Supplementary Online Content

Kanwal F, Hernaez R, Liu Y, et al. Factors associated with access to and receipt of liver transplantation in veterans with end-stage liver disease. *JAMA Intern Med*. Published online May 24, 2021. doi:10.1001/jamainternmed.2021.2051

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This supplementary material has been provided by the authors to give readers additional information about their work.

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eMethods 1. MELD-Na Score Calculation

We calculated the model for end-stage liver disease with sodium correction MELD-Na longitudinally using the values of serum bilirubin, international normalized ratio (INR), creatinine, and sodium tests performed within 6 months of each, using bilirubin test date as the anchor. In patients who had multiple tests (for example, multiple creatinine values) in the six months around a given bilirubin date, we chose the one closest to the anchor bilirubin test in calculating MELD-Na.

```
MELDscore = 10 * ((0.957 * ln(Creatinine)) + (0.378 * ln(Bilirubin)) + (1.12 * ln(INR))) + 6.43

MELDNascore = MELDscore - SerumNa - (0.025 * MELDscore * (140 - SerumNa)) + 140
```

Because MELD-Na can be spuriously high in patients on warfarin or those with chronic kidney disease, we removed patients if their MELD-Na values exceeded 15 while receiving warfarin treatment or if their MELD-Na values (at index) were primarily driven by high serum creatinine, which we defined as values >3.5 mg/dL in the presence of normal range bilirubin (<1.5 mg/dL) and INR (<1.5).

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eMethods 2. Ascertainment of Referral

To be considered for liver transplantation within the VA, patients are required to undergo an initial evaluation at their home facility; results of this evaluation are then reviewed by one of the 6 VA transplant centers. Patients who are referred to non-VA transplant centers for VA Purchased care also undergo this process, where a VA transplant center physician reviewer determines the eligibility for liver transplant evaluation. The evaluation and referral information are entered in the EMR using dedicated progress note templates with specific titles. We developed and validated an algorithm that used the specific progress note titles to identify liver transplantation referral within the VA.

We started with a broad keyword search to identify all mentions of the term *transplant* which included mentions that contained the root word, such as *transplantation* and *transplants* in the progress note titles for all patients in our cohort. We then selected a random test sample of 50 patients who had at least one progress note that met the search criteria. To refine our search to improve its precision (positive predictive value, PPV) for *actual referral*, we reviewed *all* progress notes for these patients to identify and record the exact (full) titles that were associated with the actual referral request. To ensure we did not miss any instances of referral, we then used an iterative process where we repeated the step above to identify additional titles. Specifically, after removing patients in our cohort who were classified as being referred based on findings of the previous step, we reviewed an additional 50 random cases with the keyword transplant in a note title to ascertain actual referral status and record referral-specific titles. We then repeated this process until no new note titles were identified suggesting we had a comprehensive list of titles that indicated *actual* referral for liver transplant. We have included the complete list of titles so identified in the **Table 1**. **Figure** below depicts our algorithm development process.

To further validate the completeness of the list, we compared actual referral rates in a random sample of 50 patients with notes from the list and 50 patients without such notes. All of the patients with notes were referred for transplantation and none without notes from the list were (**PPV for transplant referral 100%**). However, 3 out of 50 were referred for kidney rather than liver transplantation **(PPV for liver transplant referral 94%**). The 3 patients had chronic liver disease, but the high MELD-Na was driven by high serum creatinine (>2.0 mg/dLn all 3 cases) with serum bilirubin values <1.5 mg/dl and normal range INR.

To maximize the precision of our referral outcome, we again conducted targeted medical record reviews of all patients classified as referred but whose laboratory profile

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indicated primary kidney dysfunction (serum creatinine >2.0 mg/dL and serum bilirubin values <1.5 mg/dL at the time of the index MELD-Na >15). Of the 117 such patients, 37 patients were referred for kidney transplantation only; we re-classified them as not referred for liver transplantation in further analyses. This hierarchical approach allowed complete ascertainment of referral for liver transplantation in our study cohort.

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Figure. Development and validation of algorithm to define liver transplant referral

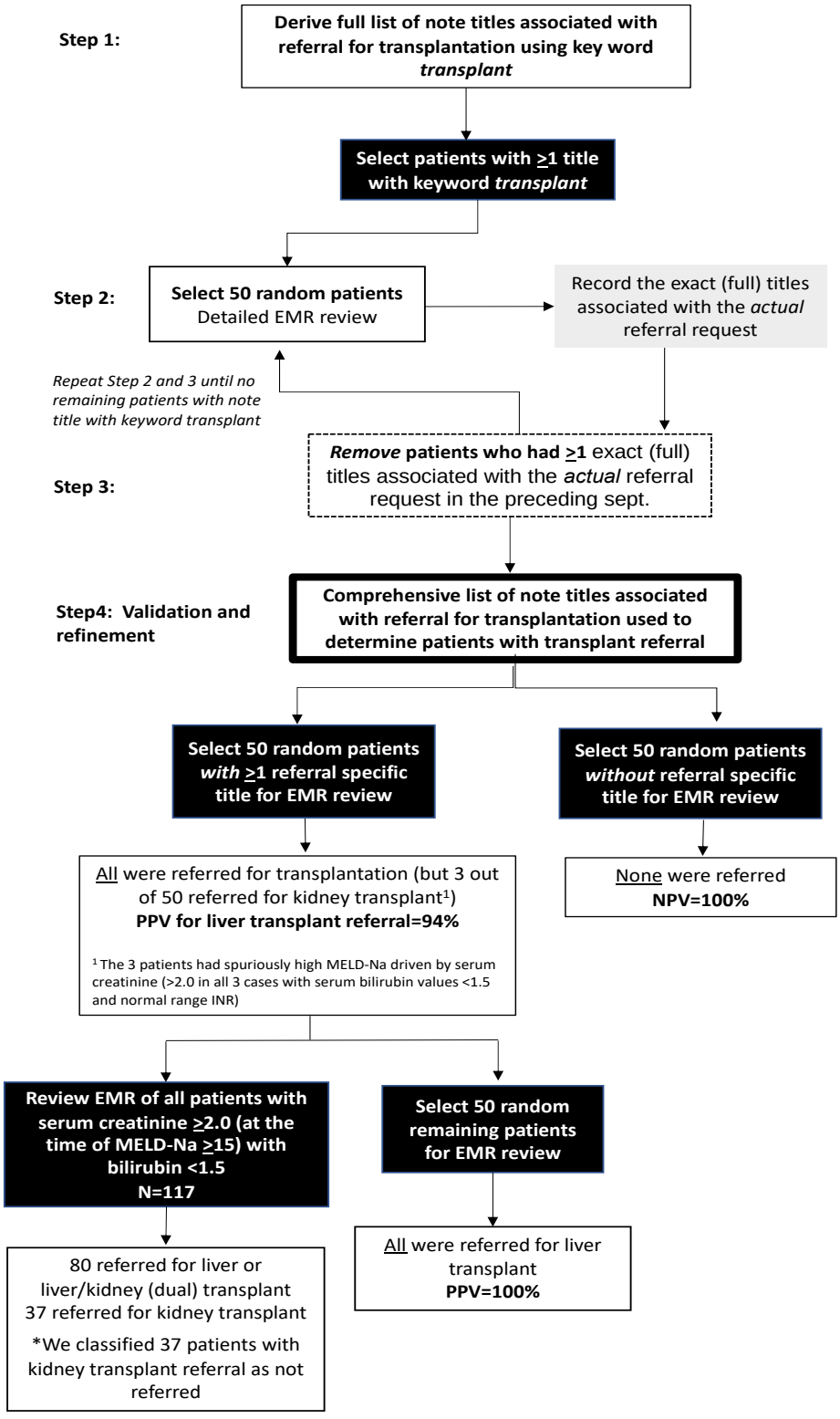

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Table 1. Complete list of titles used to identify liver transplant referral
RAW TIU Document Definition
PRE-TRANSPLANT
PRE-TRANSPLANT/BHOST/BHIP ASSESSMENT
PRE-TRANSPLANT/PHYSICIAN ASSESSMENT
PRE-TRANSPLANT/VACO REFERRAL
PHYSICIAN OR STAFF ASSESMENT
PHYSICIAN ASSESSMENT FOR TRANSPLANT CANDIDATE
PHYSICIAN ASSESSMENT FOR TRANSPLANT CANDIDATES
PHYSICIAN ASSESSMENT FOR TRANSPLANT CANDIDATES - T
PHYSICIAN ASSESSMENT FOR TRANSPLANT CANDIDATES (T)
PHYSICIAN TRANSPLANT CANDIDATE EVALUATION
PHYSICIAN TRANSPLANT CANDIDATE EVALUATION NOTE
STAFF PHYSICIAN ASSESSMENT FOR TRANSPLANT CANDIDAT
VA STAFF PHYSICIAN ASSESSMENT FOR TRANSPLANT CANDI
PHYSICIAN SUMMARY FOR
PHYSICIAN SUMMARY FOR TRANSPLANT
PHYSICIAN SUMMARY FOR TRANSPLANT (T)
PHYSICIAN SUMMARY FOR TRANSPLANT (TP)
PHYSICIAN SUMMARY FOR TRANSPLANT CANDIDATE
PHYSICIAN SUMMARY FOR TRANSPLANT CANDIDATE (CI)(T)
PHYSICIAN SUMMARY FOR TRANSPLANT CANDIDATE NOTE
PHYSICIAN SUMMARY FOR TRANSPLANT CANDIDATE NOTE (T
PHYSICIAN SUMMARY FOR TRANSPLANT CANDIDATES
PHYSICIAN SUMMARY FOR TRANSPLANT CANDIDATES (T)
PHYSICIAN SUMMARY FOR TRANSPLANT NOTE
PHYSICIAN SUMMARY FOR TRANSPLANT-T
TRANSPLANT PHYSICIAN SUMMARY FOR TRANSPLANT CANDID
TRANSPLANT
TRANSPLANT CANDIDATE EVALUATION NOTE
TRANSPLANT CANDIDATE EVALUATION NOTE/MEDICAL
TRANSPLANT CANDIDATE PHYSICIAN EVALUATION
TRANSPLANT CANDIDATE PHYSICIAN SUMMARY
TRANSPLANT CANDIDATE VACO REFERRAL NOTE
TRANSPLANT REFERRAL
TRANSPLANT REFERRAL
TRANSPLANT REFERRAL (BASE)
TRANSPLANT REFERRAL CANDIDATE NOTE (CI)
TRANSPLANT REFERRAL CONSULT
TRANSPLANT REFERRAL FORM
TRANSPLANT REFERRAL FORM (SCANNED)
TRANSPLANT REFERRAL FORM NOTE
TRANSPLANT REFERRAL FORM VAF 10-0390
TRANSPLANT REFERRAL FORM-MUSC-TL

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TRANSPLANT REFERRAL INPATIENT (C)
TRANSPLANT REFERRAL LETTER
TRANSPLANT REFERRAL NOTE
TRANSPLANT REFERRAL NOTE (T)
TRANSPLANT REFERRAL OLD
TRANSPLANT REFERRAL OUTPATIENT (C)
TRANSPLANT REFERRAL PACKET
TRANSPLANT REFERRAL RESPONSE TO CONSULT
TRANSPLANT REFERRAL/DECISION (SCANNED)
TRANSPLANT REFERRAL-NWI (T)
TRANSPLANT REFERRAL-PHYSICIAN ASSESSMENT/SUMMARY
TRANSPLANT REFERRALS
VACO
VACO TRANSPLANT REFERRAL
VACO TRANSPLANT REFERRAL - IC
VACO TRANSPLANT REFERRAL (595-DT-479)
VACO TRANSPLANT REFERRAL (B)
VACO TRANSPLANT REFERRAL (CI)(DT)
VACO TRANSPLANT REFERRAL (D)
VACO TRANSPLANT REFERRAL (LINK SF)
VACO TRANSPLANT REFERRAL (RD)
VACO TRANSPLANT REFERRAL (SR)
VACO TRANSPLANT REFERRAL (T)
VACO TRANSPLANT REFERRAL (TP)
VACO TRANSPLANT REFERRAL FORM
VACO TRANSPLANT REFERRAL NOTE
VACO TRANSPLANT REFERRAL NOTE(O)(T)
VACO TRANSPLANT REFERRAL STAFF PHYSICIAN ASSESSMEN
VACO TRANSPLANT REFERRAL SUMMARY
VACO TRANSPLANT REFERRAL T
VACO TRANSPLANT REFERRAL TEMPLATE
VACO TRANSPLANT REFERRAL(T)
VACO TRANSPLANT REFERRAL**LB 1/12
VACO TRANSPLANT REFERRAL-NOLA
VACO TRANSPLANT REFERRAL-TL
TRANSPLANT VACO TRANSPLANT REFERRAL (T)
TRANSPLANT VACO TRANSPLANT REFERRAL
Others
LIVER TRANSPLANT - SELECTION CONFERENCE
LIVER TRANSPLANT REVIEW COMMITTEE DECISION NOTE
MED SVC PHYSICIAN SUMMARY FOR TRANSPLANT CANDIDATE
MTU - LIVER TRANSPLANT EVALUATION
TRANSPLANT MULTIDISCIPLINARY SELECTION CONFERENCE

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eMethods 3. Handling Missing Data

To handle missing data, data based Multiple Imputation (PROC MI and PROC MIANALYZE in SAS) with Fully Conditional Specification (FCS)[1] was conducted with 10 imputed datasets. We also allowed the primary outcomes to inform missingness patterns as is commonly recommended.[2] Subsequent to MI estimation, multivariable Cox regression models with Γ frailty was specified to account for the correlation between patients clustered within VA facility. Estimated hazard ratios and 95% confidence intervals were reported from the pooled estimates across the 10 imputed datasets using Rubin's rule; for each model, the pooled p-values were also adjusted using the Benjamini Hochberg False-Discovery-Rate (FDR) method to conservatively account for the many covariate and tests of statistical significance in the multivariable frailty models [3]. The FDR is the estimated proportion of null estimates that are falsely rejected among the set of null parameter estimates in the frailty models that were identified as statistically significant.

Data-Based Multiple Imputation Diagnostics

Table 2 presents the MI diagnostics across 10 imputed datasets using SAS PROC MI with Fully Conditional Specification (FCS). We focus on the Fraction of Missing Information (FMI) and Relative Efficiency (RE) diagnostics from the MI estimation. The FMI provides an estimate of the total variance due to the missing data for each variable; lower FMIs suggest less influence of imputation sampling variance in contribution to the overall variance of each variable. RE incorporates FMI and an RE estimate closer to 1.00 suggests the estimates of the population parameters in the frailty models are close to population parameter estimates that would be estimated if there were not missing data; estimates lower than 1.00 suggest the parameter estimates are proportionally less efficient (higher variance) as a result of the amount of missing data and imputation datasets (k=10) across which pooling of frailty model estimates is performed.

Across the 20 predictors in models that had some degree of missing data, the FMI had a Mean=.012 (SD = .025, SE=.006), a Median FMI=.004, a Minimum FMI < .001, and a Maximum FMI = .112 (**Table 2**). With the exception of ethnicity, sampling variance attributable to the missing data was very low, and only slightly higher for ethnicity. Accordingly, the impact on RE estimates of missing data imputation was also limited with RE remaining near 1.00 for all imputed variables with the RE Mean=.999 (SD = .002,

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SE=.001), a Median RE = .999, a Minimum RE = .989, and a Maximum RE > .999. To the authors' knowledge, there are no specific thresholds for which RE is thought to be too low, though these RE estimates all are quite close to 1.00 which suggests strong relative efficiency of the MI frailty model estimates.

Table 2: Multiple Imputation Diagnostics

	Variance			Relative	Fraction	Relative
				Increase	Missing	Efficiency
Variable	Between	Within	Total	in Variance	Information	
MELD-Na	0.0000	0.0000	0.0000	0.0406	0.0393	0.9961
Ascites	0.0000	0.0037	0.0037	0.0054	0.0054	0.9995
Hepatic encephalopathy	0.0000	0.0025	0.0025	0.0045	0.0044	0.9996
Hepatocellular cancer	0.0000	0.0029	0.0029	0.0083	0.0083	0.9992
Varices	0.0000	0.0031	0.0031	0.0040	0.0040	0.9996
Depression	0.0000	0.0027	0.0027	0.0041	0.0041	0.9996
Anxiety	0.0000	0.0047	0.0048	0.0045	0.0045	0.9995
Race/ethnicity	0.0020	0.0179	0.0201	0.1230	0.1119	0.9889
Age	0.0001	1.0044	1.0045	0.0001	0.0001	1.0000
Sex	0.0002	0.0163	0.0164	0.0102	0.0101	0.9990
Etiology	0.0002	0.0124	0.0127	0.0189	0.0186	0.9981
VA Priority status	0.0000	0.0050	0.0051	0.0061	0.0061	0.9994
Health Insurance	0.0001	0.0260	0.0260	0.0023	0.0023	0.9998
CIRCOM Score	0.0000	0.0044	0.0044	0.0062	0.0061	0.9994
Facility complexity	0.0001	0.0202	0.0203	0.0044	0.0044	0.9996
Distance to transplant facility	0.0000	0.0086	0.0086	0.0034	0.0033	0.9997
Transplant Center	0.0001	0.0309	0.0310	0.0027	0.0027	0.9997
Region	0.0000	0.0205	0.0205	0.0023	0.0023	0.9998
Volume of cirrhosis cases/facility	0.0001	0.0332	0.0333	0.0033	0.0033	0.9997

References:

[1]. Van Buuren, S, J P L Brand, C G M Groothuis-Oudshoorn, and D B Rubin. "Fully conditional specification in multivariate imputation." Journal of Statistical Computation and Simulation, 2006.

[2]. Moons, K G, R A Donders, Stijnen T, and Harrell F E. "Using the outcome for imputation of missing predictor values was preferred." Journal of Clinical Epidemiology, 2006: 1092 - 1101.

[3] Benjamini Y, Hochberg Y. Controlling the false discovery rate: A practical and powerful approach to multiple testing. Journal of the Royal Statistical Society: Series B. Available at: https://rss.onlinelibrary.wiley.com/doi/abs/10.1111/j.2517-6161.1995.tb02031.x

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eMethods 4. Frailty Models

We specified frailty models. We accounted for clustering of outcomes by hospital using a gamma-distributed frailty. We assessed the frailty random effect via the pooled estimate of the frailty across the 10 multiply imputed datasets for both referral and waitlisting models. With this pooled variance estimate, we computed an estimate of $Kendall's\ \tau = \frac{\theta}{\theta+2}$ where θ is the pooled frailty variance and the resulting tau represents is an estimate of Kendall's τ correlation coefficient. This estimate can be interpreted as the degree of similarity between any two patients' times to event within each facility. In this respect, the *τ* is similar to the Intra-Class Correlation estimate commonly reported in generalized linear mixed effects models.

For each of the 10 imputed datasets, the frailty random effect was statistically significantly different from 0.00 with all *p* values < .0001 for the referral model and all *p-values* < .01 for the waitlisting model. For the referral model, the pooled frailty was 0.292 and for the waitlisting model, the pooled frailty was 0.07. The *τ* was 0.127 and 0.034 for the consideration of referral and waitlisting models. These results show statistically significant variation in referral and waitlisting that relates to the facility where the patient seeks care.

We did not estimate *τ* for the transplantation models due to relatively few individuals who underwent transplantation.

Reference: Hougaard P (2000). Analysis of Multivariate Survival Data. Springer-Verlag.

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eMethods 5. Taxonomy Used to Guide Abstraction of Reasons for Nonreferral

We adapted a published taxonomy originally developed to understand reasons why clinicians do not provide guidelines recommended treatments for heart failure. [1] This taxonomy includes:

- **Prioritization and assessment of patient benefit**: Examples included instances where benefit may not outweigh potential harms, such as in individuals with advanced age or comorbidity, and patients who experience improvement in liver function with medical management.
- **Adverse effect of treatment**. Examples included advanced hepatocellular cancer that is not amenable to transplantation and liver transplantation may indeed increase the risk of mortality in the short term.
- **Non-adherence to treatment recommendations and monitoring**. Examples included ongoing alcohol and drug use as well as limited social support and uncontrolled mental health comorbidity that could influence patients' ability to adhere to recommended treatments.
- **Patient preference and other contextual reasons.** Examples included patient's life circumstances and treatment goals.

This taxonomy is also consistent with the general guidance included in the **AASLD guidelines** for evaluation of patients for liver transplantation. [2] We have added this information in the Supplementary Materials.

Reference

1. Steinman MA, Patil S, Kamat P, Peterson C, Knight SJ. A taxonomy of reasons for not prescribing guideline-recommended medications for patients with heart failure. *Am J Geriatr Pharmacother.* 2010;8(6):583-594.
2. Martin P, DiMartini A, Feng S, Brown R, Jr., Fallon M. Evaluation for liver transplantation in adults: 2013 practice guideline by the American Association for the Study of Liver Diseases and the American Society of Transplantation. *Hepatology.* 2014;59(3):1144-1165.

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eTable 1. Association Between Clinical and Clinical-Patient Factors and Referral, Wait-Listing and Transplantation in Patients with Limited Comorbidity (CirCom 0 or 1).

	Referral		Waitlisting		Transplant	
Total N patients	**17,126**		**17,126**		**17,126**	
Outcome events, n	**1,238**		**894**		**525**	
	Adj HR (95% CI)	**P-value[a]**	**Adj HR (95% CI)**	**P-value[a]**	**Adj HR (95% CI)**	**P-value[a]**
Clinical characteristics						
Cirrhosis etiology						
HCV alone	ref		ref		ref	
Alcohol alone	0.40 (0.34-0.47)	<.0001	0.33 (0.27-0.41)	<.0001	0.30 (0.23-0.40)	<.0001
HCV and alcohol	0.56 (0.48-0.66)	<.0001	0.53 (0.44-0.64)	<.0001	0.60 (0.47-0.77)	0.00
NASH	0.97 (0.81-1.17)	0.85	0.80 (0.65-0.99)	0.07	0.95 (0.73-1.24)	0.78
Other	0.75 (0.58-0.98)	0.07	0.73 (0.55-0.97)	0.06	0.70 (0.48-1.02)	0.12
Na-MELD score						
<20	ref		ref		ref	
20-24	1.40 (1.19-1.64)	0.00	1.47 (1.22-1.78)	0.00	1.39 (1.09-1.76)	0.02
25-29	1.55 (1.29-1.87)	<.0001	1.74 (1.42-2.13)	<.0001	2.20 (1.71-2.83)	<.0001
30 and higher	1.81 (1.48-2.21)	<.0001	1.41 (1.08-1.84)	0.02	1.94 (1.37-2.75)	0.00
Cirrhosis complications						
Hepatic encephalopathy	2.14 (1.89-2.42)	<.0001	2.03 (1.76-2.35)	<.0001	2.04 (1.69-2.46)	<.0001
Ascites	2.08 (1.77-2.45)	<.0001	1.87 (1.56-2.24)	<.0001	2.16 (1.69-2.76)	<.0001
Varices	2.27 (1.96-2.63)	<.0001	1.80 (1.53-2.13)	<.0001	1.50 (1.21-1.86)	0.00
Hepatocellular cancer	1.75 (1.54-1.99)	<.0001	1.59 (1.36-1.85)	<.0001	1.91 (1.57-2.31)	<.0001
Cir-COM score						
0	ref		ref		ref	
1+0	0.76 (0.67-0.86)	<.0001	0.62 (0.54-0.72)	<.0001	0.57 (0.47-0.69)	<.0001
Socio-demographics						
Age group (years)						
<55	ref		ref		ref	
55-59	0.84 (0.72-0.99)	0.07	0.76 (0.63-0.92)	0.01	0.71 (0.55-0.92)	0.02
60-64	0.80 (0.68-0.93)	0.01	0.68 (0.57-0.81)	<.0001	0.69 (0.55-0.88)	0.01
65-70	0.45 (0.37-0.56)	<.0001	0.47 (0.38-0.59)	<.0001	0.49 (0.37-0.66)	<.0001
70 and older	0.11 (0.07-0.19)	<.0001	0.08 (0.04-0.16)	<.0001	0.09 (0.04-0.20)	<.0001
Gender						
Female	ref		ref		ref	
Male	0.82 (0.60-1.11)	0.31	0.81 (0.57-1.16)	0.37	1.24 (0.72-2.13)	0.58
Race/ethnicity						
White	ref		ref		ref	
African American	0.82 (0.68-0.99)	0.07	0.78 (0.64-0.96)	0.03	0.79 (0.60-1.03)	0.15
Hispanic	1.05 (0.85-1.30)	0.78	0.99 (0.77-1.28)	0.96	0.92 (0.64-1.33)	0.78
Other	1.04 (0.73-1.47)	0.87	0.92 (0.60-1.41)	0.78	0.89 (0.50-1.59)	0.78
Insurance status						
VA-Private	ref		ref		ref	
VA-Medicare	1.09 (0.94-1.26)	0.36	0.92 (0.79-1.08)	0.41	0.90 (0.73-1.09)	0.41
VA-Medicaid	0.74 (0.50-1.08)	0.22	0.43 (0.26-0.71)	0.00	0.42 (0.21-0.83)	0.03

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VA only	0.79 (0.67-0.94)	0.02	0.42 (0.34-0.52)	<.0001	0.32 (0.24-0.43)	<.0001
Region						
Northeast	ref		ref		ref	
Midwest	0.96 (0.71-1.28)	0.85	0.88 (0.67-1.16)	0.45	0.97 (0.68-1.39)	0.88
South	0.95 (0.73-1.23)	0.78	0.70 (0.55-0.90)	0.01	0.86 (0.62-1.18)	0.48
West	0.83 (0.61-1.12)	0.32	0.55 (0.41-0.74)	0.00	0.60 (0.40-0.88)	0.02
Priority status						
6-8	ref		ref		ref	
1-3	1.04 (0.88-1.23)	0.78	0.88 (0.73-1.06)	0.27	0.75 (0.60-0.95)	0.03
4-5	0.83 (0.71-0.98)	0.06	0.68 (0.56-0.81)	<.0001	0.64 (0.51-0.80)	0.00
Depression	0.84 (0.73-0.95)	0.02	0.86 (0.74-1.00)	0.08	0.88 (0.72-1.07)	0.32
Anxiety	1.00 (0.84-1.20)	0.99	0.95 (0.77-1.17)	0.71	0.93 (0.70-1.24)	0.78
Facility characteristics						
Complexity level						
Low/Median Complexity	ref		ref		ref	
High Complexity	1.00 (0.74-1.36)	0.99	1.04 (0.76-1.43)	0.85	0.90 (0.59-1.35)	0.76
Facility cirrhosis volume						
Low	ref		ref		ref	
Medium	0.81 (0.58-1.12)	0.32	0.84 (0.59-1.18)	0.41	0.92 (0.58-1.46)	0.78
Medium-high	0.86 (0.58-1.27)	0.58	1.02 (0.68-1.54)	0.96	1.42 (0.83-2.42)	0.32
High	0.78 (0.52-1.16)	0.32	0.89 (0.59-1.34)	0.69	1.00 (0.58-1.71)	0.99
Transplant Center						
Yes	ref		ref		ref	
No	0.78 (0.54-1.11)	0.29	0.84 (0.61-1.16)	0.39	0.74 (0.48-1.12)	0.26
Urban/Rural						
Urban	ref		ref		ref	
Rural	1.11 (0.97-1.26)	0.22	1.00 (0.86-1.16)	0.98	0.98 (0.81-1.19)	0.88
Driving distance to closest transplant center (miles)						
<200	ref		ref		ref	
200-<500	0.91 (0.77-1.07)	0.36	0.90 (0.75-1.08)	0.37	0.90 (0.71-1.14)	0.53
≥500 +	0.92 (0.75-1.14)	0.58	0.88 (0.70-1.11)	0.39	0.84 (0.62-1.13)	0.38

[a]False discovery rate (FDR) adjusted P value.

Adj HR, adjusted hazard ratio, CI, confidence intervals. Adj HR, adjusted hazard ratio, CI, confidence intervals.

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eTable 2. Association Between Clinical and Clinical-Patient Factors and Referral, Wait-Listing and Transplantation in Patients Who Survived for >12 Months Following Meeting MELD-Na Criteria

Characteristics	Referral		Waitlisting		Transplant	
Total N patients	**11,920**		**11,920**		**11,920**	
Outcome events, n	**705**		**338**		**88**	
	Adj HR (95% CI)	**P-value[a]**	**Adj HR (95% CI)**	**P-value[a]**	**Adj HR (95% CI)**	**P-value[a]**
Clinical characteristics						
Cirrhosis etiology						
HCV alone	ref		ref		ref	
Alcohol alone	0.40 (0.32-0.51)	<.0001	0.31 (0.22-0.43)	<.0001	0.25 (0.12-0.52)	0.00
HCV & alcohol	0.58 (0.46-0.72)	<.0001	0.49 (0.36-0.67)	<.0001	0.76 (0.41-1.42)	0.67
NASH	1.03 (0.80-1.32)	0.85	0.66 (0.46-0.94)	0.05	0.78 (0.39-1.56)	0.71
Other	0.67 (0.45-1.00)	0.10	0.78 (0.48-1.26)	0.39	0.84 (0.32-2.18)	0.88
Na-MELD score						
<20	ref		ref		ref	
20-24	1.02 (0.84-1.24)	0.85	0.95 (0.73-1.24)	0.78	1.26 (0.70-2.26)	0.70
25-29	0.85 (0.67-1.08)	0.31	0.82 (0.59-1.14)	0.32	1.52 (0.80-2.88)	0.51
30 and higher	0.89 (0.67-1.18)	0.55	0.53 (0.33-0.86)	0.03	1.09 (0.44-2.66)	0.92
Cirrhosis complications						
Hepatic encephalopathy	2.51 (2.11-2.99)	<.0001	2.40 (1.88-3.06)	<.0001	3.02 (1.81-5.06)	0.00
Ascites	1.97 (1.57-2.46)	<.0001	1.67 (1.24-2.25)	0.00	2.05 (1.06-3.95)	0.14
Varices	2.11 (1.75-2.56)	<.0001	1.79 (1.37-2.33)	<.0001	1.28 (0.76-2.15)	0.66
Hepatocellular cancer	1.66 (1.40-1.96)	<.0001	1.19 (0.93-1.53)	0.23	1.52 (0.94-2.46)	0.29
Cir-COM score						
0	ref		ref		ref	
1+0	0.84 (0.69-1.02)	0.14	0.71 (0.54-0.94)	0.04	0.48 (0.27-0.84)	0.07
1+1	0.51 (0.39-0.65)	<.0001	0.49 (0.35-0.70)	0.00	0.24 (0.11-0.53)	0.01
>=3	0.53 (0.42-0.67)	<.0001	0.44 (0.31-0.61)	<.0001	0.35 (0.19-0.66)	0.01
Socio-demographics						
Age group (years)						
<55	ref		ref		ref	
55-59	0.72 (0.58-0.91)	0.02	0.73 (0.52-1.01)	0.10	0.98 (0.49-1.98)	0.96
60-64	0.79 (0.63-0.97)	0.07	0.71 (0.52-0.97)	0.06	0.92 (0.47-1.80)	0.92
65-70	0.55 (0.42-0.72)	<.0001	0.57 (0.39-0.83)	0.01	0.72 (0.32-1.59)	0.69
70 and older	0.08 (0.04-0.16)	<.0001	0.10 (0.04-0.24)	<.0001	0.28 (0.07-1.03)	0.22
Gender						
Female	ref		ref		ref	
Male	0.83 (0.54-1.26)	0.51	0.95 (0.50-1.80)	0.92	1.10 (0.26-4.61)	0.92
Race/ethnicity						
White	ref		ref		ref	
African American	0.72 (0.56-0.92)	0.03	0.70 (0.50-0.99)	0.09	0.72 (0.38-1.39)	0.66
Hispanic	0.81 (0.58-1.13)	0.35	0.65 (0.40-1.08)	0.17	0.82 (0.31-2.19)	0.88
Other	0.86 (0.53-1.40)	0.60	0.99 (0.50-1.94)	0.98	0.47 (0.06-3.49)	0.71

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Insurance status						
VA-Private	ref		ref		ref	
VA-Medicare	0.92 (0.75-1.11)	0.51	0.69 (0.53-0.88)	0.01	0.57 (0.35-0.93)	0.12
VA-Medicaid	0.85 (0.55-1.32)	0.56	0.26 (0.11-0.65)	0.01	0.23 (0.03-1.71)	0.43
VA only	0.70 (0.56-0.88)	0.01	0.41 (0.29-0.57)	<.0001	0.20 (0.09-0.43)	0.00
Region						
Northeast	ref		ref		ref	
Midwest	0.84 (0.59-1.19)	0.46	0.84 (0.58-1.22)	0.44	2.08 (0.93-4.66)	0.27
South	0.84 (0.61-1.14)	0.40	0.58 (0.41-0.82)	0.01	1.50 (0.71-3.17)	0.63
West	0.74 (0.52-1.06)	0.20	0.43 (0.28-0.66)	0.00	0.20 (0.05-0.80)	0.12
Priority status						
6-8	ref		ref		ref	
1-3	1.08 (0.85-1.38)	0.59	0.98 (0.71-1.34)	0.92	1.05 (0.56-1.97)	0.92
4-5	0.91 (0.72-1.16)	0.56	0.73 (0.53-1.01)	0.10	0.87 (0.46-1.64)	0.88
Depression	0.81 (0.69-0.96)	0.04	0.87 (0.69-1.11)	0.35	0.86 (0.53-1.41)	0.77
Anxiety	1.00 (0.80-1.24)	0.97	0.91 (0.65-1.26)	0.63	0.64 (0.30-1.38)	0.60
Facility characteristics						
Complexity level						
Low/Median Complexity	ref		ref		ref	
High Complexity	1.28 (0.88-1.85)	0.33	1.72 (1.06-2.79)	0.06	0.77 (0.32-1.86)	0.77
Facility cirrhosis volume						
Low	ref		ref		ref	
Medium	0.76 (0.51-1.12)	0.30	0.66 (0.39-1.12)	0.19	1.24 (0.41-3.77)	0.88
Medium-high	0.58 (0.36-0.94)	0.07	0.66 (0.36-1.20)	0.24	2.34 (0.67-8.12)	0.48
High	0.62 (0.38-1.00)	0.10	0.62 (0.35-1.13)	0.19	1.12 (0.32-3.97)	0.92
Transplant Center						
Yes	ref		ref		ref	
No	0.80 (0.53-1.19)	0.40	0.68 (0.45-1.02)	0.11	0.54 (0.25-1.17)	0.37
Urban/Rural						
Urban	ref		ref		ref	
Rural	1.20 (1.02-1.41)	0.08	1.19 (0.95-1.51)	0.20	1.26 (0.79-2.01)	0.66
Driving distance to closest transplant center (miles)						
<200	ref		ref		ref	
200-<500	0.92 (0.75-1.15)	0.56	0.92 (0.70-1.21)	0.63	0.96 (0.58-1.59)	0.92
≥500 +	0.92 (0.70-1.21)	0.61	0.97 (0.68-1.39)	0.92	0.68 (0.31-1.52)	0.66

[a]False discovery rate (FDR) adjusted P value

Adj HR, adjusted hazard ratio, CI, confidence intervals. Adj HR, adjusted hazard ratio, CI, confidence intervals.

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eTable 3. Association Between Clinical and Clinical-Patient Factors and Referral, Wait-Listing and Transplantation in Patients With Persistently High MELD-Na (>15) Throughout Follow-Up

	Referral		Waitlisting		Transplant	
Total N patients	**17766**		**17766**		**17766**	
Outcome events, n	**1393**		**888**		**447**	
	Adj HR (95% CI)	**P-value[a]**	**Adj HR (95% CI)**	**P-value[a]**	**Adj HR (95% CI)**	**P-value[a]**
Clinical characteristics						
Cirrhosis etiology						
HCV alone	ref		ref		ref	
Alcohol alone	0.42 (0.36-0.50)	<.0001	0.36 (0.29-0.44)	<.0001	0.31 (0.23-0.41)	<.0001
HCV and alcohol	0.54 (0.46-0.64)	<.0001	0.48 (0.40-0.59)	<.0001	0.53 (0.40-0.70)	<.0001
NASH	0.95 (0.80-1.13)	0.713	0.78 (0.63-0.96)	0.036	0.86 (0.65-1.14)	0.4065
Other	0.99 (0.77-1.28)	0.989	1.02 (0.77-1.36)	0.941	0.85 (0.56-1.30)	0.573
Na-MELD score						
<20	ref		ref		ref	
20-24	1.16 (1.02-1.32)	0.052	0.99 (0.85-1.17)	0.944	0.84 (0.66-1.06)	0.2647
25-29	1.18 (1.01-1.38)	0.073	1.13 (0.93-1.37)	0.356	1.32 (1.02-1.72)	0.0754
30 and higher	1.14 (0.95-1.37)	0.246	0.79 (0.62-1.02)	0.137	1.17 (0.84-1.61)	0.4614
Cirrhosis complications						
Hepatic encephalopathy	2.12 (1.88-2.39)	<.0001	2.10 (1.81-2.44)	<.0001	2.38 (1.92-2.96)	<.0001
Ascites	1.73 (1.47-2.04)	<.0001	1.56 (1.28-1.89)	<.0001	1.82 (1.35-2.45)	0.0004
Varices	1.87 (1.64-2.14)	<.0001	1.45 (1.23-1.71)	<.0001	1.18 (0.94-1.49)	0.2679
Hepatocellular cancer	1.10 (0.97-1.25)	0.230	1.07 (0.92-1.25)	0.501	1.38 (1.12-1.70)	0.0072
Cir-COM score						
0	ref		ref		ref	
1+0	0.71 (0.62-0.81)	<.0001	0.61 (0.52-0.72)	<.0001	0.55 (0.44-0.69)	<.0001
1+1	0.48 (0.40-0.57)	<.0001	0.38 (0.30-0.48)	<.0001	0.29 (0.20-0.41)	<.0001
>=3	0.48 (0.41-0.57)	<.0001	0.33 (0.26-0.40)	<.0001	0.26 (0.19-0.35)	<.0001
Socio-demographics						
Age group (years)						
54 and younger	ref		ref		ref	
55 to 59	0.74 (0.63-0.86)	0.000	0.71 (0.58-0.86)	0.001	0.70 (0.53-0.91)	0.0231
60 to 64	0.68 (0.59-0.79)	<.0001	0.58 (0.48-0.69)	<.0001	0.63 (0.49-0.81)	0.0012
65 to 69	0.41 (0.34-0.50)	<.0001	0.38 (0.30-0.48)	<.0001	0.36 (0.26-0.51)	<.0001
70 or older	0.08 (0.05-0.13)	<.0001	0.06 (0.03-0.11)	<.0001	0.08 (0.04-0.19)	<.0001
Gender						
Female	ref		ref		ref	
Male	0.78 (0.58-1.05)	0.168	0.71 (0.49-1.01)	0.109	0.99 (0.54-1.83)	0.9792
Race/ethnicity						
White	ref		ref		ref	
African American	0.79 (0.67-0.93)	0.014	0.70 (0.57-0.87)	0.002	0.69 (0.52-0.92)	0.0267
Hispanic	1.00 (0.80-1.24)	0.990	0.85 (0.64-1.13)	0.386	0.76 (0.50-1.14)	0.2831
Other	0.87 (0.62-1.23)	0.582	0.88 (0.58-1.34)	0.678	0.73 (0.37-1.43)	0.4614
Insurance status						
VA-Private	ref		ref		ref	
VA-Medicare	0.96 (0.84-1.10)	0.738	0.92 (0.78-1.07)	0.396	0.87 (0.70-1.08)	0.3077
VA-Medicaid	0.72 (0.51-1.03)	0.131	0.47 (0.29-0.76)	0.005	0.46 (0.23-0.93)	0.0655
VA only	0.73 (0.62-0.85)	0.000	0.41 (0.33-0.51)	<.0001	0.30 (0.22-0.42)	<.0001
Region						
Northeast	ref		ref		ref	
Midwest	1.02 (0.78-1.34)	0.922	0.84 (0.63-1.12)	0.356	1.04 (0.70-1.55)	0.891
South	0.94 (0.74-1.20)	0.738	0.67 (0.52-0.87)	0.005	0.88 (0.62-1.26)	0.5918
West	0.72 (0.55-0.96)	0.058	0.47 (0.35-0.65)	<.0001	0.55 (0.35-0.86)	0.0231
Priority status						

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6-8	ref		ref		ref	
1-3	1.03 (0.87-1.21)	0.824	0.90 (0.74-1.09)	0.388	0.84 (0.64-1.09)	0.2831
4-5	0.86 (0.73-1.01)	0.127	0.72 (0.59-0.87)	0.002	0.70 (0.54-0.91)	0.0231
Depression	0.81 (0.72-0.92)	0.003	0.79 (0.67-0.91)	0.005	0.77 (0.62-0.95)	0.0375
Anxiety	1.04 (0.88-1.21)	0.761	0.95 (0.78-1.17)	0.749	0.96 (0.72-1.30)	0.8765
Facility characteristics						
Complexity level						
Low/Median Complexity	ref		ref		ref	
High Complexity	0.97 (0.73-1.29)	0.891	0.98 (0.70-1.36)	0.941	0.88 (0.55-1.41)	0.687
Facility cirrhosis volume						
Low	ref		ref		ref	
Medium	0.84 (0.62-1.14)	0.370	0.89 (0.62-1.27)	0.661	0.89 (0.53-1.49)	0.7255
Medium-high	0.91 (0.64-1.31)	0.738	1.12 (0.74-1.70)	0.710	1.49 (0.83-2.69)	0.2831
High	0.75 (0.52-1.08)	0.193	0.93 (0.61-1.42)	0.823	0.96 (0.53-1.75)	0.9177
Transplant Center						
Yes	ref		ref		ref	
No	0.75 (0.54-1.05)	0.157	0.77 (0.55-1.09)	0.234	0.69 (0.44-1.08)	0.1945
Urban/Rural						
Urban	ref		ref		ref	
Rural	1.12 (0.99-1.26)	0.138	0.99 (0.86-1.16)	0.944	0.94 (0.76-1.16)	0.6381
Driving distance to closest transplant center (miles)						
<200	ref		ref		ref	
200-<500	0.83 (0.71-0.97)	0.052	0.86 (0.72-1.04)	0.214	0.80 (0.62-1.03)	0.1632
≥500	0.92 (0.75-1.13)	0.582	0.93 (0.73-1.18)	0.678	0.81 (0.58-1.13)	0.3077

[a]False discovery rate (FDR) adjusted P value

Adj HR, adjusted hazard ratio, CI, confidence intervals. Adj HR, adjusted hazard ratio, CI, confidence intervals.

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eTable 4. Association Between Clinical and Clinical-Patient Factors and Referral, Wait-Listing and Transplantation in Patients With Complete Data on all Covariates

	Referral		Waitlisting		Transplantation	
Total N patients	**24918**		**24918**		**24918**	
Outcome events, n	**1389**		**923**		**530**	
	Adj HR (95% CI)	**P-value[a]**	**Adj HR (95% CI)**	**P-value[a]**	**Adj HR (95% CI)**	**P-value[a]**
Clinical characteristics						
Cirrhosis etiology						
HCV alone	ref		ref		ref	
Alcohol alone	0.38 (0.33-0.45)	<.0001	0.33 (0.27-0.40)	<.0001	0.29 (0.22-0.38)	<.0001
HCV and alcohol	0.55 (0.47-0.64)	<.0001	0.52 (0.43-0.62)	<.0001	0.59 (0.46-0.75)	<.0001
NASH	0.93 (0.78-1.10)	0.50	0.87 (0.71-1.07)	0.27	1.00 (0.77-1.30)	0.97
Other	0.63 (0.48-0.83)	0.00	0.59 (0.43-0.81)	0.00	0.52 (0.34-0.80)	0.01
Na-MELD score						
<20	ref		ref		ref	
20-24	1.27 (1.09-1.49)	0.01	1.24 (1.02-1.51)	0.06	1.53 (1.20-1.96)	0.00
25-29	1.53 (1.21-1.95)	0.00	1.34 (0.99-1.80)	0.10	1.26 (0.83-1.92)	0.42
30 and higher	1.30 (0.92-1.85)	0.21	1.03 (0.70-1.51)	0.92	1.30 (0.79-2.12)	0.43
Cirrhosis complications						
Hepatic encephalopathy	2.27 (2.02-2.55)	<.0001	2.22 (1.93-2.56)	<.0001	2.43 (2.00-2.94)	<.0001
Ascites	2.12 (1.83-2.46)	<.0001	2.00 (1.68-2.39)	<.0001	2.46 (1.92-3.16)	<.0001
Varices	2.26 (1.97-2.58)	<.0001	2.11 (1.80-2.48)	<.0001	1.73 (1.40-2.14)	<.0001
Hepatocellular cancer	1.70 (1.50-1.92)	<.0001	1.59 (1.37-1.84)	<.0001	1.88 (1.55-2.27)	<.0001
Cir-COM score						
0	ref		ref		ref	
1+0	0.75 (0.65-0.86)	<.0001	0.67 (0.57-0.78)	<.0001	0.59 (0.48-0.73)	<.0001
1+1	0.50 (0.42-0.60)	<.0001	0.42 (0.34-0.52)	<.0001	0.31 (0.23-0.42)	<.0001
>=3	0.53 (0.45-0.63)	<.0001	0.36 (0.29-0.45)	<.0001	0.27 (0.20-0.36)	<.0001
Depression	0.82 (0.72-0.92)	0.00	0.88 (0.76-1.01)	0.12	0.89 (0.73-1.08)	0.34
Anxiety	0.97 (0.83-1.14)	0.74	0.87 (0.72-1.07)	0.27	0.91 (0.69-1.19)	0.59
Socio-demographics						
Age group (years)						
54 and younger	ref		ref		ref	
55 to 59	0.81 (0.70-0.95)	0.02	0.78 (0.64-0.93)	0.02	0.77 (0.60-0.99)	0.08
60 to 64	0.75 (0.65-0.87)	0.00	0.62 (0.52-0.74)	<.0001	0.65 (0.52-0.83)	0.00
65 to 69	0.48 (0.39-0.58)	<.0001	0.45 (0.36-0.56)	<.0001	0.46 (0.35-0.63)	<.0001
70 and older	0.10 (0.06-0.16)	<.0001	0.06 (0.03-0.12)	<.0001	0.05 (0.02-0.14)	<.0001
Gender						
Female	ref		ref		ref	
Male	0.83 (0.62-1.10)	0.27	0.84 (0.59-1.21)	0.44	1.09 (0.64-1.87)	0.79
Race/ethnicity						
White	ref		ref		ref	
African American	0.83 (0.71-0.98)	0.05	0.81 (0.67-0.98)	0.06	0.84 (0.66-1.09)	0.30
Hispanic	1.22 (0.99-1.52)	0.12	1.01 (0.76-1.33)	0.97	0.92 (0.63-1.34)	0.76

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Other	1.14 (0.84-1.56)	0.50	1.04 (0.70-1.54)	0.91	0.98 (0.56-1.72)	0.96
Priority status						
6-8	ref		ref		ref	
1-3	1.03 (0.87-1.21)	0.79	0.90 (0.74-1.08)	0.35	0.79 (0.62-1.01)	0.11
4-5	0.83 (0.71-0.98)	0.05	0.71 (0.59-0.85)	0.00	0.71 (0.56-0.90)	0.01
Insurance status						
VA-Private	ref		ref		ref	
VA-Medicare	0.97 (0.85-1.11)	0.72	0.92 (0.79-1.07)	0.36	0.85 (0.70-1.04)	0.21
VA-Medicaid	0.77 (0.55-1.08)	0.19	0.35 (0.21-0.59)	0.00	0.33 (0.17-0.66)	0.00
VA only	0.81 (0.69-0.95)	0.02	0.38 (0.31-0.47)	<.0001	0.27 (0.20-0.36)	<.0001
Region						
Northeast	ref		ref		ref	
Midwest	0.94 (0.70-1.26)	0.72	0.81 (0.62-1.07)	0.22	0.86 (0.60-1.24)	0.57
South	0.91 (0.70-1.19)	0.58	0.64 (0.50-0.82)	0.00	0.78 (0.57-1.07)	0.21
West	0.70 (0.51-0.95)	0.05	0.47 (0.35-0.63)	<.0001	0.47 (0.32-0.71)	0.00
Facility characteristics						
Complexity level						
Low/Median Complexity	ref		ref		ref	
High Complexity	1.04 (0.76-1.43)	0.80	1.06 (0.77-1.45)	0.81	0.84 (0.55-1.29)	0.57
Facility cirrhosis volume						
Low	ref		ref		ref	
Medium	0.80 (0.58-1.10)	0.25	0.83 (0.59-1.18)	0.40	0.91 (0.57-1.45)	0.76
Medium-high	0.83 (0.56-1.23)	0.47	1.06 (0.71-1.58)	0.84	1.53 (0.89-2.66)	0.21
High	0.71 (0.48-1.06)	0.16	0.89 (0.60-1.34)	0.66	1.10 (0.63-1.92)	0.79
Transplant Center						
Yes	ref		ref		ref	
No	0.73 (0.50-1.06)	0.16	0.72 (0.52-0.99)	0.08	0.60 (0.39-0.91)	0.03
Urban/Rural						
Urban	ref		ref		ref	
Rural	1.21 (1.07-1.37)	0.00	1.07 (0.93-1.24)	0.43	1.05 (0.87-1.27)	0.74
Driving distance to closest transplant center (miles)						
<200	ref		ref		ref	
200-<500	0.94 (0.80-1.10)	0.53	0.95 (0.80-1.14)	0.66	0.94 (0.74-1.18)	0.71
≥500	0.94 (0.77-1.16)	0.66	0.93 (0.74-1.17)	0.64	0.90 (0.66-1.21)	0.59

[a]False discovery rate (FDR) adjusted p-value.

Adj HR, adjusted hazard ratio, CI, confidence intervals. Adj HR, adjusted hazard ratio, CI, confidence intervals.

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eTable 5. Association Between Clinical and Clinical-Patient Factors and Referral, Wait-Listing and Transplantation in Patients Who Entered the Study Cohort Before vs After the Implementation of Organ Allocation Policy (Regional Share 35) in June 2013

	Referral		Waitlisting		Transplant	
	Before 01/01/2013	**After 01/01/2013**	**Before 01/01/2013**	**After 01/01/2013**	**Before 01/01/2013**	**After 01/01/2013**
Total N patients	**11686**	**22808**	**11686**	**22808**	**11686**	**22808**
Outcome events, n	**747**	**989**	**512**	**674**	**308**	**361**
	Adj HR (95% CI)					
Clinical characteristics						
Cirrhosis etiology						
HCV alone	ref	ref	ref	ref	ref	ref
Alcohol alone	**0.38 (0.31-0.47)**	**0.38 (0.31-0.46)**	**0.30 (0.23-0.39)**	**0.34 (0.27-0.43)**	**0.25 (0.18-0.36)**	**0.33 (0.24-0.45)**
HCV & alcohol	**0.54 (0.44-0.66)**	**0.55 (0.45-0.66)**	**0.57 (0.45-0.73)**	**0.46 (0.37-0.58)**	**0.61 (0.44-0.83)**	**0.55 (0.40-0.75)**
NASH	0.78 (0.60-1.02)	0.97 (0.79-1.18)	**0.71 (0.52-0.95)**	0.81 (0.64-1.03)	0.76 (0.52-1.10)	1.02 (0.75-1.40)
Other	0.76 (0.53-1.09)	0.72 (0.53-0.98)	0.65 (0.43-0.97)	0.69 (0.49-0.98)	0.60 (0.35-1.01)	0.71 (0.44-1.14)
Na-MELD score						
<20	ref	ref	ref	ref	ref	ref
20-24	**1.70 (1.41-2.04)**	**1.86 (1.58-2.18)**	0.67 (0.54-0.84)	0.73 (0.59-0.89)	0.66 (0.48-0.91)	0.73 (0.54-0.97)
25-29	**1.73 (1.38-2.17)**	**2.02 (1.65-2.48)**	0.99 (0.75-1.31)	**1.38 (1.05-1.80)**	1.15 (0.79-1.66)	**1.54 (1.04-2.28)**
30 and higher	**1.44 (1.10-1.89)**	**2.28 (1.80-2.88)**	0.98 (0.64-1.59)	**1.58 (1.16-2.15)**	0.94 (0.59-1.50)	**1.77 (1.15-2.74)**
Cirrhosis complications						
Hepatic encephalopathy	**3.22 (2.67-3.89)**	**1.73 (1.52-1.98)**	**2.78 (2.25-3.43)**	**1.79 (1.53-2.10)**	**2.74 (2.09-3.58)**	**1.85 (1.49-2.30)**
Ascites	**1.83 (1.49-2.26)**	**2.22 (1.86-2.64)**	**1.72 (1.36-2.18)**	**2.05 (1.67-2.52)**	**1.79 (1.31-2.43)**	**2.67 (1.98-3.61)**
Varices	**1.85 (1.54-2.21)**	**2.81 (2.39-3.31)**	**1.52 (1.24-1.88)**	**2.37 (1.96-2.88)**	**1.38 (1.06-1.81)**	**1.88 (1.45-2.44)**
Hepatocellular cancer	**1.50 (1.27-1.77)**	**1.91 (1.65-2.21)**	**1.33 (1.09-1.62)**	**1.97 (1.65-2.34)**	**1.65 (1.29-2.12)**	**2.33 (1.85-2.93)**
Cir-COM score						
0	ref	ref	ref	ref	ref	ref
1+0	0.81 (0.67-0.97)	**0.74 (0.63-0.87)**	**0.61 (0.49-0.76)**	**0.65 (0.53-0.78)**	**0.56 (0.42-0.75)**	**0.57 (0.44-0.74)**
1+1	**0.55 (0.43-0.70)**	**0.43 (0.34-0.53)**	**0.45 (0.34-0.60)**	**0.32 (0.24-0.43)**	**0.31 (0.21-0.47)**	**0.26 (0.17-0.39)**
>=3	**0.49 (0.39-0.62)**	**0.55 (0.45-0.67)**	**0.36 (0.27-0.47)**	**0.36 (0.28-0.46)**	**0.30 (0.21-0.44)**	**0.31 (0.22-0.44)**
Socio-demographics						
Age group (years)						
54 and younger	ref	ref	ref	ref	ref	ref
55 to 59	0.89 (0.73-1.09)	**0.72 (0.59-0.87)**	0.85 (0.67-1.08)	**0.66 (0.52-0.84)**	0.88 (0.64-1.21)	**0.63 (0.46-0.86)**
60 to 64	**0.79 (0.65-0.96)**	**0.69 (0.57-0.83)**	**0.65 (0.52-0.83)**	**0.63 (0.50-0.78)**	0.80 (0.59-1.09)	**0.58 (0.43-0.78)**
65 to 69	**0.43 (0.31-0.58)**	**0.44 (0.36-0.55)**	**0.47 (0.34-0.67)**	**0.50 (0.39-0.63)**	**0.53 (0.34-0.83)**	**0.46 (0.33-0.64)**
70 or older	**0.03 (0.01-0.12)**	**0.10 (0.06-0.16)**	**0.07 (0.03-0.20)**	**0.07 (0.04-0.14)**	**0.07 (0.02-0.29)**	**0.08 (0.03-0.19)**
Gender						

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Female	ref	ref	ref	ref	ref	ref
Male	0.76 (0.51-1.12)	0.92 (0.65-1.30)	0.84 (0.52-1.37)	0.84 (0.56-1.27)	1.24 (0.60-2.55)	1.52 (0.74-3.09)
Race/ethnicity						
White	ref	ref	ref	ref	ref	ref
African American	0.79 (0.63-0.99)	0.82 (0.67-1.01)	**0.69 (0.52-0.90)**	0.83 (0.65-1.06)	0.71 (0.51-0.99)	0.87 (0.63-1.20)
Hispanic	1.12 (0.84-1.50)	1.13 (0.87-1.48)	0.81 (0.55-1.18)	1.07 (0.78-1.47)	0.61 (0.36-1.03)	1.20 (0.79-1.83)
Other	0.81 (0.48-1.37)	1.38 (0.91-2.07)	0.90 (0.51-1.58)	1.13 (0.69-1.85)	0.79 (0.35-1.78)	1.35 (0.73-2.52)
Insurance status						
VA-Private	ref	ref	ref	ref	ref	ref
VA-Medicare	1.05 (0.87-1.27)	0.96 (0.82-1.13)	0.91 (0.74-1.12)	0.85 (0.71-1.02)	0.87 (0.67-1.13)	0.79 (0.62-1.01)
VA-Medicaid	0.75 (0.48-1.19)	0.66 (0.42-1.05)	**0.50 (0.28-0.89)**	**0.36 (0.18-0.70)**	0.48 (0.22-1.05)	0.40 (0.17-0.93)
VA only	0.81 (0.65-1.01)	**0.72 (0.59-0.87)**	**0.34 (0.26-0.46)**	**0.48 (0.37-0.62)**	**0.20 (0.13-0.31)**	**0.40 (0.28-0.57)**
Region						
Northeast	ref	ref	ref	ref	ref	ref
Midwest	0.68 (0.48-0.96)	1.18 (0.85-1.63)	0.74 (0.53-1.04)	1.03 (0.73-1.46)	1.12 (0.71-1.76)	0.96 (0.62-1.50)
South	0.82 (0.61-1.11)	0.92 (0.68-1.23)	**0.64 (0.47-0.87)**	0.73 (0.53-1.00)	1.09 (0.73-1.62)	0.74 (0.50-1.09)
West	0.77 (0.55-1.09)	**0.64 (0.45-0.90)**	**0.50 (0.35-0.72)**	**0.47 (0.32-0.70)**	0.57 (0.35-0.93)	**0.44 (0.27-0.73)**
Priority status						
6-8	ref	ref	ref	ref	ref	ref
1-3	0.92 (0.73-1.16)	1.13 (0.93-1.36)	0.81 (0.63-1.05)	0.90 (0.73-1.12)	0.74 (0.54-1.03)	0.74 (0.56-0.97)
4-5	0.82 (0.66-1.03)	0.81 (0.67-0.98)	**0.67 (0.52-0.87)**	**0.67 (0.54-0.84)**	0.69 (0.50-0.96)	**0.61 (0.46-0.81)**
Depression	**0.80 (0.67-0.94)**	**0.82 (0.71-0.95)**	0.85 (0.69-1.03)	0.86 (0.73-1.03)	0.89 (0.69-1.15)	0.87 (0.69-1.11)
Anxiety	0.99 (0.79-1.24)	0.98 (0.82-1.18)	0.82 (0.62-1.09)	0.96 (0.77-1.21)	0.85 (0.58-1.23)	0.92 (0.67-1.26)
Facility characteristics						
Complexity level						
Low/Median Complexity	ref	ref	ref	ref	ref	ref
High Complexity	1.14 (0.79-1.65)	1.03 (0.73-1.46)	1.06 (0.70-1.60)	1.16 (0.78-1.72)	0.72 (0.43-1.23)	1.12 (0.66-1.89)
Facility cirrhosis volume						
Low	ref	ref	ref	ref	ref	ref
Medium	0.84 (0.56-1.24)	0.83 (0.58-1.19)	0.91 (0.58-1.44)	0.83 (0.54-1.26)	1.00 (0.56-1.79)	0.83 (0.46-1.47)
Medium-high	0.74 (0.46-1.18)	0.94 (0.60-1.45)	1.13 (0.67-1.90)	0.99 (0.60-1.63)	1.65 (0.84-3.24)	1.20 (0.62-2.36)
High	0.73 (0.46-1.16)	0.71 (0.45-1.12)	1.05 (0.62-1.77)	0.79 (0.48-1.31)	1.16 (0.58-2.29)	0.85 (0.43-1.69)
Transplant Center						
Yes	ref	ref	ref	ref	ref	ref
No	0.83 (0.57-1.23)	**0.62 (0.41-0.93)**	0.76 (0.52-1.12)	0.71 (0.47-1.09)	0.65 (0.39-1.07)	0.66 (0.39-1.11)
Urban/Rural						
Urban	ref	ref	ref	ref	ref	ref

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Rural	1.12 (0.95-1.32)	1.16 (1.01-1.34)	0.97 (0.80-1.18)	1.11 (0.93-1.33)	0.83 (0.65-1.07)	1.14 (0.90-1.44)
Distance to closest transplant center (miles)						
<200	ref	ref	ref	ref	ref	ref
200-<500	**0.72 (0.58-0.88)**	1.06 (0.88-1.29)	0.91 (0.73-1.15)	0.95 (0.76-1.18)	1.06 (0.78-1.42)	0.83 (0.62-1.11)
≥500	0.76 (0.58-0.98)	1.15 (0.90-1.46)	0.85 (0.63-1.15)	1.07 (0.81-1.42)	1.00 (0.68-1.49)	0.90 (0.62-1.31)

Bold-face values indicate p-value <0.05 after adjustment for multiple comparisons using false discovery rate.

Adj HR, adjusted hazard ratio, CI, confidence intervals.

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eTable 6. Association Between Clinical and Clinical-Patient Factors and Referral, Wait-Listing and Transplantation in Patients Who Entered the Study Cohort Before vs After Revisions to Awarding Hepatocellular Cancer Exception Points (October 2015)

	Referral		Waitlisting		Transplantation	
	Before 10/01/2015	**After 10/01 2015**	**Before 10/01/2015**	**After 10/01 2015**	**Before 10/01/2015**	**After 10/01 2015**
Total N patients	**29925**	**4569**	**29925**	**4569**	**29925**	**4569**
Outcome events, n	**1573**	**163**	**1075**	**111**	**615**	**54**
	Ajd HR (95% CI)					
Clinical characteristics						
Cirrhosis etiology						
HCV alone	ref	ref	ref	ref	ref	ref
Alcohol alone	**0.39 (0.33-0.45)**	**0.35 (0.21-0.59)**	**0.31 (0.26-0.37)**	**0.41 (0.21-0.78)**	**0.28 (0.22-0.36)**	0.44 (0.16-1.21)
HCV & alcohol	**0.56 (0.48-0.64)**	**0.43 (0.26-0.72)**	**0.51 (0.43-0.61)**	**0.42 (0.21-0.81)**	**0.59 (0.47-0.74)**	0.50 (0.18-1.35)
NASH	0.85 (0.72-1.01)	1.21 (0.75-1.94)	**0.68 (0.56-0.83)**	1.64 (0.91-2.96)	0.78 (0.61-1.01)	2.49 (1.01-6.17)
Other	**0.76 (0.59-0.96)**	0.55 (0.23-1.28)	**0.65 (0.50-0.86)**	0.78 (0.31-1.98)	**0.63 (0.43-0.91)**	1.24 (0.33-4.68)
Na-MELD score						
<20	ref	ref	ref	ref	ref	ref
20-24	**1.82 (1.59-2.07)**	**1.56 (1.02-2.38)**	0.66 (0.57-0.77)	1.25 (0.70-2.20)	**0.65 (0.52-0.81)**	1.68 (0.71-3.94)
25-29	**1.86 (1.58-2.18)**	**2.33 (1.39-3.91)**	1.14 (0.93-1.40)	1.58 (0.69-3.63)	1.31 (0.99-1.74)	3.06 (1.06-8.84)
30 and higher	**1.80 (1.49-2.17)**	**2.71 (1.46-5.02)**	0.85 (0.65-1.10)	**3.74 (1.70-8.19)**	1.27 (0.91-1.77)	4.80 (1.43-16.1)
Cirrhosis complications						
Hepatic encephalopathy	**2.44 (2.17-2.73)**	0.85 (0.59-1.23)	**2.33 (2.03-2.66)**	1.09 (0.71-1.68)	**2.36 (1.97-2.82)**	1.12 (0.61-2.04)
Ascites	**2.01 (1.75-2.32)**	**2.80 (1.85-4.26)**	**1.85 (1.57-2.18)**	**3.42 (2.06-5.69)**	**2.05 (1.64-2.56)**	**7.21 (3.11-16.7)**
Varices	**2.22 (1.96-2.52)**	**3.62 (2.34-5.60)**	**1.88 (1.62-2.18)**	**2.42 (1.49-3.91)**	**1.60 (1.32-1.95)**	1.41 (0.75-2.65)
Hepatocellular cancer	**1.74 (1.55-1.95)**	1.55 (1.07-2.25)	**1.62 (1.41-1.86)**	**1.79 (1.12-2.84)**	**1.98 (1.66-2.35)**	2.12 (1.11-4.04)
Cir-COM score						
0	ref	ref	ref	ref	ref	ref
1+0	**0.76 (0.67-0.86)**	0.90 (0.61-1.31)	**0.62 (0.54-0.72)**	0.68 (0.42-1.09)	**0.56 (0.46-0.69)**	0.57 (0.29-1.11)
1+1	**0.47 (0.40-0.56)**	**0.49 (0.28-0.86)**	**0.38 (0.31-0.47)**	**0.43 (0.21-0.87)**	**0.28 (0.21-0.38)**	0.27 (0.09-0.81)
>=3	**0.53 (0.46-0.63)**	**0.44 (0.26-0.74)**	**0.36 (0.29-0.44)**	**0.42 (0.22-0.79)**	**0.31 (0.24-0.40)**	0.30 (0.12-0.76)
Socio-demographics						
Age group (years)						
54 and younger	ref	ref	ref	ref	ref	ref
55 to 59	**0.78 (0.67-0.90)**	0.97 (0.55-1.73)	**0.77 (0.65-0.91)**	**0.37 (0.19-0.73)**	**0.74 (0.59-0.93)**	0.61 (0.24-1.51)
60 to 64	**0.75 (0.65-0.86)**	0.58 (0.33-1.02)	**0.65 (0.55-0.77)**	**0.43 (0.24-0.77)**	**0.67 (0.54-0.83)**	0.48 (0.21-1.11)
65 to 69	**0.44 (0.36-0.53)**	0.54 (0.31-0.94)	**0.50 (0.40-0.61)**	**0.32 (0.17-0.58)**	**0.50 (0.38-0.66)**	0.28 (0.11-0.67)
70 or older	**0.04 (0.02-0.08)**	**0.22 (0.11-0.48)**	**0.07 (0.04-0.13)**	**0.05 (0.02-0.16)**	**0.08 (0.03-0.17)**	**0.05 (0.01-0.24)**
Gender						
Female	ref	ref	ref	ref	ref	ref
Male	0.78 (0.60-1.02)	1.66 (0.59-4.66)	0.90 (0.64-1.26)	0.69 (0.30-1.60)	1.48 (0.85-2.58)	0.97 (0.27-3.45)
Race/ethnicity						
White	ref	ref	ref	ref	ref	ref

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African American	**0.82 (0.70-0.96)**	0.74 (0.42-1.31)	0.74 (0.62-0.89)	0.77 (0.39-1.51)	**0.76 (0.60-0.97)**	0.87 (0.33-2.27)
Hispanic	1.15 (0.94-1.40)	1.33 (0.72-2.43)	0.98 (0.75-1.27)	1.12 (0.55-2.27)	0.85 (0.60-1.21)	1.67 (0.58-4.75)
Other	0.93 (0.67-1.29)	2.28 (1.13-4.63)	1.00 (0.68-1.47)	1.16 (0.40-3.32)	0.93 (0.54-1.60)	2.23 (0.64-7.76)
Insurance status						
VA-Private	ref	ref	ref	ref	ref	ref
VA-Medicare	0.95 (0.84-1.08)	1.21 (0.82-1.79)	**0.85 (0.73-0.98)**	1.22 (0.76-1.94)	**0.79 (0.66-0.95)**	1.44 (0.75-2.78)
VA-Medicaid	0.70 (0.50-0.97)	0.76 (0.18-3.28)	**0.42 (0.27-0.66)**	0.58 (0.08-4.41)	**0.42 (0.23-0.77)**	0.97 (0.12-8.04)
VA only	**0.75 (0.65-0.87)**	0.69 (0.38-1.23)	**0.40 (0.33-0.49)**	0.65 (0.32-1.34)	**0.28 (0.21-0.37)**	0.67 (0.23-1.95)
Region						
Northeast	ref	ref	ref	ref	ref	ref
Midwest	0.94 (0.70-1.25)	1.11 (0.61-2.00)	0.86 (0.65-1.14)	0.64 (0.32-1.29)	1.05 (0.73-1.50)	0.46 (0.19-1.15)
South	0.88 (0.68-1.14)	0.85 (0.48-1.48)	0.66 (0.51-0.85)	0.66 (0.36-1.19)	0.90 (0.66-1.24)	0.52 (0.24-1.12)
West	**0.68 (0.51-0.92)**	0.75 (0.39-1.47)	**0.47 (0.35-0.64)**	0.42 (0.19-0.92)	**0.53 (0.36-0.78)**	0.21 (0.06-0.71)
Priority status						
6-8	ref	ref	ref	ref	ref	ref
1-3	0.97 (0.83-1.13)	1.40 (0.86-2.27)	0.89 (0.75-1.05)	0.61 (0.37-1.02)	**0.76 (0.61-0.95)**	0.68 (0.32-1.42)
4-5	**0.81 (0.70-0.94)**	0.75 (0.45-1.25)	**0.68 (0.58-0.81)**	**0.51 (0.30-0.88)**	**0.65 (0.52-0.81)**	0.67 (0.31-1.46)
Depression	**0.82 (0.73-0.92)**	**0.83 (0.58-1.17)**	**0.85 (0.74-0.97)**	0.92 (0.60-1.40)	0.89 (0.74-1.06)	0.72 (0.39-1.32)
Anxiety	1.00 (0.86-1.16)	0.75 (0.48-1.18)	0.91 (0.76-1.10)	0.71 (0.41-1.25)	0.83 (0.65-1.08)	1.08 (0.51-2.27)
Facility characteristics						
Complexity level						
Low/Median Complexity	ref	ref	ref	ref	ref	ref
High Complexity	1.05 (0.78-1.43)	0.97 (0.49-1.94)	1.15 (0.84-1.57)	0.87 (0.38-1.99)	0.88 (0.58-1.32)	1.25 (0.44-3.50)
Facility cirrhosis volume						
Low	ref	ref	ref	ref	ref	ref
Medium	0.82 (0.60-1.12)	0.72 (0.34-1.53)	0.81 (0.58-1.13)	1.28 (0.48-3.42)	0.84 (0.54-1.30)	1.83 (0.51-6.57)
Medium-high	0.83 (0.57-1.22)	0.90 (0.38-2.13)	0.96 (0.64-1.42)	1.91 (0.62-5.86)	1.38 (0.82-2.31)	1.47 (0.35-6.24)
High	0.72 (0.49-1.07)	0.71 (0.30-1.68)	0.85 (0.57-1.26)	1.32 (0.42-4.16)	0.97 (0.57-1.64)	0.89 (0.20-3.88)
Transplant Center						
Yes	ref	ref	ref	ref	ref	ref
No	0.73 (0.50-1.05)	0.87 (0.50-1.51)	0.76 (0.54-1.07)	0.78 (0.41-1.50)	0.64 (0.42-0.97)	1.14 (0.46-2.86)
Urban/Rural						
Urban	ref	ref	ref	ref	ref	ref
Rural	**1.15 (1.03-1.29)**	1.24 (0.88-1.75)	1.03 (0.90-1.18)	1.34 (0.89-2.03)	0.95 (0.79-1.14)	1.88 (1.05-3.34)
Driving distance to closest transplant center (miles)						
<200	ref	ref	ref	ref	ref	ref
200-<500	0.89 (0.76-1.03)	0.78 (0.52-1.17)	0.92 (0.78-1.10)	0.84 (0.51-1.36)	0.94 (0.75-1.18)	0.58 (0.30-1.10)
≥500	0.98 (0.80-1.19)	0.73 (0.43-1.25)	0.93 (0.75-1.17)	1.10 (0.59-2.06)	0.97 (0.72-1.30)	0.53 (0.20-1.38)

Bold-face values indicate p-value <0.05 after adjustment for multiple comparisons using false discovery rate.

Adj HR, adjusted hazard ratio, CI, confidence intervals.

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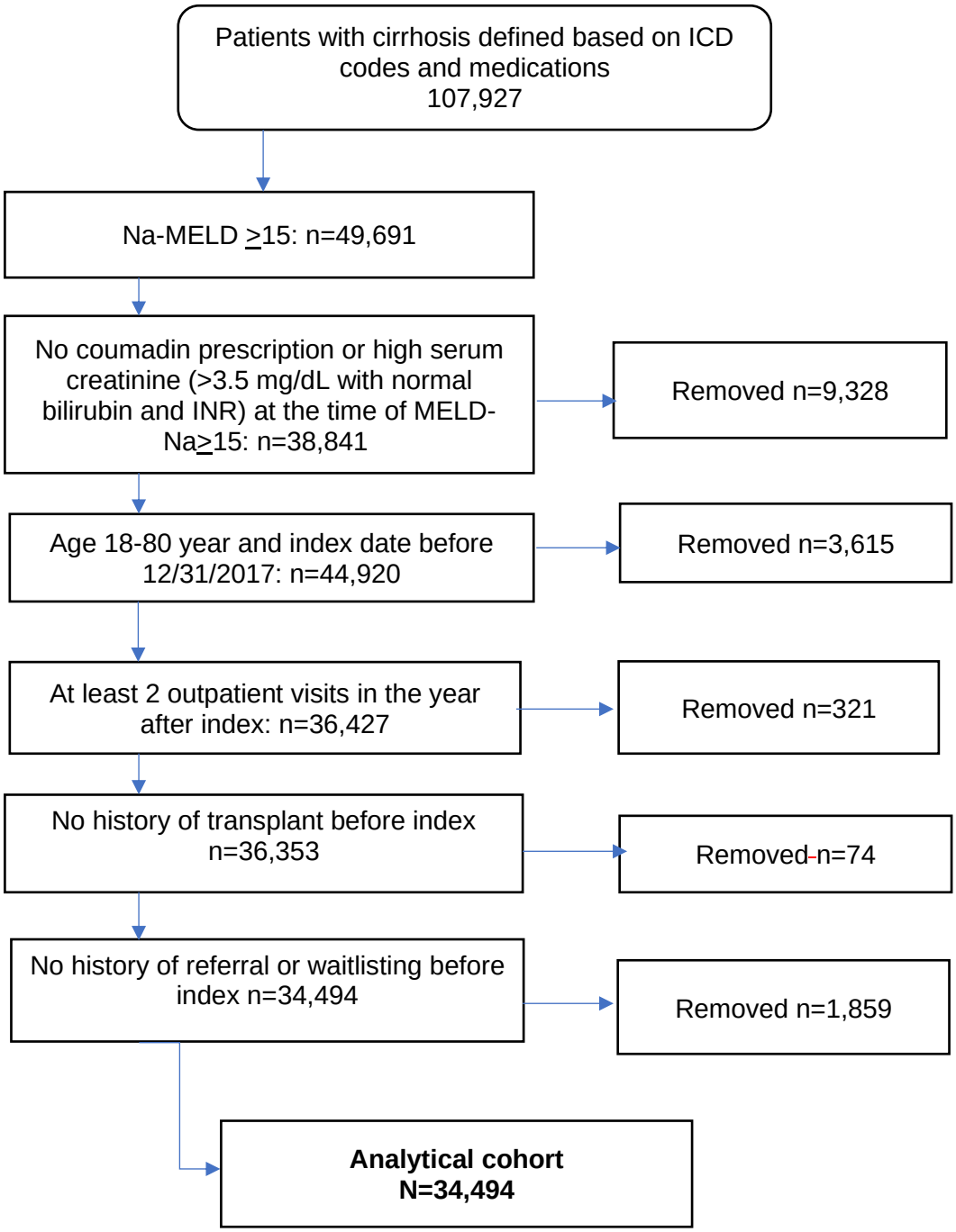
eFigure. Cohort Selection



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