A Clinical Tool to Guide Selection and Utilization of Marginal Donor Livers with Graft

Biopsy in Liver Transplantation

Supplemental Materials

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Table S1. Complete Population Characteristics

	All Transplants (n=16 691)	Test Cohort (n=11 600)	Validate Cohort (n=5,091)	p-Value
Donor Characteristics				
Age, years (median, IQR)	51 (40 – 61)	51 (40 – 61)	51 (40 – 60)	0.28
Gender, female (n, %)	7,745 (46.4%)	5,406 (46.6%)	2,339 (45.9%)	0.43
Ethnicity				0.23
White	11 343 (68.0%)	7,923 (68.3%)	3,420 (67.2%)	
Black	3,086 (18.5%)	2,109 (18.2%)	977 (19.2%)	
Hispanic	1,632 (9.8%)	1,147 (9.9%)	485 (9.5%)	
Asian	408 (2.4%)	269 (2.3%)	139 (2.7%)	
Other	222 (1.3%)	152 (1.3%)	70 (1.4%)	
Body Mass Index, kg/m^2	28.2 (24.3 – 33.4)	28.2 (24.3 – 33.3)	28.3 (24.3 – 33.6)	0.37
Blood Type				0.67
O	7,995 (47.9%)	5,557 (47.9%)	2,438 (47.9%)	
A	6,217 (37.3%)	4,331 (37.3%)	1,886 (37.1%)	
B	1,974 (11.8%)	1,353 (11.7%)	621 (12.2%)	
AB	505 (3.0%)	359 (3.1%)	146 (2.9%)	
MaS on Biopsy (%)	5 (0 – 10)	5 (0 – 10)	5 (0 – 10)	0.41
Cause of Death				0.93
Anoxia	4,306 (25.8%)	3,002 (25.9%)	1,304 (25.6%)	
Trauma	3,623 (21.7%)	2,524 (21.8%)	1,099 (21.6%)	
CVA/Stroke	8,377 (50.2%)	5,811 (50.1%)	2,566 (50.4%)	
Other	385 (2.3%)	263 (2.3%)	122 (2.4%)	
Diabetes	3,221 (19.4%)	2,219 (19.3%)	1,002 (19.8%)	0.39
Hypertension	8,643 (52.1%)	6,003 (52.1%)	2,640 (52.2%)	0.91
Prior Malignancy	841 (5.1%)	601 (5.2%)	240 (4.7%)	0.22
Prior MI	994 (6.0%)	682 (5.9%)	312 (6.1%)	0.55
CDC High Risk	2,076 (12.4%)	1,433 (12.4%)	643 (12.6%)	0.63
Cigarette Smoker	5,704 (34.2%)	3,964 (34.2%)	1,740 (34.2%)	0.99
Any Drug Use	5,822 (34.9%)	4,010 (34.6%)	1,812 (35.6%)	0.20
HCV-Positive	1,367 (8.2%)	922 (8.0%)	445 (8.7%)	0.09
HBV-Positive	1,511 (9.1%)	1,060 (9.1%)	451 (8.9%	0.58
EBV-Positive	14 368 (86.1%)	10 008 (86.3%)	4,360 (85.6%)	0.27
CMV-Positive	11 353 (68.0%)	7,932 (68.4%)	3,421 (67.2%)	0.13
Terminal AST	41 (25 – 81)	42 (25 – 81)	41 (25 – 80)	0.30
Terminal ALT	33 (21 – 66)	34 (21 – 67)	33 (21 – 67)	0.72
Terminal Bilirubin	0.7 (0.4 – 1.1)	0.7 (0.4 – 1.1)	0.7 (0.4 – 1.1)	0.91
Transplant Characteristics				
Cold Ischemic Time, hrs	6.6 (5.1 – 8.4)	6.6 (5.1 – 8.4)	6.5 (5.2 – 8.3)	0.36
CIT Groups				0.44
<4 Hours	1,356 (8.3%)	938 (8.2%)	418 (8.4%)	
4 to <6 Hours	4,594 (28.0%)	3,187 (28.0%)	1,407 (28.1%)	
6 to <8 Hours	5,164 (31.5%)	3,543 (31.1%)	1,621 (32.4%)	

8 to <10 Hours	3,212 (19.6%)	2,262 (19.8%)	950 (19.0%)	
10 to <12 Hours	1,357 (8.3%)	962 (8.4%)	395 (7.9%)	
≥12 Hours	727 (4.4%)	511 (4.5%)	216 (4.3%)	
Recipient Characteristics				
Age, years	56 (51 – 62)	56 (51 – 61)	57 (51 – 62)	0.39
Gender, female	4,987 (0.74)	3,475 (30.0%)	1,512 (29.7%)	0.74
Ethnicity				0.68
White	12 324 (73.8%)	8,559 (73.8%)	3,765 (74.0%)	
Black	1,550 (9.3%)	1,080 (9.3%)	470 (9.2%)	
Hispanic	1,877 (11.3%)	1,306 (11.3%)	571 (11.2%)	
Asian	702 (4.2%)	480 (4.1%)	222 (4.4%)	
Other	238 (1.4%)	175 (1.5%)	63 (1.2%)	
Body Mass Index, kg/m^2	28.1 (24.6 – 32.3)	28.1 (24.7 – 32.4)	28.1 (24.6 – 32.2)	0.61
Blood Type				0.79
O	7,650 (45.8%)	5,323 (45.9%)	2,327 (45.7%)	
A	6,118 (36.7%)	4,253 (38.9%)	1,865 (36.6%)	
B	2,164 (13.0%)	1,488 (12.8%)	676 (13.3%)	
AB	759 (4.6%)	536 (4.6%)	223 (4.4%)	
MELD-Na Score	21.6 (15.0 – 29.2)	21.6 (15.0 – 29.3)	21.3 (15.0 – 29.0)	0.16
Exception Points				0.66
No Exceptions	10 360 (62.1%)	7,224 (62.3%)	3,136 (61.6%)	
HCC Exceptions	4,677 (28.0%)	3,239 (27.9%)	1,438 (28.3%)	
Other Exceptions	1,654 (9.9%)	1,137 (9.8%)	517 (10.2%)	
Etiology of ESLD				0.70
Acute Liver Failure	517 (3.1%)	362 (3.1%)	155 (3.0%)	
Alcohol	2,113 (12.7%)	1,495 (12.9%)	618 (12.1%)	
NASH/CC	2,039 (12.2%)	1,438 (12.4%)	601 (11.8%)	
Hepatitis C Virus	4,504 (27.0%)	3,082 (26.6%)	1,408 (27.7%)	
Hepatitis B Virus	255 (1.5%)	179 (1.5%)	76 (1.5%)	
HCC	4,605 (27.6%)	3,197 (27.6%)	1,408 (27.7%)	
Cholestatic Disease	1,159 (6.9%)	805 (6.9%)	354 (7.0%)	
Congenital/Metabolic	459 (2.8%)	326 (2.8%)	133 (2.6%)	
Cirrhosis (NOS)	703 (4.2%)	479 (4.1%)	224 (4.4%)	
Other	337 (2.0%)	237 (2.0%)	100 (2.0%)	
Prior Malignancy	3,137 (18.8%)	2,191 (18.9%)	946 (18.6%)	0.65
Diabetes	4,226 (25.3%)	2,940 (25.3%)	1,286 (25.3%)	0.91
EBV-Positive	10 484 (62.8%)	7,324 (63.1%)	3,160 (62.1%)	0.19
CMV-Positive	10 035 (66.1%)	6,978 (66.1%)	3,057 (66.0%)	0.91
Prior Abdominal Surgery	7,077 (43.2%)	4,939 (43.3%)	2,138 (42.8%)	0.58
Prior TIPS	1,522 (9.3%)	1,051 (9.2%)	471 (9.4%)	0.66
PV Thrombosis	1,629 (9.9%)	1,139 (9.9%)	490 (9.8%)	0.74
Encephalopathy	10 223 (61.3%)	7,096 (61.2%)	3,127 (61.4%)	0.76
Ascites	12 323 (73.8%)	8,542 (73.6%)	3,781 (74.3%)	0.39

Dialysis 2x Within Week Prior to Txp	1,097 (6.4%)	772 (6.7%)	325 (6.4%)	0.54
On Mechanical Ventilation at Txp	613 (3.7%)	421 (3.6%)	192 (3.8%)	0.65

Abbreviations: ALT- alanine aminotransferase, AST- aspartate aminotransferase, CMV- cytomegalovirus, EBV- Epstein-Barr virus, ESLD- end-stage liver disease, HBV- hepatitis B virus, HCC- hepatocellular carcinoma, HCV- hepatitis C virus, IQR- interquartile range, MaS- macrosteatosis, MELD-Na- Model for End-stage Liver Disease- Sodium score, MI- myocardial infarction, NASH/CC- nonalcoholic steatosis/cryptogenic cirrhosis, PV- portal vein, TIPS- transjugular intrahepatic portosystemic shunt

Table S2A. 30 Day Allograft Survival (Test Population)

	Univariate Analysis			Multivariable Analysis		
	HR	95% CI	p-Value	HR	95% CI	p-Value
Donor Characteristics						
MaS on Biopsy (per % steatosis)	1.010	1.004 – 1.015	<0.001	1.010	1.004 – 1.016	0.001
Transplant Characteristics						
Cold Ischemic Time			<0.001			<0.001
<4 Hours	Reference			Reference		
4 to <6 Hours	1.348	0.889 – 2.044		1.363	0.877 – 2.117	
6 to <8 Hours	1.556	1.034 – 2.340		1.508	0.977 – 2.329	
8 to <10 Hours	2.014	1.330 – 3.049		1.872	1.201 – 2.918	
10 to >12 Hours	2.353	1.501 – 3.690		1.882	1.150 – 3.081	
≥12 Hours	3.028	1.871 – 4.899		2.871	1.697 – 4.856	
Recipient Characteristics						
Body Mass Index (per kg/m^2)	1.028	1.104 – 1.042	<0.001	1.022	1.007 – 1.037	0.004
MELD-Na Score (per point)	1.019	1.011 – 1.027	<0.001	1.021	1.009 – 1.033	<0.001
Exception Points Awarded			0.001			<0.001
No Exception Points	Reference			Reference		
HCC Exception Points	0.698	0.568 – 0.858		1.241	0.946 – 1.629	
Other Exception Points	1.115	0.858 – 1.448		1.831	1.338 – 2.509	
Prior Abdominal Surgery	1.432	1.212 – 1.692	<0.001	1.434	1.200 – 1.714	<0.001
Portal Vein Thrombosis	2.129	1.721 – 2.635	<0.001	2.052	1.631 – 2.583	<0.001
On Mechanical Ventilation at Time of Transplant	1.768	1.358 – 2.302	<0.001	3.583	2.647 – 4.851	<0.001
*Year of transplant and UNOS region of transplant controlled for by inclusion in model						

Table S2B. 90 Day Allograft Survival (Test Population)

	Univariate Analysis			Multivariable Analysis		
	HR	95% CI	p-Value	HR	95% CI	p-Value
Donor Characteristics						
MaS on Biopsy (per % steatosis)	1.007	1.002 – 1.012	0.006	1.007	1.002 – 1.012	0.013
Cause of Death			<0.001			0.015
Anoxia	Reference			Reference		
Trauma	1.204	0.973 – 1.490		1.257	1.002 – 1.577	
Cerebrovascular Accident	1.433	1.202 – 1.710		1.358	1.122 – 1.644	
Other	1.509	0.968 – 2.353		1.478	0.925 – 2.363	
HCV-Positive	0.457	0.321 – 0.651	<0.001	0.565	1.223 – 2.557	0.002
Transplant Characteristics						
Cold Ischemic Time (per hour)			<0.001			<0.001
<4 Hours	Reference			Reference		
4 to <6 Hours	1.328	0.950 – 1.855		1.342	0.945 – 1.907	
6 to <8 Hours	1.526	1.099 – 2.118		1.479	1.046 – 2.091	
8 to <10 Hours	1.805	1.290 – 2.526		1.694	1.185 – 2.420	
10 to >12 Hours	2.292	1.595 – 3.293		1.875	1.263 – 2.783	
≥12 Hours	2.511	1.681 – 3.753		2.327	1.502 – 3.606	
Recipient Characteristics						
Body Mass Index (per kg/m^2)	1.026	1.014 – 1.038	<0.001	1.020	1.007 – 1.032	0.002
MELD-Na Score (per point)	1.024	1.018 – 1.031	<0.001	1.026	1.016 – 1.036	<0.001
Exception Points Awarded			<0.001			0.003
No Exception Points	Reference			Reference		
HCC Exception Points	0.652	0.549 – 0.774		1.170	0.933 – 1.468	
Other Exception Points	0.988	0.789 – 1.236		1.602	1.225 – 2.096	
Prior Abdominal Surgery	1.378	1.201 – 1.582	<0.001	1.419	1.225 – 1.643	<0.001
Portal Vein Thrombosis	1.867	1.552 – 2.246	<0.001	1.806	1.480 – 2.203	<0.001
On Mechanical Ventilation at Time of Transplant	3.274	2.612 – 4.102	<0.001	2.826	2.178 – 3.668	<0.001
*Year of transplant and UNOS region of transplant controlled for by inclusion in model						

Table S2C. 1-Year Allograft Survival (Test Population)

	Univariate Analysis			Multivariable Analysis		
	HR	95% CI	p-Value	HR	95% CI	p-Value
Donor Characteristics						
Age (per year)	1.011	1.007 – 1.014	<0.001	1.007	1.003 – 1.011	<0.001
Cause of Death			<0.001			0.027
Anoxia	Reference			Reference		
Trauma	1.083	0.927 – 1.266		1.136	0.964 – 1.338	
Cerebrovascular Accident	1.315	1.158 – 1.494		1.200	1.044 – 1.380	
Other	1.450	1.048 – 2.006		1.474	1.051 – 2.069	
Hx of Diabetes	1.239	1.097 – 1.347	<0.001	1.216	1.070 – 1.382	0.003
Transplant Characteristics						
Cold Ischemic Time (per hour)			<0.001			0.002
<4 Hours	Reference			Reference		
4 to <6 Hours	1.260	0.999 – 1.587		1.190	0.948 – 1.516	
6 to <8 Hours	1.419	1.132 – 1.780		1.353	1.074 – 1.705	
8 to <10 Hours	1.399	1.130 – 1.773		1.318	1.033 – 1.680	
10 to >12 Hours	1.694	1.303 – 2.204		1.474	1.121 – 1.939	
≥12 Hours	1.972	1.471 – 2.643		1.800	1.325 – 2.444	
Recipient Characteristics						
Age (per year)	1.007	1.002 – 1.013	0.010	1.013	1.007 – 1.019	<0.001
Ethnicity			0.023			0.026
White	Reference			Reference		
Black	1.220	1.038 – 1.435		1.292	1.092 – 1.529	
Asian	0.785	0.590 – 1.045		0.941	0.786 – 1.126	
Hispanic	0.921	0.779 – 1.089		0.897	0.668 – 1.206	
Other	0.823	0.523 – 1.295		0.889	0.563 – 1.404	
MELD-Na Score (per point)	1.017	1.012 – 1.024	<0.001	1.023	1.014 – 1.031	<0.001
Exception Points Awarded			0.001			0.003
No Exception Points	Reference			Reference		
HCC Exception Points	0.800	0.709 – 0.902		1.197	1.018 – 1.408	
Other Exception Points	0.938	0.789 – 1.116		1.407	1.152 – 1.719	
EBV-Positive	0.916	0.825 – 1.016	0.09	0.831	0.739 – 0.934	0.002
Prior Abdominal Surgery	1.295	1.170 – 1.434	<0.001	1.311	1.179 – 1.457	<0.001
Portal Vein Thrombosis	1.625	1.407 – 1.877	<0.001	1.662	1.430 – 1.933	<0.001
On Mechanical Ventilation at Time of Transplant	2.480	2.050 – 2.999	<0.001	2.155	1.733 – 2.678	<0.001
On Dialysis Within Week Prior to Transplant	1.603	1.353 – 1.900	<0.001	1.276	1.039 – 1.566	0.020
*Year of transplant and UNOS region of transplant controlled for by inclusion in model						

Table S2D. 3-Year Allograft Survival (Test Population)

	Univariate Analysis			Multivariable Analysis		
	HR	95% CI	p-Value	HR	95% CI	p-Value
Donor Characteristics						
Age (per year)	1.010	1.001 – 1.013	<0.001	1.009	1.006 – 1.013	<0.001
Cause of Death			<0.001			0.017
Anoxia	Reference			Reference		
Trauma	1.112	0.983 – 1.258		1.174	1.031 – 1.336	
Cerebrovascular Accident	1.294	1.168 – 1.433		1.188	1.063 – 1.328	
Other	1.164	0.875 – 1.548		1.251	0.931 – 1.680	
Hx of Diabetes	1.220	1.107 – 1.345	<0.001	1.181	1.066 – 1.309	0.001
Procurement Characteristics						
Cold Ischemic Time (per hour)			<0.001			<0.001
<4 Hours	Reference			Reference		
4 to <6 Hours	1.115	0.935 – 1.329		1.070	0.894 – 1.280	
6 to <8 Hours	1.255	1.057 – 1.491		1.205	1.010 – 1.437	
8 to <10 Hours	1.240	1.035 – 1.486		1.193	0.991 – 1.436	
10 to >12 Hours	1.432	1.169 – 1.755		1.300	1.053 – 1.607	
≥12 Hours	1.610	1.278 – 2.028		1.523	1.196 – 1.940	
Recipient Characteristics						
Age (per year)	1.005	1.000 – 1.009	0.040	1.005	1.000 – 1.011	0.032
Ethnicity			<0.001			<0.001
White	Reference			Reference		
Black	1.409	1.244 – 1.596		1.389	1.218 – 1.584	
Asian	0.751	0.594 – 0.950		1.010	0.879 – 1.161	
Hispanic	1.037	0.911 – 1.180		0.832	0.649 – 1.067	
Other	0.794	0.547 – 1.154		0.862	0.592 – 1.256	
MELD-Na Score (per point)	1.008	1.004 – 1.012	<0.001	1.015	1.009 – 1.020	<0.001
Etiology of ESLD			<0.001			<0.001
Acute Liver Failure	Reference			Reference		
NASH/CC	0.839	0.652 – 1.080		1.031	0.777 – 1.368	
Alcohol	0.732	0.547 – 0.945		0.895	0.676 – 1.186	
Hepatitis C Virus	1.046	0.828 – 1.322		1.404	1.083 – 1.821	
Hepatitis B Virus	0.621	0.396 – 0.974		0.862	0.536 – 1.389	
Hepatocellular Carcinoma	0.986	0.780 – 1.246		1.438	1.097 – 1.888	
Cholestatic Disease	0.723	0.546 – 0.957		0.962	0.711 – 1.302	
Congenital/Metabolic Disease	0.790	0.561 – 1.111		1.004	0.697 – 1.445	
Cirrhosis (NOS)	0.947	0.705 – 1.273		1.131	0.823 – 1.554	
EBV-Positive	0.929	0.855 – 1.009	0.08	0.887	0.808 – 0.974	0.012
Prior Malignancy	1.107	1.001 – 1.225	0.048	1.137	1.017 – 1.272	0.025
Prior TIPS	1.154	1.009 – 1.320	0.037	1.173	1.022 – 1.348	0.024
Prior Abdominal Surgery	1.192	1.099 – 1.293	<0.001	1.215	1.116 – 1.323	<0.001
Portal Vein Thrombosis	1.336	1.179 – 1.514	<0.001	1.355	1.189 – 1.544	<0.001
On Mechanical Ventilation at Time of Transplant	1.936	1.632 – 2.297	<0.001	1.966	1.617 – 2.391	<0.001
*Year of transplant and UNOS region of transplant controlled for by inclusion in model						

Table S3A. Combined Model In Test and Validate Populations (30-Day Graft Survival)

	Test			Validate		
	HR	95% CI	p-Value	HR	95% CI	p-Value
Donor Characteristics						
Age (per year)	1.003	0.997 – 1.010	0.31	1.003	0.992 – 1.015	0.58
MaS on Biopsy (per % steatosis)	1.010	1.004 – 1.016	<0.001	1.014	1.005 – 1.024	0.003
Cause of Death			0.12			0.23
Anoxia	Reference			Reference		
Trauma	1.328	1.015 – 1.739		1.115	0.687 – 1.808	
Cerebrovascular Accident	1.192	0.938 – 1.515		1.458	0.972 – 2.186	
Other	1.634	0.949 – 2.815		0.894	0.273 – 2.931	
Hx of Diabetes	1.186	0.949 – 1.481	0.13	1.036	0.708 – 1.517	0.85
Procurement Characteristics						
Cold Ischemic Time (per hour)			<0.001			0.002
<4 Hours	Reference			Reference		
4 to <6 Hours	1.391	0.895 – 2.161		1.268	0.588 – 2.733	
6 to <8 Hours	1.527	0.987 – 2.360		1.713	0.813 – 3.608	
8 to <10 Hours	1.926	1.234 – 3.004		1.887	0.873 – 4.079	
10 to >12 Hours	1.940	1.184 – 3.178		2.506	1.092 – 5.749	
≥12 Hours	2.858	1.682 – 4.856		4.042	1.709 – 9.560	
Recipient Characteristics						
Age (per year)	1.002	0.993 – 1.012	0.66	1.013	0.996 – 1.030	0.14
Body Mass Index (per kg/m^2)	1.023	1.008 – 1.039	0.002	1.042	1.017 – 1.067	<0.001
Ethnicity			0.26			0.03
White	Reference			Reference		
Black	1.224	0.908 – 1.650		1.831	1.176 – 2.851	
Hispanic	1.077	0.804 – 1.443		0.844	0.483 – 1.475	
Asian	1.473	0.951 – 2.282		1.770	0.872 – 3.591	
Other	0.720	0.320 – 1.621		0.488	0.067 – 3.540	
MELD-Na Score (per point)	1.020	1.007 – 1.034	0.003	1.019	0.997 – 1.041	0.09
Exception Points Awarded			0.001			0.46
No Exception Points	Reference			Reference		
HCC Exception Points	1.201	0.909 – 1.587		1.064	0.673 – 1.681	
Other Exception Points	1.818	1.321 – 2.500		1.405	0.816 – 2.420	
EBV-Positive	0.895	0.730 – 1.098	0.29	0.961	0.688 – 1.344	0.82
Prior Abdominal Surgery	1.447	1.209 – 1.732	<0.001	1.344	0.995 – 1.815	0.05
Portal Vein Thrombosis	2.052	1.627 – 2.587	<0.001	1.753	1.159 – 2.652	0.008
On Mechanical Ventilation at Time of Transplant	3.759	2.774 – 5.093	<0.001	2.299	1.294 – 4.083	0.005
*Year of transplant and UNOS region of transplant controlled for by inclusion in model						

Table S3B. Combined Model In Test and Validate Populations (90-Day Graft Survival)

	Test			Validate		
	HR	95% CI	p-Value	HR	95% CI	p-Value
Donor Characteristics						
Age (per year)	1.004	0.999 – 1.010	0.12	1.009	1.000 – 1.019	0.044
MaS on Biopsy (per % steatosis)	1.007	1.002 – 1.013	0.005	1.012	1.005 – 1.021	0.002
Cause of Death			0.02			0.18
Anoxia	Reference			Reference		
Trauma	1.298	1.032 – 1.632		0.975	0.662 – 1.436	
Cerebrovascular Accident	1.328	1.087 – 1.622		1.320	0.962 – 1.810	
Other	1.569	0.981 – 2.509		1.252	0.567 – 2.764	
Hx of Diabetes	1.166	0.971 – 1.400	0.10	1.063	0.793 – 1.424	0.68
Procurement Characteristics						
Cold Ischemic Time (per hour)			<0.001			<0.001
<4 Hours	Reference			Reference		
4 to <6 Hours	1.322	0.930 – 1.880		1.345	0.739 – 2.448	
6 to <8 Hours	1.495	1.056 – 2.115		1.678	0.934 – 3.014	
8 to <10 Hours	1.733	1.212 – 2.477		2.098	1.149 – 3.830	
10 to >12 Hours	1.923	1.295 – 2.857		2.194	1.125 – 4.278	
≥12 Hours	2.327	1.497 – 3.617		4.009	2.024 – 7.942	
Recipient Characteristics						
Age (per year)	1.006	0.998 – 1.014	0.14	1.021	1.007 – 1.035	0.003
Body Mass Index (per kg/m^2)	1.020	1.007 – 1.032	0.002	1.026	1.006 – 1.046	0.010
Ethnicity			0.44			0.10
White	Reference			Reference		
Black	1.183	0.927 – 1.510		1.490	1.027 – 2.161	
Hispanic	1.010	0.790 – 1.291		1.014	0.679 – 1.515	
Asian	1.113	0.742 – 1.670		1.536	0.873 – 2.701	
Other	0.638	0.316 – 1.288		0.295	0.041 – 2.121	
MELD-Na Score (per point)	1.028	1.017 – 1.039	<0.001	1.038	1.020 – 1.055	<0.001
Exception Points Awarded			0.002			0.005
No Exception Points	Reference			Reference		
HCC Exception Points	1.154	0.915 – 1.455		1.384	0.967 – 1.982	
Other Exception Points	1.642	1.252 – 2.154		1.976	1.310 – 2.981	
EBV-Positive	0.879	0.744 – 1.038	0.13	1.047	0.802 – 1.366	0.74
Prior Abdominal Surgery	1.421	1.225 – 1.647	<0.001	1.117	0.882 – 1.416	0.36
Portal Vein Thrombosis	1.785	1.462 – 2.180	<0.001	1.839	1.332 – 2.540	<0.001
On Mechanical Ventilation at Time of Transplant	3.049	2.347 – 3.961	<0.001	2.608	1.690 – 4.024	<0.001
*Year of transplant and UNOS region of transplant controlled for by inclusion in model						

Table S3C. Combined Model In Test and Validate Populations (1-Year Graft Survival)

	Test			Validate		
	HR	95% CI	p-Value	HR	95% CI	p-Value
Donor Characteristics						
Age (per year)	1.006	1.002 – 1.010	0.003	1.007	1.001 – 1.014	0.029
MaS on Biopsy (per % steatosis)	1.003	0.998 – 1.007	0.24	1.009	1.003 – 1.015	0.003
Cause of Death			0.019			0.005
Anoxia	Reference			Reference		
Trauma	1.160	0.980 – 1.373		0.926	0.701 – 1.224	
Cerebrovascular Accident	1.222	1.057 – 1.413		1.340	1.070 – 1.678	
Other	1.502	1.056 – 2.138		0.857	0.447 – 1.642	
Hx of Diabetes	1.176	1.029 – 1.345	0.017	1.230	0.913 – 1.381	0.271
Procurement Characteristics						
Cold Ischemic Time (per hour)			0.049			0.001
<4 Hours	Reference			Reference		
4 to <6 Hours	1.230	0.965 – 1.568		1.091	0.751 – 1.585	
6 to <8 Hours	1.352	1.063 – 1.718		1.361	0.946 – 1.958	
8 to <10 Hours	1.328	1.032 – 1.708		1.372	0.934 – 2.016	
10 to >12 Hours	1.404	1.055 – 1.869		1.371	0.878 – 2.140	
≥12 Hours	1.636	1.184 – 2.261		2.401	1.508 – 3.822	
Recipient Characteristics						
Age (per year)	1.014	1.007 – 1.020	<0.001	1.023	1.013 – 1.033	<0.001
Body Mass Index (per kg/m^2)	1.005	0.996 – 1.015	0.29	1.012	0.997 – 1.026	0.119
Ethnicity			0.031			0.003
White	Reference			Reference		
Black	1.314	1.104 – 1.563		1.648	1.273 – 2.133	
Hispanic	0.976	0.812 – 1.174		1.100	0.832 – 1.456	
Asian	0.907	0.665 – 1.238		1.181	0.768 – 1.814	
Other	0.925	0.586 – 1.461		0.587	0.217 – 1.586	
MELD-Na Score (per point)	1.026	1.018 – 1.035		1.031	1.018 – 1.044	<0.001
Exception Points Awarded			0.001			0.001
No Exception Points	Reference			Reference		
HCC Exception Points	1.245	1.054 – 1.471		1.439	1.116 – 1.855	
Other Exception Points	1.445	1.174 – 1.779		1.728	1.726 – 2.341	
EBV-Positive	0.848	0.751 – 0.958	0.008	0.975	0.807 – 1.178	0.792
Prior Abdominal Surgery	1.311	1.175 – 1.463	<0.001	1.177	0.994 – 1.394	0.059
Portal Vein Thrombosis	1.684	1.443 – 1.965	<0.001	1.378	1.066 – 1.782	0.014
On Mechanical Ventilation at Time of Transplant	2.360	1.899 – 2.935	<0.001	2.516	1.816 – 3.488	<0.001
*Year of transplant and UNOS region of transplant controlled for by inclusion in model						

Table S3D. Combined Model In Test and Validate Populations (3-Year Graft Survival)

	Test			Validate		
	HR	95% CI	p-Value	HR	95% CI	p-Value
Donor Characteristics						
Age (per year)	1.007	1.004 – 1.010	<0.001	1.006	1.001 – 1.012	0.015
MaS on Biopsy (per % steatosis)	1.001	0.998 – 1.005	0.540	1.007	1.002 – 1.012	0.005
Cause of Death			0.022			0.004
Anoxia	Reference			Reference		
Trauma	1.165	1.019 – 1.331		1.043	0.840 – 1.296	
Cerebrovascular Accident	1.192	1.063 – 1.338		1.336	1.115 – 1.602	
Other	1.223	0.899 – 1.663		0.991	0.608 – 1.616	
Hx of Diabetes	1.161	1.044 – 1.292	0.006	1.121	0.949 – 1.324	0.178
Procurement Characteristics						
Cold Ischemic Time (per hour)			0.024			<0.001
<4 Hours	Reference			Reference		
4 to <6 Hours	1.077	0.896 – 1.296		1.077	0.803 – 1.446	
6 to <8 Hours	1.194	0.996 – 1.432		1.319	0.990 – 1.757	
8 to <10 Hours	1.212	1.001 – 1.467		1.397	1.034 – 1.889	
10 to >12 Hours	1.259	1.012 – 1.568		1.394	0.985 – 1.976	
≥12 Hours	1.443	1.225 – 1.854		2.114	1.452 – 3.078	
Recipient Characteristics						
Age (per year)	1.007	1.002 – 1.012	0.006	1.014	1.006 – 1.022	<0.001
Body Mass Index (per kg/m^2)	0.999	0.992 – 1.007	0.878	1.005	0.993 – 1.017	0.450
Ethnicity			<0.001			0.001
White	Reference			Reference		
Black	1.454	1.271 – 1.664		1.526	1.236 – 1.883	
Hispanic	1.042	0.903 – 1.202		1.007	0.799 – 1.270	
Asian	0.800	0.623 – 1.027		1.037	0.727 – 1.478	
Other	0.899	0.617 – 1.310		0.565	0.251 – 1.271	
MELD-Na Score (per point)	1.018	1.011 – 1.024	<0.001	1.018	1.008 – 1.028	
Exception Points Awarded			<0.001			0.006
No Exception Points	Reference			Reference		
HCC Exception Points	1.373	1.207 – 1.563		1.356	1.111 – 1.656	
Other Exception Points	1.292	1.091 – 1.531		1.333	1.036 – 1.716	
EBV-Positive	0.910	0.826 – 1.003	0.057	0.981	0.843 – 1.141	0.801
Prior Abdominal Surgery	1.220	1.118 – 1.331	<0.001	1.159	1.012 – 1.327	0.033
Portal Vein Thrombosis	1.395	1.221 – 1.593	<0.001	1.286	1.040 – 1.590	0.020
On Mechanical Ventilation at Time of Transplant	1.965	1.621 – 2.383	<0.001	2.366	1.786 – 3.134	<0.001
*Year of transplant and UNOS region of transplant controlled for by inclusion in model						

Figure S1.

Figure S1. 3-Year Allograft Survival in Test and Validate Cohorts
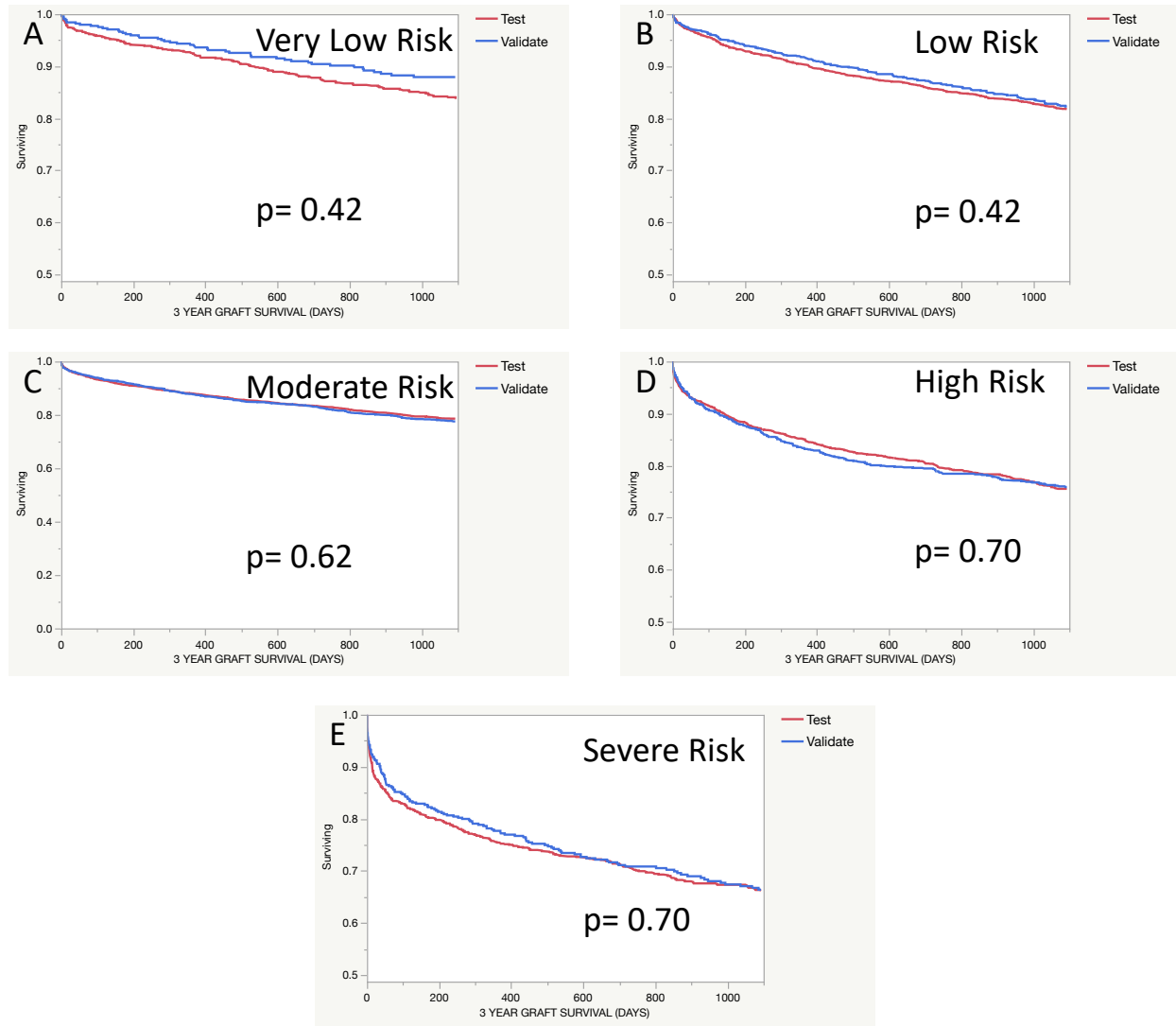

Figure S1. Three-year allograft survival in Test and Validate Cohorts. Kaplan-Meier survival curves evaluated graft survival between Test and Validate cohorts within LTAB Risk Groups. No significant differences in graft survival were identified between cohorts within each risk group.

Figure S2.

Figure S2. Distribution of Mini-LTAB Scores in Test and Validate Cohorts
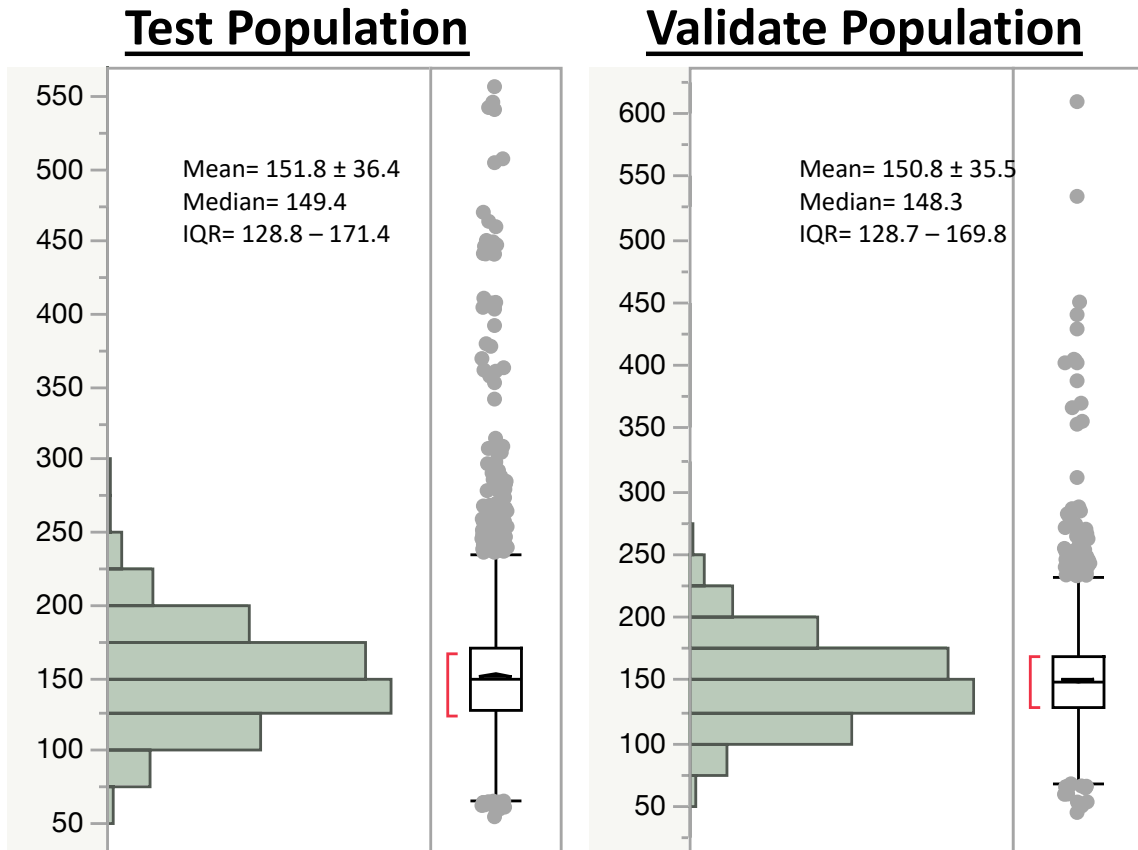

Figure S2. Distribution of Mini-LTAB Scores in Test and Validate Cohorts. Histograms depict the distribution of Mini-LTAB scores in Test and Validate cohorts. Means, medians, and interquartile ranges (IQR) are reported.

Figure S3.

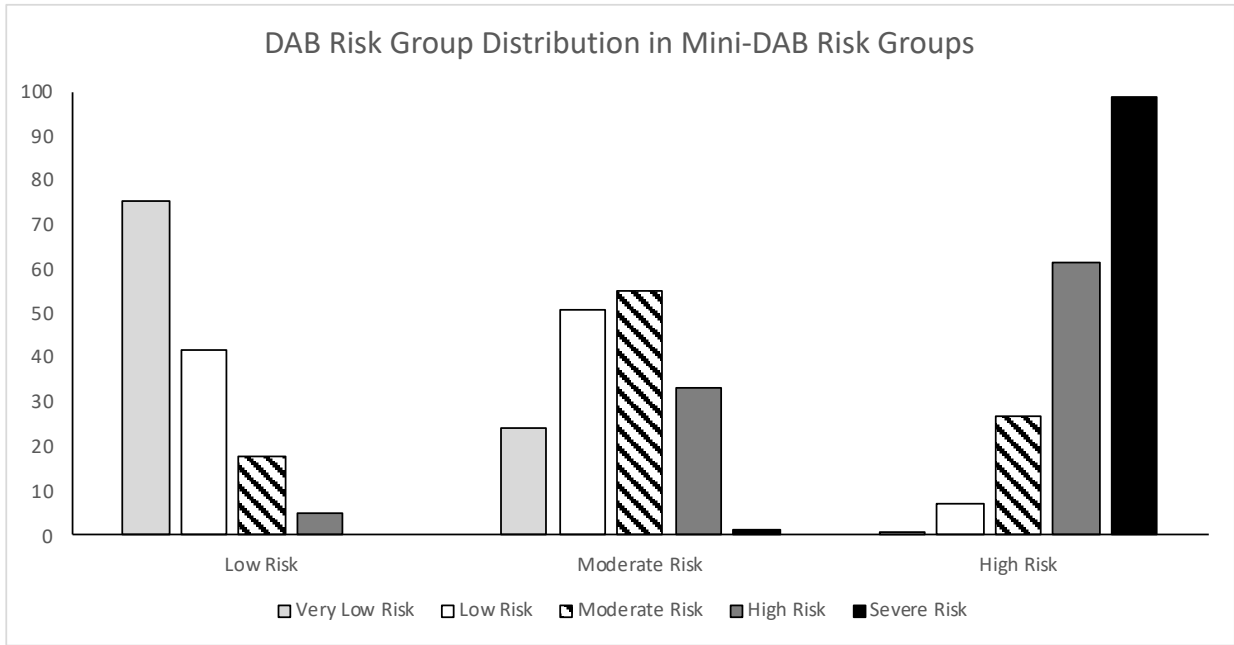## Figure S3. Cross-Over Between LTAB and Mini-LTAB Risk Groups

Figure S3. Cross-Over Between LTAB and Mini-LTAB Risk Groups. The percent of transplants within each LTAB risk groups were re-grouped by their Mini-LTAB risk group.

Figure S4.

Figure S1. Receiver Operator Curves for Scoring Systems in Transplant
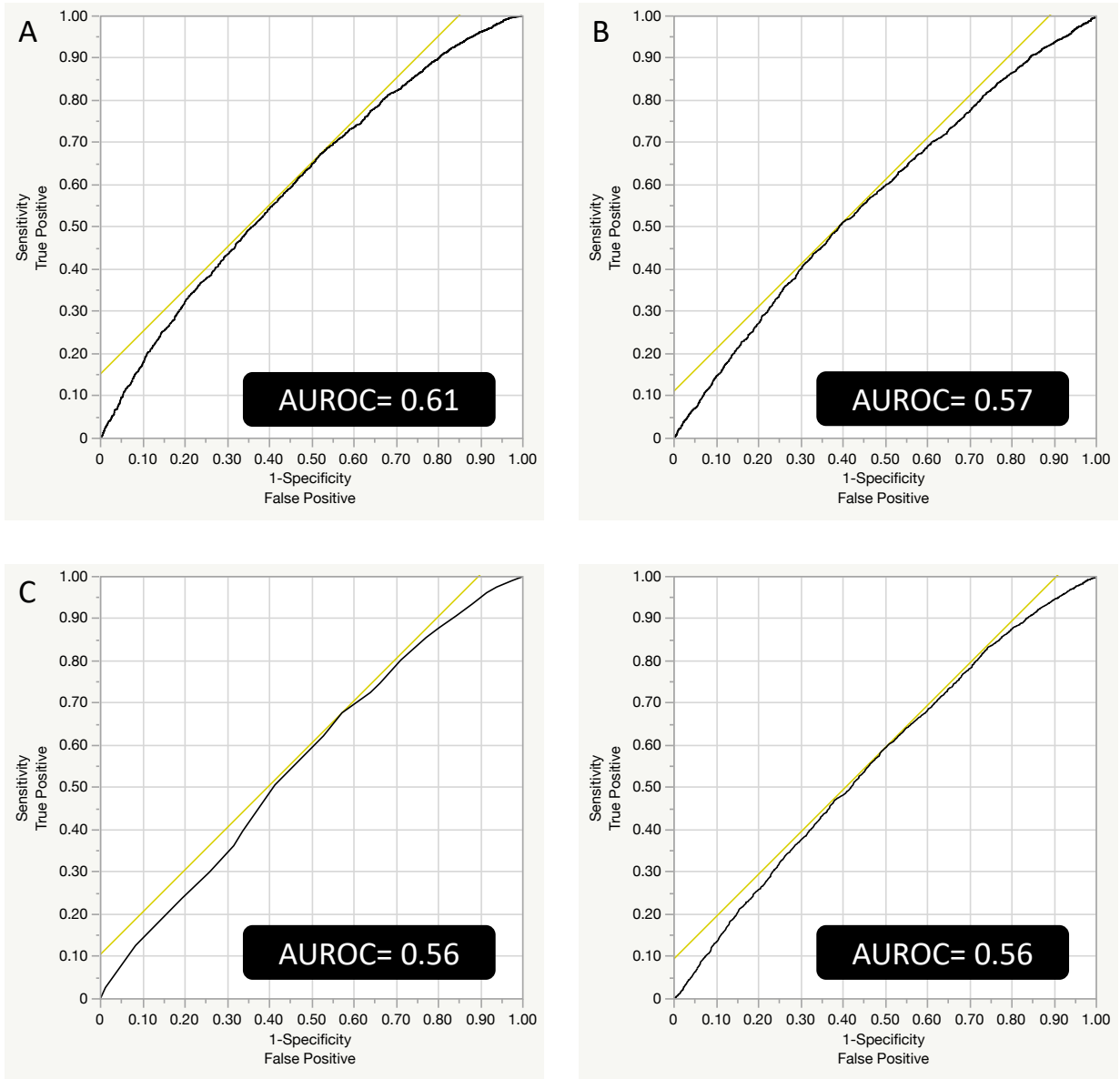
Figure S4. Area under receiver operator curves for multiple predictive scores in liver transplant outcomes. ROC are depicted for A) LTAB score, B) mini-LTAB score, C) BAR score, and D) Donor-MELD score, and AUROC are reported for all.