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# Simulated Allocation Models

## Strengths, Limitations, & Data Availability

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# Disclosures



The views expressed do not necessarily reflect the official policies of the U.S. Department of Health and Human Services nor does mention of trade names, commercial practices, or organizations imply endorsement by the U.S. Government.

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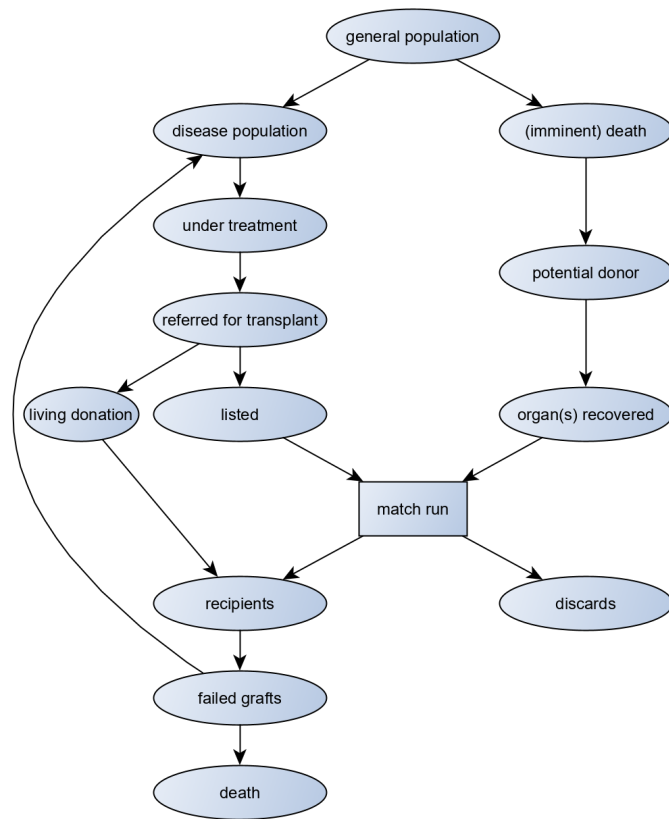
**LifeSource**  
ORGAN, EYE AND TISSUE DONATION



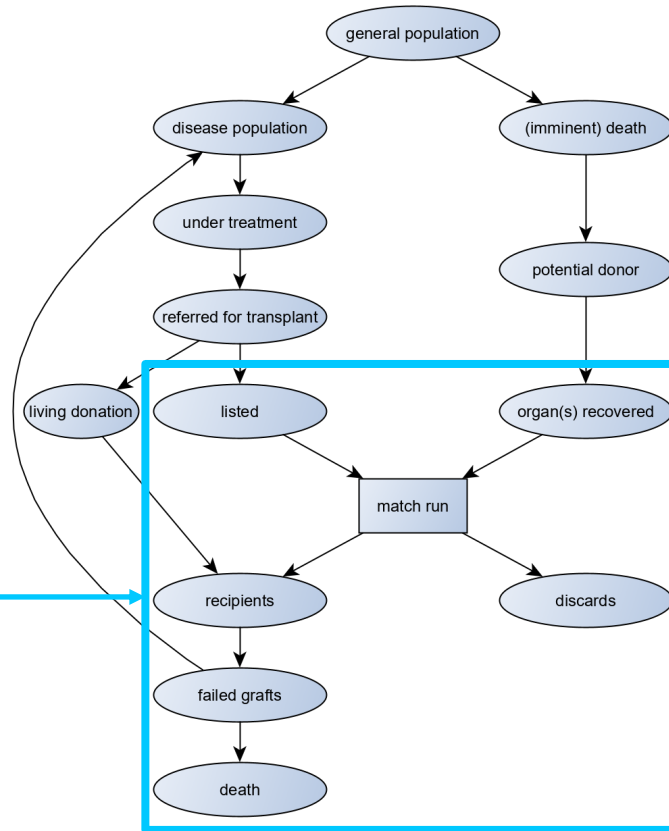
# Modeling Team Acknowledgments

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# Conceptualizing the Transplant System & Process

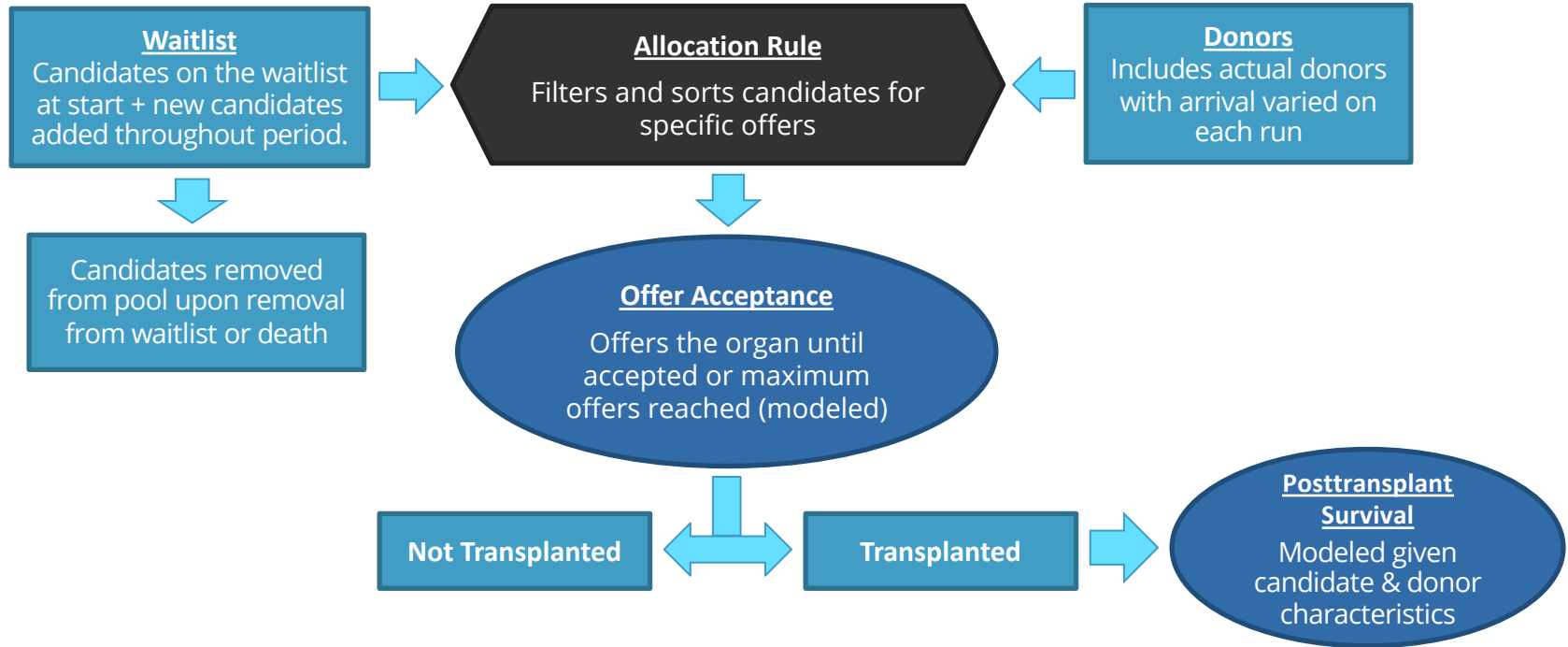


# Simulating Organ Allocation

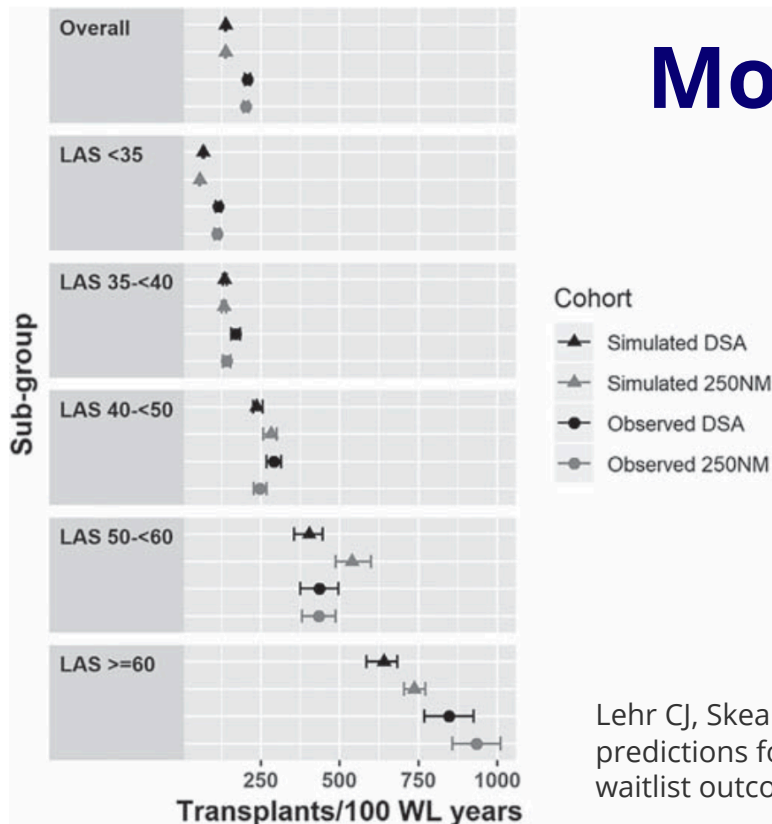


Simulated Allocation Process

# Modeling Flow Chart



# Modeling Lung Allocation

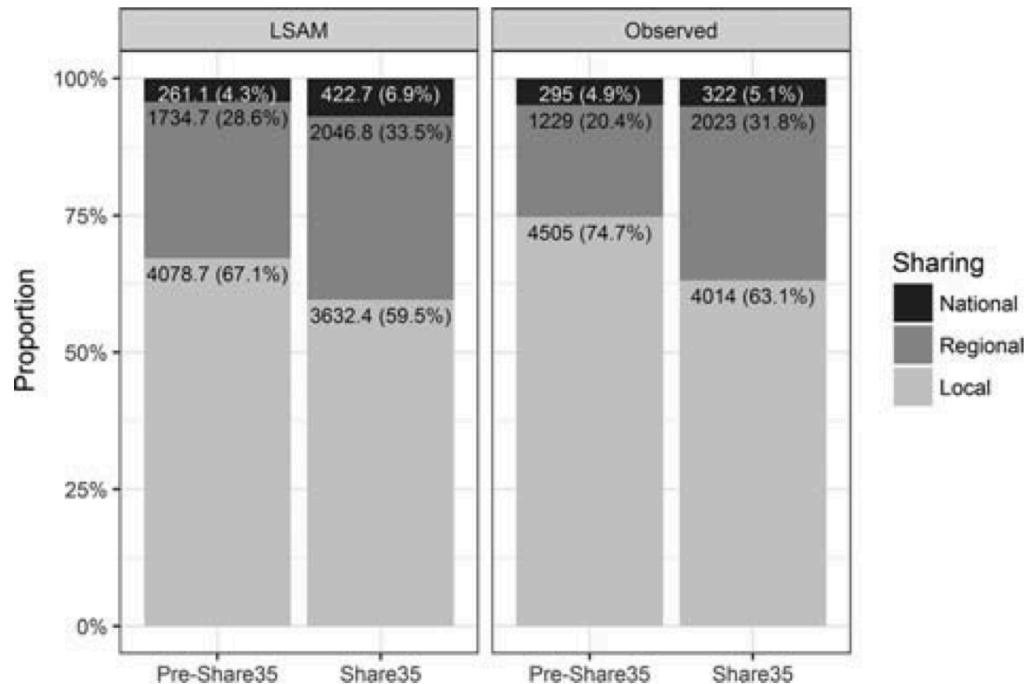


**RESULTS:** TSAM correctly predicted no change in overall waitlist mortality or transplant rates with the policy change. Observed waitlist mortality values were higher, as were transplant rates, because of increased organ donation and population change. TSAM predicted increased transplant rates for diagnosis group D (idiopathic pulmonary fibrosis), decreased rates for group A (chronic obstructive pulmonary disease), and increased rates for candidates with lung allocation score  $\geq 50$ , but these changes did not occur in the waitlist and transplant populations after the policy change.

Lehr CJ, Skeans, M, Valapour M. Validating thoracic simulated allocation model predictions for impact of broader geographic sharing of donor lungs on transplant waitlist outcomes. J Heart Lung Transplant. 2020;39(5):433-440.

# Modeling Liver Share 35

Conclusions. Although the absolute number of transplants was underestimated and waitlist deaths overestimated, the direction of change was consistent with observed data. LSAM correctly predicted change in discarded organs, regional and national sharing, waitlist mortality, and transplants after Share 35 implementation.



**FIGURE 2.** Organ sharing before and after Share 35. LSAM predictions of increased regional and national sharing of organs with a concurrent decrease in locally transplanted organs were consistent with observed results with Share 35.

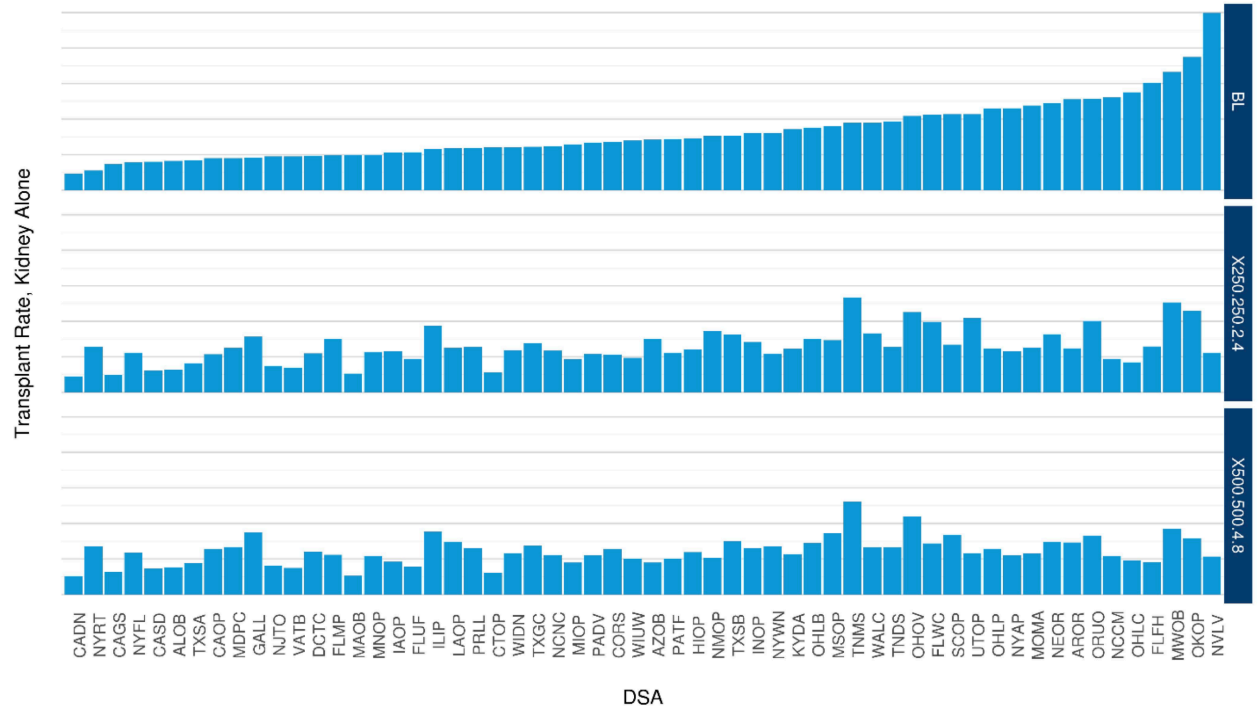
Kim SP, Gupta K, Israni AK, Kasiske BL. Accept/decline decision module for the liver simulated allocation model Health Care Manag Sci. 2015;18:35-57.



# Recent Kidney Policy Modeling

**Figure 19** illustrates how the proposed allocation framework reduces disparities in access among the DSAs compared to current practice under KAS.

**Figure 19: Kidney Transplant Rate by DSA**



Briefing to the OPTN Board of Directors on Elimination of DSA and Region from Kidney Allocation Policy OPTN Kidney Transplantation Committee. Available at [OPTN.transplant.HRSA.gov](https://optn.transplant.HRSA.gov).

# The Future

Historic Modeling  
Software Suite:

Kidney & Pancreas



Liver



Thoracic



Modeling Software in Development:



# Out with the old...



- Written in Delphi (object-oriented Pascal) – outdated, difficult to debug and optimize
- Memory addressing limited by 32-bit architecture
- Three parallel applications with overlapping functionality
- Limited support for different statistical models
- Challenging and error-prone input data preparation requirements
- Custom configuration formats with poor validation

# ...in with the new!



- Improved error checking and ease of use
- Policy validation checks
- Generalized data model (one match run engine compatible with all policies; policy implementations separate from source code)
- Robust mathematical expression support
- Objected oriented, 64-bit C#/ .NET environment
- .NET Standard match run engine and simulator engine
- .NET Core applications
- Cross-platform (Windows, OS X, Linux)
- Analytic packages to assist users in compiling simulation results into standardized metrics and data summaries.

# Limitations of the Current Modeling

- Past behavior may not predict behavior under updated policies.
  - Offer acceptance practices relative to donor/recipient characteristics may change under new policies.
  - For example, organs that were historically offered over long distances tended to be more difficult to place due to underlying donor characteristics. Policies with broader distribution may offer organs farther away early in the match run, which may underestimate offer acceptance.
- Organ discard is unable to be modeled due to underlying limitations of the source database.
  - Existing match run data within the OPTN do not capture when an organ ceased to be offered to transplant programs in a systematic way. Therefore, all acceptance models are trained only on organs that were eventually accepted.
  - Models currently do not attempt to "model" discard, but deem an organ as discarded if it reaches 200 declines.

# Recommendations for Continued Simulation Modeling Improvements

## Data Improvements:

- Improved OPTN capture of the organ offer process such that actual offers are easier to identify for organs that were eventually discarded prior to acceptance.
- Improved OPTN capture of transport modality and times or other “resource” capture to better characterize efficiency/cost of the system.

## Methodological Improvements:

- As data allows, improved modeling of organ discard probability and offer acceptance probabilities.
- Incorporation of modules that allow the user to hypothesize behavior change in response to a proposed policy.



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