



Historical Comparison of Projected and Observed Liver Transplants

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Introduction

- The allocation of deceased donor livers in the United States is guided by a complex set of rules specifying geographic allocation units, candidate priority, and organ compatibility. The complexity of the allocation system makes it challenging to predict the impact that a proposed policy change would have on candidate access and outcomes.
- The liver simulated allocation model (LSAM) is a discrete-event simulation program used to predict the impact of liver policy changes. Despite the importance of this tool in the policy development process, there are few opportunities to compare LSAM simulations to real data because major policy changes are relatively rare.
- In 2013, the Share35 policy was implemented, specifying that livers would be shared across the donor's entire region for candidates with model for end-stage liver disease (MELD) scores of 35 and above. This created the opportunity for a natural experiment.
- We aimed to evaluate LSAM performance by comparing liver transplant simulation projections to observed data before and after this major policy update.

Methods

- The current liver simulated allocation model (LSAM 2014) was used to simulate 1 year of liver transplants under two sets of allocation rules, representing policy before and after implementation of the Share35 regional sharing policy. LSAM simulations were repeated 10 times for each policy scenario with varying sequences of organ arrivals. Results from these simulations are reported as the mean, minimum and maximum across the 10 runs in order to quantify the degree of variability for each scenario.
- LSAM 2014 uses organs recovered for transplant during 2010. Candidates include those already on the waiting list on December 31, 2009 as well as those who were newly listed during 2010. Logistic regression and random number generation are used to model the uncertainty associated with offer acceptance decisions and posttransplant outcomes.
- For comparison to the LSAM simulations actual data was extracted from SRTR's standard analysis files for the 1-year periods immediately before and after Share35 implementation on June 18, 2013. The outcome rates were calculated for this real transplant data.

Results

- LSAM projected a minor decrease in rates of livers recovered for transplant but not transplanted (from 9.3% to 8.9%) and a decrease was observed in the actual data (from 10.1% to 9.5%, Table 1).
- LSAM overestimated the proportion of livers shared regionally under the pre-Share35 rules (28.6% regional sharing in LSAM vs. 20.4% observed) but correctly projected that regional sharing would increase under Share35 (33.5% projected vs. 31.8% observed, Table 2).
- LSAM projected an increase in transplant rates for MELD 35+ candidates from 862 to 1258 transplants per 100 patient-years, and an increase from 1085 to 1478 was observed. While LSAM estimated a decrease in transplant rate for MELD 30-34 candidates, the magnitude was lower than observed (Table 3).
- Finally, LSAM projected a slight decrease in waitlist death rates for MELD 35+ candidates from 105 to 100 deaths per 100 waitlist years and a decrease from 157 to 143 was observed (Table 4).

Table 1
Disposition of organs recovered for transplant.

	LSAM Pre-Share35	LSAM Share35	Actual pre-Share35	Actual Share35
Total Livers	6698	6698	6706	7026
Transplanted	6074 (5997-6123) 90.7%	6102 (6079-6126) 91.1%	6028 (89.9%)	6361 (90.5%)
Not Transplanted	624 (575-701) 9.3%	596 (572-619) 8.9%	678 (10.1%)	665 (9.5%)

Table 2
Geographic distribution of transplanted organs.

	LSAM Pre-Share35	LSAM Share35	Actual pre-Share35	Actual Share35
Local	4079 (4049-4131) 67.1%	3632 (3585-3660) 59.5%	4505 (74.7%)	4014 (63.1%)
Regional	1735 (1687-1783) 28.6%	2047 (2010-2079) 33.5%	1229 (20.4%)	2023 (31.8%)
National	261 (249-281) 4.3%	423 (408-446) 6.9%	295 (4.9%)	322 (5.1%)

Table 3
Waiting list transplant rates by status (transplants per 100 person-years).

	LSAM Pre-Share35	LSAM Share35	SAF pre-Share35	SAF Share35
Status 1A	5638.8 (5357-5803.8)	5915.7 (5597.7-6323.7)	4960.8	5217.8
Status 1B	529.1 (406.5-678.7)	518 (448.2-562.8)	981.7	695.4
>= MELD/PELD 35	862.3 (834-909)	1258.4 (1199.1-1342.8)	1085.5	1478.4
MELD/PELD 30-34	396.8 (380.4-414.7)	393 (375.9-416.9)	463.6	312.6
MELD/PELD 25-29	136 (132.5-139.5)	135.1 (131.9-140.1)	145.8	137.3
MELD/PELD 15-24	28.9 (27.9-29.4)	28.6 (28.3-29.1)	44.3	38.2
< MELD/PELD 15	0.3 (0.3-0.3)	0.1 (0.1-0.1)	1.8	1.6

Table 4
Waiting list death rates by status (deaths per 100 person-years).

	LSAM Pre-Share35	LSAM Share35	SAF pre-Share35	SAF Share35
Status 1A	457.7 (359.1-528.7)	502.1 (378.6-653.4)	541.5	395.6
Status 1B	47.1 (30.5-65.1)	44.8 (22-61.7)	44.6	43.5
>= MELD/PELD 35	105.1 (94.3-112.6)	100.1 (88.6-109.5)	156.8	142.8
MELD/PELD 30-34	28.6 (25.6-34.4)	29.4 (26.6-32.4)	15.5	18.2
MELD/PELD 25-29	8 (7.2-8.4)	8 (7.5-8.5)	6.4	7.1
MELD/PELD 15-24	3.4 (3.2-3.5)	3.3 (3.2-3.4)	5.5	6.1
< MELD/PELD 15	0.5 (0.4-0.5)	0.5 (0.5-0.5)	2.6	2.6
Inactive	6.7 (6.6-6.9)	6.6 (6.4-6.7)	25.4	25.2

For all tables: LSAM results from 10 iterations presented as mean (min-max).

Conclusions

- Implementation of Share35 presents a rare opportunity to evaluate LSAM projections against observed data across a policy-change boundary.
- LSAM correctly predicted the direction of change in most outcome categories of interest, although the magnitude of some changes was smaller than observed.
- In general, LSAM overestimates the proportion of regional transplants. This is likely related to the offer acceptance model. However, this did not prevent the simulation from predicting the direction of change in each geographic category.
- LSAM underestimates transplant rates and overestimates waiting list death rates for candidates in the MELD 25-34 range, which may be useful context for evaluating future simulation analyses.
- Due to these differences, comparison of LSAM simulations to other LSAM simulations is often more informative than comparison directly to observed data. Projected trends are more reliable than exact rates and proportions.
- Despite its limitations, LSAM offered useful insight into the potential impact of this policy change.

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