SCIENTIFIC REGISTRY OF TRANSPLANT RECIPIENTS

A priori identification of hard-to-place livers

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Disclosures

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Background

The OPTN OPO and Liver Committees have formed a working group to investigate expedited placement of livers at risk of discard.

In support of the working group, SRTR investigated the feasibility of identifying hard-to-place donor livers before the match run is generated.

Predictive models were developed, and the accuracy of corresponding decision rules evaluated.

Hard-to-place livers

Hard-to-place livers were either (1) not transplanted, or (2) transplanted outside of the recovering OPTN region. We considered all donors with at least one organ recovered for transplant between January 1, 2016, and December 31, 2016.

Data sources

Because the data must be available at the generation of the match run, two different data sources were considered:

1. DonorNet
2. Deceased donor registration (DDR) values likely available at the generation of the match run

Compared with DDR data, DonorNet data are more extensive and more difficult to work with, with higher rates of missingness.

Data sources: DonorNet

DonorNet can include multiple entries for the same donor within a very short period of time, and data for some donors may not be present until after the first match run is generated. To address these issues, we selected

1. The DonorNet entry immediately prior to generation of the match run.
2. If none existed, the first submission after generation of the match run.

Multiple submissions to DonorNet can occur in very short time periods. When necessary, we averaged over multiple values submitted during the same millisecond.

DonorNet variables with less than 20% missingness were included.

Data sources: DDR

The deceased donor registration (DDR) data include less missingness than DonorNet data, but are not entered before generation of the match run. Based on feedback from the OPTN expedited placement working group, DDR values likely available at the time of allocation were used to estimate the predictive model.

Importance of missing data

Missing data are problematic because they typically correspond to donors with hard-to-place livers. If the models included indicators for missing data, then donors with missing data may be more likely to qualify for the expedited pathway, which could create incentives to not enter donor data.

In contrast, decision rules based on models without indicators for missing data could handle missingness during the allocation process to ensure appropriate incentives, e.g., imputing the values least likely to initiate expedited placement.

Model estimation

For each data source, a logistic regression estimated the probability of a donor not yielding a transplanted liver or the liver being transplanted nationally.

Important components of the model:

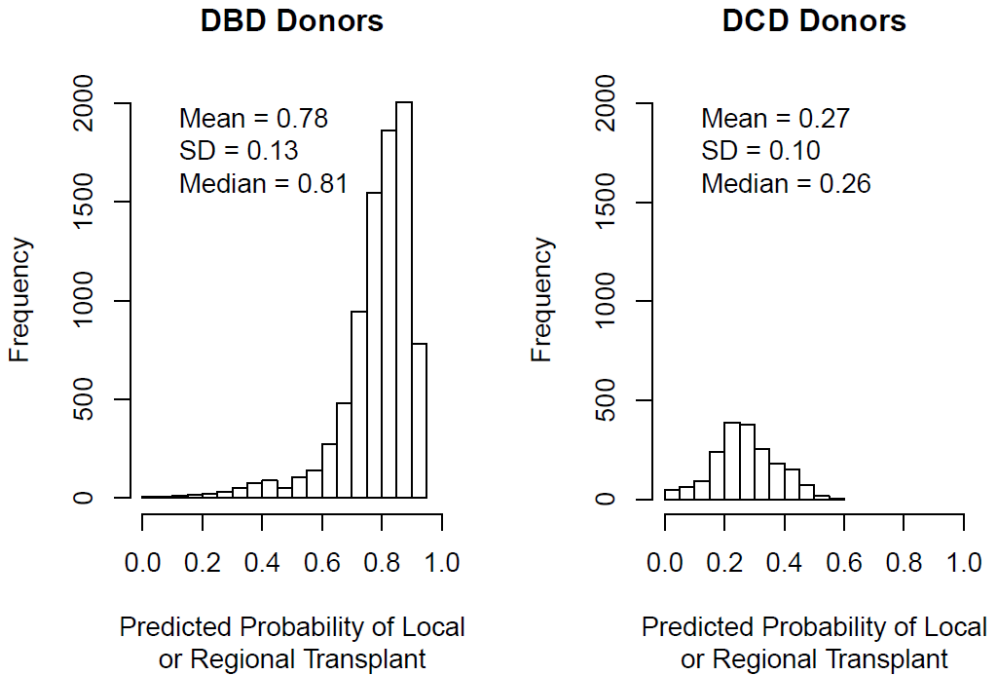
- Linear splines estimated the effect of continuous variables.
- The LASSO maintained parsimonious models while simultaneously considering the possible effect of many variables.

Estimated models

Model	Total Non-Zero Effects	Non-Zero Effects for Missingness
DonorNet	37	9
DDR	21	0

The DDR model is more parsimonious (i.e., fewer effects) and had no effects for missingness.

Predicted probabilities by DCD status



Model-based decision rules

For expedited placement, we want a decision rule that *a priori* identifies donors at risk of difficult placement or discard while simultaneously not identifying easily placed livers (i.e., transplanted locally or regionally).

Therefore, for each model, we considered four different decision rules for the predicted probability of local or regional transplant: 40%, 50%, 60%, and 70%. Donors below these cutoffs were considered high risk and possible donors for expedited placement.

To minimize the effect of overfitting, the performance of these decision rules was evaluated with donors recovered between January 1, 2017, and December 31, 2017.

Measuring the accuracy of decision rules

Three metrics measured the accuracy of the decision rules:

- Correct classification rate: The probability that the decision rule (1) recommended expedited placement for donors without a locally or regionally transplanted liver, or (2) did not recommend expedited placement for donors with a locally or regionally transplanted liver.
- Sensitivity: The probability that the decision rule did not recommend expedited placement for donors with a locally or regionally transplanted liver.
- Specificity: The probability that the decision recommended expedited placement for donors without a locally or regionally transplanted liver.

Results: Correct classification rate

Model	Decision Rule Cutoffs				DCD
	40%	50%	60%	70%	
DonorNet model	80.2%	80.7%	80.7%	78.4%	78.9%
DDR model	79.9%	80.2%	80.3%	78.4%	78.9%

Correct classification rate: The probability that the decision rule (1) recommended expedited placement for donors without a locally or regionally transplanted liver, or (2) did not recommend expedited placement for donors with a locally or regionally transplanted liver.

Results: Sensitivity

Model	Decision Rule Cutoffs				DCD
	40%	50%	60%	70%	
DonorNet model	94.5%	92.2%	89.6%	82.5%	93.2%
DDR model	94.1%	91.8%	89.9%	83.2%	93.2%

Sensitivity: The probability that the decision rule did not recommend expedited placement for donors with a locally or regionally transplanted liver.

Results: Specificity

Model	Decision Rule Cutoffs				DCD
	40%	50%	60%	70%	
DonorNet model	46.5%	53.9%	59.9%	68.8%	45.4%
DDR model	46.7%	53.2%	58.0%	67.2%	45.4%

Specificity: The probability that the decision recommended expedited placement for donors without a locally or regionally transplanted liver.

Conclusion

Despite slightly worse predictive performance, the DDR model had fewer risk factors with a non-zero effect, and no effects for the missingness of any risk factors. Because the DDR model was built on risk factors likely available at generation of the match run (i.e., allocation), it may provide a parsimonious and practical approach for the *a priori* identification of hard-to-place livers.

Future research may seek to investigate a separate model for only DBD donors due to the significant differences between DCD and DBD donors.

DDR-based model (1/3)

Characteristic	Required Value	Coefficient
Intercept		-5.4323
Age	>20	-0.020961
Age	>80	-0.118594
BMI	>20	-0.016548
Height (cm)	>0	0.006288
Height (cm)	<150	-0.011076
Weight (kg)	<50	-0.032121
Weight (kg)	>100	-0.008701

DDR-based model (2/3)

Characteristic	Required Value	Coefficient
Total bilirubin	<10	0.244507
SGOT/AST	<5000	0.000581
SGPT/ALT	<2000	0.000631
INR	<10	0.030724
Hematocrit	>20	-0.000930
Race	Black	0.206808
Hepatitis C+	Positive	-0.695260
DCD donor	Yes	-2.484474

DDR-based model (3/3)

Characteristic	Required Value	Coefficient
Circ. of death	Death from natural causes	-0.050648
Circ. of death	Suicide	0.009928
Circ. of death	Motor vehicle accident	0.028209
Heavy alcohol use	2+ drinks/day	-0.502583
Other drug use	Yes	0.130326
History of diabetes	Yes	-0.069494