
Multiple Listings as a Reflection of Geographic Disparity in Liver Transplantation



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- BACKGROUND:** Geographic disparity in access to liver transplantation (LT) exists. This study sought to examine Model for End-Stage Liver Disease—era multiply listed (ML) LT candidate (ie, candidates who list at 2 or more LT centers to receive a liver transplant).
- STUDY DESIGN:** Data on adult, primary, non—status 1 LT candidates (n = 59,557) listed from January 1, 2005 to December 31, 2011 were extracted from the United Network for Organ Sharing's Standard Transplant Analysis and Research files. Comparisons of ML vs singly listed LT candidates were performed, with additional analysis performed at the donor service area (DSA) and regional level, as well as assessment of the donor population used.
- RESULTS:** There were 1,358 (2.3%) ML candidates during the 7-year study period. Multiply listed candidates compared with singly listed candidates were more often male, white, blood type O, nondiabetic, college educated, and privately insured. The odds of pursuing ML increased considerably as time on the waitlist increased. Of the ML candidates, 918 (67.6%) went on to receive a liver transplant (ML-LT), 767 (83.6%) at the secondary listing DSA, which was a median of 588 miles (range 229 to 1095 miles) from the primary listing DSA. When compared with the primary listing DSA, the secondary listing DSA had significantly lower match Model for End-Stage Liver Disease scores, as well as shorter wait times. Regional analysis demonstrated significantly higher odds for pursuing ML from LT candidates located within regions 1, 5, and 9.
- CONCLUSIONS:** A small and distinctive cohort of LT candidates pursue ML, indicating willingness and means to travel to receive a liver transplant. Efforts toward equalizing LT access across regional disparities are warranted, and can help obviate the need for ML. (*J Am Coll Surg* 2014;219:496–504. © 2014 by the American College of Surgeons)
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With the demonstration of excellent survival after liver transplantation (LT), the demand for liver allografts has quickly outpaced the supply, and has generated a persistent gap between organ supply and patient demand. Despite

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the 2002 implementation of Model for End-Stage Liver Disease (MELD) score allocation, which allowed for allocation to address medical need through objective criteria, there remains geographic inequity because patients in certain donor service areas (DSAs) receive a deceased donor liver transplant before their sicker counterparts in other DSAs.¹ These geographic differences in deceased donor organ availability within the United States shape the current clinical practice of LT, as exemplified by the increased use of living donor liver transplants in highly competitive regions,² as well as the increased use of imported liver grafts and extended donor criteria liver grafts.^{3–5} Another approach to address the growing waitlisted population, pursued by candidates located in competitive DSAs, is multiple listing (ML). These candidates undergo evaluation and listing at another center located in a different DSA that allocates transplants at lower MELD scores and with shorter waiting times.

Abbreviations and Acronyms

DRI	= Donor Risk Index
DSA	= donor service area
HCV	= hepatitis C virus
IQR	= interquartile range
LT	= liver transplantation
MELD	= Model for End-Stage Liver Disease
ML	= multiple listing
NT	= no transplantation
OR	= odds ratio
SL	= single listing
UNOS	= United Network for Organ Sharing

Multiply listed LT candidates have only been characterized previously in the pre-MELD era.⁶ From 1997 to 2000, 3.3% of all liver candidates were listed at >1 center. Since then, there have been extensive changes in liver allocation policy, including the application of MELD and the subsequent “Share 15” provision,⁷⁻⁹ which have sought to allocate liver allografts more equitably. To date, there does not exist an examination of ML practices for LT candidates during the MELD era of allocation. We hypothesize that the persistent geographic disparities drive some patients to continue to ML at centers located in DSAs with shorter waitlist times, thereby redistributing the waitlisted population. We sought to characterize MELD-era ML candidates, including those who receive a transplant (ML-LT) and those who do not receive a transplant (ML-NT), comparing them with singly listed candidates (SL) at the DSA and regional level, as well as investigate the donor population used.

METHODS

Data about adult, primary, non—status 1 LT candidates (n = 59,557) listed from January 1, 2005 to December 31, 2011 were extracted from the United Network for Organ Sharing (UNOS) Standard Transplant Analysis and Research file created on December 31, 2011. Candidates who were ML within the same DSA, traveled <50 miles between centers, or lacked time overlap between listings, were excluded. For patients with listings at ≥ 3 DSAs (n = 131), we evaluated the primary DSA and 1 additional listing DSA. If the patient received a transplant at the secondary, tertiary, or quaternary DSA, we selected the DSA where transplant occurred as the secondary DSA. If the patient did not receive a transplant, we selected the chronologic secondary listing DSA.

Trends in multiple listing

Using MELD-era primary listings from January 1, 2005 to December 31, 2011, we assessed for trends in ML

during the study period by calculating the proportion of all new listings per year attributed to ML during 2005 to 2011 and applied the Cochran-Armitage trend test.

Comparison with single listing

Demographic and clinical characteristics of SL and ML (both ML-NT and ML-LT) patients were described with frequency (percent) and median (interquartile range [IQR]). Distance in miles between primary and secondary listing centers was calculated using the centroid of the ZIP code for each center. Characteristics of SL vs ML and ML-NT vs ML-LT were compared using chi-square and Wilcoxon rank sum tests, as appropriate.

Donor service area—level characteristics and calculation of donor service area time to transplantation

Median match MELD and median Donor Risk Index (DRI) scores for ML patients at both their primary and secondary listing DSAs were analyzed. Differences in these median values were calculated for each ML patient. The signed-rank test determined if the difference in median MELD and DRI scores between primary and secondary DSAs were significantly different from 0.

We estimated the time from listing until 25% of waitlist candidates received transplants within the DSA by year of listing using the Kaplan-Meier method per Merion and colleagues.⁶ Time on the waiting list was defined as the number of days from listing to transplantation, with patients who did not receive transplants censored at waitlist removal or last follow-up. In 6 DSAs, 25% of their waitlist did not receive transplants for 1 calendar year (range 18% to 24% of waitlist received transplants). For the latter 6 DSAs, we imputed the number of days from listing to the last censored observation, slightly underestimating the time to LT of the 25% of waitlisted candidates for the DSA.

Odds of multiple listing

The likelihood of ML was evaluated by logistic regression. Demographic and clinical characteristics with $p < 0.1$ in univariate comparisons were evaluated in multivariate models. Final model covariates were selected with backward elimination using $p > 0.05$ for exclusion from the model.

Post-transplantation survival

Graft survival was estimated using the Kaplan-Meier method and compared between SL and ML with the log-rank test. Survival time was measured in years from transplantation to the earliest of death, retransplantation,

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