be attributed to several factors. As noted above, the strongest predictor of increased hospital costs is higher MELD score at transplantation. In this analysis the average MELD at transplant for recipients of shared livers was 16, which was significantly lower than that of recipients of local organs. In addition, recipients of shared organs were more likely to have their transplant procedures performed at high-volume, high-efficiency hospitals. Lai et al. demonstrates that over 60% of all nationally shared liver allografts are utilized by just six transplant centers, all of which were classified as high-volume centers. When small transplant centers lacking the infrastructure and efficiency of larger centers begin to use these shared organs there will likely be a substantial increase in overall costs associated with the initial transplant admission. Lastly, there are many extraneous costs such as transportation that are not captured in this analysis. Thus the overall cost of shared liver allograft transplantations are likely underestimated in the current analysis.

This retrospective study of a large, national cohort of deceased donor LT recipients is not without its limitations, specifically those that come with the use of a large administrative database. Due to the nature of liver allocation, we do not know the overall number of shared allografts that were accepted but not utilized for transplantation. Additionally, the UHC database reports cost estimates but is lacking the granularity that is necessary for a more thorough analysis to identifying what accounts for cost differences. It is unlikely that many of the extraneous costs, including graft transport, have been accounted for in this model, and thus it may underestimate the overall cost of transplantations with shared liver allografts. We were also unable to determine which livers were obtained via DonorNet versus an expedited allocation. Lastly, this

linkage only represents 43% of all liver transplants during this time period and as a result, there may be some unavoidable selection bias.

In conclusion, it is necessary for us to recognize the potential ramifications of the proposed redistricting policies on patient outcomes. This analysis demonstrates that as broader sharing becomes the routine method of liver allocation, patient outcomes and hospital resource utilization will likely be affected.

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Appendix

Table 1. Demographic and Clinical Characteristics of Liver Allograft Donors

Sex				0.005
Male	6450 (60.3%)	1606 (57.6%)	452 (56.4%)	
Female	4240 (39.7%)	1184 (42.4%)	350 (43.6%)	
Age of Donor (years)	42 (28)	43 (28)	50 (26)	<0.001
Race				0.003
White	7042 (65.9%)	1864 (66.8%)	553 (69%)	
Black	2017 (18.9%)	549 (19.7%)	155 (19.3%)	
Hispanic	1260 (11.8%)	298 (10.7%)	60 (7.5%)	
Other	371 (3.5%)	79 (2.8%)	34 (4.2%)	
Donor Type				<0.001
SCD	7542 (70.6%)	1857 (66.6%)	380 (47.4%)	
DCD	496 (4.6%)	173 (6.2%)	64 (5.0%)	
Donor History of Hepatitis C	284 (2.7%)	135 (4.8%)	106 (13.2%)	<0.001
Cause of Death				<0.001
Trauma	3796 (35.5%)	933 (33.4%)	180 (22.4%)	
Anoxia	2435 (22.8%)	622 (22.3%)	207 (25.8%)	
CVA	4193 (39.2%)	1144 (41.0%)	392 (48.9%)	
Other	266 (2.5%)	91 (3.3%)	23 (2.9%)	
Donor Risk Index				<0.001
<1.2	4063 (38.0%)	540 (19.4%)	15 (1.9%)	
1.2 - 1.49	3068 (28.7%)	792(28.4%)	112 (14.0%)	
1.5 - 1.79	2317 (21.7%)	666 (23.9%)	159 (19.8%)	
>1.8	1242 (11.6%)	792 (28.4%)	516 (64.3%)	
BMI	26.29758 (7.2)	26.30804 (7.4)	27.08352 (8.5)	<0.001
Cold Ischemia Time (hours)	6.17 (3)	7.26 (3)	9 (3)	<0.001
Warm Ischemia Time (minutes)	40 (20)	39 (17)	39 (18)	<0.001

SCD= standard criteria donor, ECD= extended criteria donor, DCD= donation after cardiac death, CVA=cerebrovascular accident

Table 2. Demographic and Clinical Characteristics of Liver Transplant Recipients

Sex				<0.001
Male	7404 (69.2%)	1812 (65.0%)	536 (66.8%)	
Female	3286 (30.7%)	978 (35.0%)	266 (33.2%)	
Recipient Age (years)	56 (11)	56 (12)	57 (11)	<0.001
Race				0.221
White	7681 (71.9%)	2043 (73.2%)	584 (72.8%)	
Black	1078 (10.0%)	298 (10.7%)	75 (9.4%)	
Hispanic	1225 (11.5%)	272 (9.8%)	91 (11.4%)	
Other	706 (6.6%)	177 (6.3%)	52 (6.5%)	
Cause of Liver Disease				<0.001
<i>Alcohol</i>	1432 (13.4%)	333 (11.9%)	131 (16.3%)	
<i>HBV</i>	349 (3.3%)	90 (3.2%)	22 (2.7%)	
<i>HCC</i>	1330 (12.4%)	279 (10.0%)	84 (10.5%)	
<i>HCV</i>	3750 (35.1%)	931 (33.4%)	289 (36.0%)	
<i>HCV/HBV</i>	47 (0.4%)	11 (0.4%)	4 (0.5%)	
<i>NASH</i>	1370 (12.8%)	363 (13.0%)	105 (13.1%)	
<i>Other</i>	2410 (22.6%)	782 (28.0%)	167 (20.8%)	
Functional Status				<0.001
<i>Independent</i>	5112 (47.8%)	1127 (40.4%)	430 (53.6%)	
<i>Dependent</i>	3335 (31.2%)	887 (31.8%)	258 (32.2%)	
<i>Severely Ill</i>	1710 (16%)	653 (23.4%)	105 (13.1%)	
<i>Unknown</i>	533 (5.0%)	123 (4.4%)	9 (1.1%)	
Severity of Illness				<0.001
<i>Minor</i>	845 (8.8%)	209 (8.3%)	65 (9.6%)	
<i>Moderate</i>	3805 (39.8%)	864 (34.3%)	288 (42.7%)	
<i>Major</i>	3382 (35.4%)	962 (38.1%)	240 (35.6%)	
<i>Extreme</i>	1530 (16.0%)	487 (19.3%)	81 (12.0%)	
Physical Capacity				<0.001
<i>Hospitalized or Severely Limited</i>	2254 (27.7%)	812 (34.7%)	136 (19.3%)	
<i>Limited</i>	1404 (17.3%)	308 (13.2%)	151 (21.4%)	
<i>No Limitations</i>	4483 (55.1%)	1219 (52.1%)	419 (59.4%)	
MELD	19 (13)	21 (16)	16 (8)	<0.001
BMI	27.5652 (7.7)	27.56585 (7.7)	27.3362 (7.7)	<0.001
Pre-Transplant Lab Values				
<i>ALT</i>	43 (45)	46 (56)	38 (37)	<0.001
<i>Bilirubin</i>	3.3 (6.5)	4.1 (9.3)	2.5 (3.3)	<0.001
<i>Albumin</i>	2.9 (0.9)	3 (1)	3 (0.9)	<0.001
<i>INR</i>	1.5 (0.7)	1.6 (1)	1.4 (0.6)	<0.001
<i>Cr</i>	1.1 (0.8)	1.1 (0.9)	1 (0.5)	<0.001
<i>Na</i>	136 (6)	136 (6)	136 (6)	<0.001

Recipient on Ventilator	328 (3.1%)	167 (5.9%)	27 (3.4%)	<0.001
Center Volume				<0.001
<i>LV-C</i>	3840 (36.0%)	769 (27.6%)	203 (25.3%)	
<i>MV-C</i>	35.97 (33.4%)	1003 (36.0%)	205 (25.6%)	
<i>HV-C</i>	3269 (30.6%)	1018 (36.5%)	393 (49.1%)	
Length of Stay	9 (8)	10 (9)	11 (9)	<0.001
Direct Cost	104527 (64953)	97830 (57200)	102299 (67292)	<0.001
Mortality	385 (3.6)	129 (4.6)	53 (6.6)	<0.001
Routine Discharge Home	8784 (85.2)	2292 (86.1)	611 (81.5)	0.008
Readmission (30 day)	3820 (37.1)	967 (36.34)	297 (39.7)	0.253

MELD=Model for End Stage Liver disease, LV-C= low-volume center, MV-C= medium-volume center, HV-C= high-volume center

Table 3a: Multivariate analysis for predictors of in-hospital mortality for OLT recipients

Organ Location				
	<i>Local</i>	1.00		
	<i>Regional</i>	1.09	0.85- 1.39	0.515
	<i>Shared</i>	1.64	1.13-2.39	0.01
Physical Capacity				
	<i>Limited</i>	1.19	0.87-1.64	0.262
	<i>Severely limited</i>	3.13	1.63-6.02	0.001
Recipient on Ventilator		2.14	1.44-3.18	<0.001
Severity of Illness				
	<i>Minor</i>	1.00		
	<i>Moderate</i>	0.81	0.50-1.31	0.39
	<i>Major</i>	1.20	0.76-1.91	0.440
	<i>Extreme</i>	1.89	1.16-3.07	0.011
Center Volume				
	<i>LV-C</i>	1.00		
	<i>MV-C</i>	0.66	0.52-0.85	0.001
	<i>HV-C</i>	0.69	0.54-0.87	0.002
Recipient Albumin		0.83	0.72-0.95	0.009
Donor Type				
	<i>SCD</i>	1.00		
	<i>ECD</i>	0.86	0.66-1.11	0.251
	<i>DCD</i>	2.02	1.39-2.92	<0.001
Recipient Age (years)		1.01	1.00-1.02	0.009
Recipient MED condition				
	<i>ICU</i>	0.72	0.36-1.45	0.357
	<i>Hospital Ward</i>	0.49	0.26-0.97	0.041
	<i>Not Hospitalized</i>	1.00		
Cause of Death				
	<i>Trauma</i>	1.00		
	<i>Anoxia</i>	1.27	0.96-1.67	0.090
	<i>Cerebrovascular accident</i>	1.49	1.15-1.94	0.003
	<i>Other</i>	0.59	0.26-1.38	0.227

LV-C= low-volume center, MV-C= medium-volume center, HV-C= high-volume center, SCD= standard criteria donor, ECD= extended criteria donor, DCD= donation after cardiac death, ICU=intensive care unit.

Table 3b: Multivariate analysis for predictors of total length of stay mortality for OLT recipients

Organ Location				
	<i>Local</i>	1.00		
	<i>Regional</i>	0.97	0.93-1.02	0.307
	<i>Shared</i>	1.12	1.02-1.21	0.012
Physical Capacity				
	<i>Limited</i>	1.19	1.13-1.27	<0.001
	<i>Severely limited</i>	1.57	1.34-1.84	<0.001
Recipient on Ventilator		0.75	0.63-0.89	0.001
Recipient on Life support		1.75	1.48-2.07	<0.001
Severity of Illness				
	<i>Minor</i>	1.00		
	<i>Moderate</i>	1.12	1.01-1.23	0.025
	<i>Major</i>	1.47	1.33-1.62	<0.001
	<i>Extreme</i>	1.92	1.73-2.13	<0.001
Center Volume				
	<i>LV-C</i>	1.00		
	<i>MV-C</i>	0.89	0.85-0.94	<0.001
	<i>HV-C</i>	0.96	0.91-1.01	0.105
Recipient Bilirubin		1.01	1.00-1.01	0.017
Recipient Albumin		0.96	0.93-0.99	0.006
Recipient on Dialysis		1.08	1.01-1.15	0.025
Recipient Age (years)		1.01	1.00-1.01	<0.001
Recipient MED condition				
	<i>ICU</i>	0.83	0.70-0.99	0.042
	<i>Hospital Ward</i>	0.76	0.65-0.89	0.001
	<i>Not Hospitalized</i>	1.00		

LV-C= low-volume center, MV-C= medium-volume center, HV-C= high-volume center, SCD= standard criteria donor, ECD= extended criteria donor, DCD= donation after cardiac death, ICU=intensive care unit.

Table 3c: Multivariate analysis for predictors of discharge disposition for OLT recipients

Organ Location					
	<i>Local</i>	1.00			
	<i>Regional</i>	1.21	1.025	1.416	0.024
	<i>Shared</i>	0.61	0.481	0.777	<0.001
Cause of Liver Disease					
	<i>ALCOHOL</i>	0.74	0.615	0.901	0.003
	<i>HCC</i>	0.89	0.697	1.145	0.373
	<i>NASH</i>	0.72	0.593	0.87	<0.001
	<i>OTHER</i>	1.03	0.855	1.231	0.779
Gender					
	<i>Male</i>	1.00			
	<i>Female</i>	0.80	0.69-0.92		0.002
Race					
	<i>White</i>	1.00			
	<i>Black</i>	0.91	0.74-1.12		0.367
	<i>Hispanic</i>	1.41	1.15-1.73		0.001
	<i>Other</i>	1.39	1.02-1.91		0.038
MELD		0.97	0.96-0.99		<0.001
Recipient Angina		0.62	0.46-0.84		0.002
Recipient on Hemodialysis		0.75	0.60-0.92		0.006
Recipient TIPPS		0.73	0.58-0.94		0.013
Functional Status					
	<i>Independent</i>	1.00			
	<i>Dependent</i>	0.95	0.79-1.13		0.572
	<i>Severely Ill</i>	0.65	0.49-0.86		0.002
	<i>Unknown</i>	0.66	0.36-1.23		0.191
Physical Capacity					
	<i>Hospitalized or Severely Limited</i>	0.22	0.14-0.35		<0.001
	<i>Limited</i>	0.67	0.57-0.83		<0.001
	<i>No Limitations</i>	1.00			
Recipient MELD condition					
	<i>Not Hospitalized</i>	1.00			
	<i>Hospital Ward</i>	2.49	1.55-3.98		<0.001
	<i>ICU</i>	2.19	1.31-3.68		0.003
Recipient on Ventilator		0.34	0.24-0.48		<0.001

Severity of Illness				
	<i>Minor</i>	1.00		
	<i>Moderate</i>	0.87	0.63-1.19	0.370
	<i>Major</i>	0.46	0.34-0.63	<0.001
	<i>Extreme</i>	0.32	0.23-0.44	<0.001
Center Volume				
	<i>LV-C</i>	1.00		
	<i>MV-C</i>	1.17	1.00-1.37	0.046
	<i>HV-C</i>	1.38	1.18-1.60	<0.001
Recipient Age (years)		0.96	0.95-0.96	<0.001
Recipient Bilirubin		1.01	1.00-1.02	0.011
Recipient Albumin		1.36	1.24-1.49	<0.001
Donor Type				
	<i>SCD</i>	1.00		
	<i>ECD</i>	0.90	0.78-1.04	0.168
	<i>DCD</i>	0.63	0.49-0.82	<0.001

HCC= hepatocellular carcinoma, NASH= non-alcoholic steatohepatitis, , ICU=intensive care unit, LV-C= low-volume center, MV-C= medium-volume center, HV-C= high-volume center, SCD= standard criteria donor, ECD= extended criteria donor, DCD= donation after cardiac death.