Analysis Report, Appendix 1: Updated

Data Request from the OPTN Kidney Transplantation Committee: Provide KPSAM simulation data on effect of removing DSA and region from kidney/pancreas/kidney-pancreas organ allocation policy

Waitlist Mortality Rates, 1-Year Posttransplant Graft Failure Rates, and 1-Year Postransplant Patient Death Rates by Subgroup

Prepared By

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Data Request ID#: KI2019_01

Timeline

Request made: March 28, 2019
Analysis plan due: April 15, 2019
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Analysis report due: June 17, 2019
Analysis report submitted: June 14, 2019
Analysis report update submitted: June 21, 2019
Next committee meeting: June 25, 2019

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Executive Summary

SRTR used the updated kidney-pancreas simulated allocation model (KPSAM) to assess the simulated impact of eleven allocation frameworks based on nautical miles (NM) between candidate listing program and donor hospital. In interpreting the modeling results it is important to consider that KPSAM cannot model changes in program behaviors under new allocation policies.

All KPSAM runs were performed using a donor-only acceptance model. In contrast to previously published KPSAM runs, which considered both donor and candidate factors as well as donor/candidate interactions, this model only considered donor factors and offer number when predicting the likelihood of offer acceptance.

Update: This report contains all 10 iterations of the requested models.

Description of Runs

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Model Nickname</th>
<th>Circle Size</th>
<th>Inner Circle Maximum Points</th>
<th>Outer Circle Maximum Points</th>
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<tbody>
<tr>
<td>M2</td>
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<td>8</td>
</tr>
<tr>
<td>M11</td>
<td>500.500.step250</td>
<td>500</td>
<td>500 4</td>
<td>8</td>
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</tbody>
</table>
The baseline model (referred to as “BL” in all tables and figures) was the current allocation system, but with local pediatric candidates given priority over candidates with cPRA 98 and 99 for kidneys with KDPI < 35. The committee also wanted to similarly prioritize prior living donors, but prior living donors are not currently modeled by KPSAM.

Models 2-11 are single-circle allocation systems. Proximity points within the circle were assigned linearly, starting at X points for a 0-NM distance between the donor hospital and transplant program, and tapering to 0 points at the circle edge. Likewise, proximity points outside the circle were assigned linearly, starting at Y points at the circle's edge, and tapering to 0 points at 2500 NM.

Models 10 and 11 also contain a stepwise element, wherein a constant 4 points was awarded between 0-150 NM and 0-250 NM, respectively. This is meant to negate the effect of distance within that area. From there, proximity points taper to 0 at 500 NM. Outside the 500-NM circle, proximity points are assigned as in Models 2, e.g. starting at 8 points at 500 NM and tapering to 0 points at 2500 NM.

Data Request

Using the most recently available KPSAM version and data, model the kidney, pancreas, and kidney-pancreas distribution systems outlined in the KI2019_01 Analysis Plan.

Study population

KPSAM input files were updated to include transplant candidates listed on the kidney, kidney-pancreas, or pancreas transplant waiting lists between January 1, 2017, and December 31, 2017, and donors whose kidneys or pancreata were recovered for transplant in the same time period.

Updates to KPSAM

The unacceptable antigen equivalences and antigen splits used by KPSAM have been updated to match current (September 2018) OPTN policy. In addition, all predictive models used by KPSAM have been updated to incorporate newer data and methodology, including but not limited to the acceptance models and posttransplant outcomes models.

Metrics assessed

As noted in the OPTN data request, SRTR assessed the following outcome metrics for the simulations:

- Count (%) of transplants
- Transplant rates
- Time on dialysis distribution at transplant, kidney-alone
- Time on waiting list distribution at transplant
- Organ travel distance (NM) distribution at transplant
- Percent of organs traveling over 250 NM
- Variance in transplant rates
- Variance of median time on dialysis at transplant
- Variance in median time on waiting list at transplant
Relevant DSA-level metrics are shown choropleth maps and provided in an appendix of tables:

- Transplant rates
- Median dialysis time at transplant
- Median time on waiting list at transplant
- Median cPRA at transplant, kidney-alone
- Waitlist mortality rates
- Change in count of waitlist deaths^)

^In tables only

Metrics by organ should also be assessed by the following subgroup populations (including a comparison of percentage of waiting list vs. percentage of transplants where applicable):

- **Candidate/recipient age:** 0-5, 6-10, 11-17, 18-34, 35-49, 50-64, ≥ 65 years
- **Candidate/recipient race:** white, African American, Asian, other/unknown
- **Candidate/recipient sex:** male vs. female
- **Candidate/recipient ethnicity:** Latino, Not Latino
- **Candidate/recipient blood type (ABO):** A, B, AB, O
- **Candidate/Recipient cPRA:** 0-79, 80-89, 90-94, 95-97, 98, 99, 100
- **Candidate/recipient diagnosis:** diabetes, hypertension, GN, cystic kidney disease, other
- **Candidate/recipient time on dialysis:** pre-emptive transplant, 0-< 1, 1-< 3, 3-< 5, 5-< 10, ≥ 10 years
- **SES-related:**
  - **Candidate/recipient insurance status:** public vs. private
  - **Median income by recipient zip code at listing/transplant distribution:** using the ACS zip code level publically available dataset
  - **Urbanicity:** urban vs. rural, based on RUCA codes (individually, and grouped by metropolitan vs. micropolitan + small town + rural)
- **KDPI:** 0-20%, 21-34%, 35-85%, 86-100%
- **EPTS:** 0-20%, 21-100%
- **Donor type:** DCD vs DBD
- **Candidate/recipient sensitization:**
  - 0-HLA mismatch: 0 vs. non-0
  - DR mismatch level: 0, 1, 2
- **Geography:**
  - Percentage local (DSA), regional, national
  - By OPTN Region: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

Additional figures by subgroup are in this report (Appendix 1):

- Waitlist mortality rate
- Post-transplant graft failure rate (1 year)
- Post-transplant death rate (1 year)
The baseline model (referred to as “BL” in all tables and figures) was the current allocation system, but with local pediatrics given priority over cPRA 98 and 99 for kidneys with KDPI < 35.

Models 2 - 9 are single circle allocation systems. Proximity points within the circle were assigned linearly, starting at X points for a 0 NM distance between the donor hospital and transplant center, and tapering to 0 points at the circle's edge. Likewise, proximity points outside the circle were assigned linearly, starting at Y points at the circle's edge, and tapering to 0 points at 2500 NM.

Models 10 and 11 are stepwise models, wherein a constant 4 points was awarded between 0 - 150 NM and 0 - 250 NM, respectively. From there, proximity points taper to 0 at 500 NM. Outside of the 500 NM circle, proximity points are assigned as in Models 2-9.

**Analytic approach**

Each of the eleven requested changes to the allocation system was run with 10 iterations (repetitions) in KPSAM, to provide some measure of variability. Because the same donors and candidates are used in each of the simulations, and they are the actual donors and candidates from 2017 rather than independent samples from a larger population, statistical tests for comparison have no validity. Instead, the average and range of results (minimum - maximum) for the 10 iterations are provided.

**Subgroup Analyses**

The dot plots below display the range of results across the 10 simulations as a vertical line extending from the minimum value to the maximum value found for that metric and scenario. A point along that line marks the mean value of the metric across the 10 iterations.
Waitlist Mortality

Waitlist Mortality Rates

Waitlist Mortality Rates: Age 0-17

*Waitlist Mortality rates by Age 0-17: Kidney*
Waitlist Mortality Rates: Age 18+

Waitlist Mortality rates by Age 18+: Kidney

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Waitlist Mortality rates by Age 18+: Kidney
Waitlist Mortality rates by Age 18+: Kidney-Pancreas
Waitlist Mortality rates by Age 18+: Pancreas

Waitlist Mortality rates by Age 18+: Pancreas

Waitlist deaths per patient-year

Scenario

BL 500 500.8 500 500.8 500 500.8 500 500.8 500 500.8 500 500.8 500 500.8 500 500.8 500 500.8 500 500.8 500 500.8 500 500.8

[18, 35]

[35, 50]

[50, 65]
Waitlist Mortality Rates: Race

Waitlist Mortality rates by Race: Kidney

Waitlist Mortality rates by Race: Kidney


**Waitlist Mortality rates by Race: Kidney-Pancreas**

![Graph showing waitlist mortality rates by race for kidney-pancreas transplants.](image)

Waitlist Mortality rates by Race: Kidney-Pancreas
Waitlist Mortality rates by Race: Pancreas
Waitlist Mortality Rates: Ethnicity

Waitlist Mortality rates by Ethnicity: Kidney

Waitlist Mortality rates by Ethnicity: Kidney
Waitlist Mortality rates by Ethnicity: Kidney-Pancreas
Waitlist Mortality rates by Ethnicity: Pancreas

Waitlist Mortality rates by Ethnicity: Pancreas
Waitlist Mortality Rates: Sex

Waitlist Mortality rates by Sex: Kidney

Waitlist Mortality rates by Sex: Kidney
Waitlist Mortality rates by Sex: Kidney-Pancreas
Waitlist Mortality Rates: ABO Group

**Waitlist Mortality rates by ABO Group: Kidney**

*Graph showing waitlist mortality rates for kidney transplants by ABO group across different scenarios.*

Waitlist Mortality rates by ABO Group: Kidney
Waitlist Mortality rates by ABO Group: Kidney-Pancreas
Waitlist Mortality rates by ABO Group: Pancreas
Waitlist Mortality Rates: Diagnosis

Waitlist Mortality rates by Diagnosis: Kidney

Waitlist Mortality rates by Diagnosis: Kidney
Waitlist Mortality rates by Diagnosis: Kidney-Pancreas

Waitlist deaths per patient-year

Scenario

BL 500 500.8 500 500.4 500 150 0.8 500 250 2.4 500 250 0.8 500 150 0.8 500 150 0.2 500 500 step 150 500 500 step 250

Hypertension
Type 1 Diabetes
Type 2 Diabetes
Waitlist Mortality rates by Diagnosis: Pancreas

- Hypertension
- Type 1 Diabetes
- Type 2 Diabetes

Scenario:
- BL
- 500
- 500.0 150.0 250.0 500.0 250.0 150.0 500.0 250.0 150.0
- 500.0 step 500.0
- 500.0 step 250.0
- 500.0 step 150.0
- 500.0 step 50.0

Waitlist deaths per patient-year

Waitlist Mortality rates by Diagnosis: Pancreas
Waitlist Mortality Rates: Dialysis Time

Waitlist Mortality rates by Dialysis Time: Kidney

Waitlist Mortality rates by Dialysis Time: Kidney
Waitlist Mortality Rates: cPRA

Waitlist Mortality rates by cPRA: Kidney

*Waitlist Mortality rates by cPRA: Kidney*
Waitlist Mortality rates by cPRA: Kidney-Pancreas
Waitlist Mortality rates by cPRA: Pancreas
Waitlist Mortality Rates: Payment Status

Waitlist Mortality rates by Payment Status: Kidney

Waitlist Mortality rates by Payment Status: Kidney

Waitlist Mortality rates by Payment Status: Kidney
Waitlist Mortality rates by Payment Status: Kidney-Pancreas
Waitlist Mortality rates by Payment Status: Pancreas

Waitlist Mortality rates by Payment Status: Pancreas
Waitlist Mortality Rates: Urbanicity

Waitlist Mortality rates by Urbanicity: Kidney

Waitlist Mortality rates by Urbanicity: Kidney
Waitlist Mortality rates by Urbanicity: Kidney-Pancreas
Waitlist Mortality rates by Urbanicity: Pancreas
Waitlist Mortality Rates: EPTS

Waitlist Mortality rates by EPTS: Kidney

Waitlist Mortality rates by EPTS: Kidney

Scenario

0.02
0.03
0.04
0.05
0.06

BL 500 500 step 150 500 250 500 500 250
500 500 step 150 500 500 250 500 500 step 150

20% or Less

Over 20%
Waitlist Mortality Rates: Median Household Income by Zip Code

Waitlist Mortality rates by Median Household Income by Zip Code: Kidney

Waitlist deaths per patient-year

Scenario

Waitlist Mortality rates by Median Household Income by Zip Code: Kidney
Waitlist Mortality rates by Median Household Income by Zip Code: Kidney-Pancreas
Waitlist Mortality rates by Median Household Income by Zip Code: Pancreas

*Waitlist Mortality rates by Median Household Income by Zip Code: Pancreas*
Posttransplant Mortality

Posttransplant Mortality Rates at 1 Year

Posttransplant Mortality Rates at 1 Year: Age at Transplant 0-17

Posttransplant Mortality Rates by Age at Transplant 0-17: Kidney
Posttransplant Mortality Rates at 1 Year: Age at Transplant 18+

Posttransplant Mortality Rates by Age at Transplant 18+: Kidney

Posttransplant Mortality Rates by Age at Transplant 18+: Kidney
Posttransplant Mortality Rates by Age at Transplant 18+: Kidney-Pancreas

Posttransplant Mortality Rates by Age at Transplant 18+: Kidney-Pancreas
Posttransplant Mortality Rates by Age at Transplant 18+: Pancreas
Posttransplant Mortality Rates at 1 Year: Race

Posttransplant Mortality Rates by Race: Kidney

[Graph showing posttransplant mortality rates by race (Asian, Black, Other, White) over different scenarios (BL, 500, 500.0, 500.0, 250, 250.0, 150, 150.0, 250, 250.0, 150, 150.0).]

Posttransplant Mortality Rates by Race: Kidney
Posttransplant Mortality Rates by Race: Kidney-Pancreas
Posttransplant Mortality Rates by Race: Pancreas
Posttransplant Mortality Rates at 1 Year: Ethnicity

Posttransplant Mortality Rates by Ethnicity: Kidney
Posttransplant Mortality Rates by Ethnicity: Kidney-Pancreas
Posttransplant Mortality Rates by Ethnicity: Pancreas

Posttransplant Mortality Rates by Ethnicity: Pancreas
Posttransplant Mortality Rates at 1 Year: Sex

Posttransplant Mortality Rates by Sex: Kidney

Posttransplant Mortality Rates by Sex: Kidney
Posttransplant Mortality Rates by Sex: Kidney-Pancreas
Posttransplant Mortality Rates by Sex: Pancreas
Posttransplant Mortality Rates at 1 Year: ABO Group

Posttransplant Mortality Rates by ABO Group: Kidney

Posttransplant Mortality Rates by ABO Group: Kidney
Posttransplant Mortality Rates by ABO Group: Kidney-Pancreas

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*Posttransplant Mortality Rates by ABO Group: Kidney-Pancreas*
Posttransplant Mortality Rates by ABO Group: Pancreas
Posttransplant Mortality Rates at 1 Year: Diagnosis

Posttransplant Mortality Rates by Diagnosis: Kidney

Posttransplant Mortality Rates by Diagnosis: Kidney
Posttransplant Mortality Rates by Diagnosis: Kidney-Pancreas
Posttransplant Mortality Rates by Diagnosis: Pancreas
Posttransplant Mortality Rates at 1 Year: Dialysis Time

Posttransplant Mortality Rates by Dialysis Time: Kidney

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Posttransplant Mortality Rates by Dialysis Time: Kidney
Posttransplant Mortality Rates at 1 Year: cPRA

Posttransplant Mortality Rates by cPRA: Kidney

Posttransplant Mortality Rates by cPRA: Kidney
Posttransplant Mortality Rates by cPRA: Kidney-Pancreas
Posttransplant Mortality Rates by cPRA: Pancreas
Posttransplant Mortality Rates at 1 Year: Payment Status

**Posttransplant Mortality Rates by Payment Status: Kidney**
Posttransplant Mortality Rates by Payment Status: Kidney-Pancreas

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Posttransplant Mortality Rates by Payment Status: Kidney-Pancreas
Posttransplant Mortality Rates by Payment Status: Pancreas

Posttransplant Mortality Rates by Payment Status: Pancreas
Posttransplant Mortality Rates at 1 Year: Urbanicity

Posttransplant Mortality Rates by Urbanicity: Kidney

Posttransplant Mortality Rates by Urbanicity: Kidney
Posttransplant Mortality Rates by Urbanicity: Kidney-Pancreas

Posttransplant Mortality Rates by Urbanicity: Kidney-Pancreas
Posttransplant Mortality Rates by Urbanicity: Pancreas
Posttransplant Mortality Rates at 1 Year: Local/Regional/National

Posttransplant Mortality Rates by Local/Regional/National: Kidney
Posttransplant Mortality Rates by Local/Regional/National: Kidney-Pancreas
Posttransplant Mortality Rates by Local/Regional/National: Pancreas
Posttransplant Mortality Rates at 1 Year: Region

Posttransplant Mortality Rates by Region: Kidney

Posttransplant Mortality Rates by Region: Kidney
Posttransplant Mortality Rates by Region: Kidney-Pancreas
Posttransplant Mortality Rates by Region: Pancreas
Posttransplant Mortality Rates at 1 Year: EPTS

Posttransplant Mortality Rates by EPTS: Kidney

Posttransplant Mortality Rates by EPTS: Kidney
Posttransplant Mortality Rates at 1 Year: Median Household Income by Zip Code

Posttransplant Mortality Rates by Median Household Income by Zip Code: Kidney

Posttransplant Mortality Rates by Median Household Income by Zip Code: Kidney
Posttransplant Mortality Rates by Median Household Income by Zip Code: Kidney-Pancreas
Posttransplant Mortality Rates by Median Household Income by Zip Code: Pancreas
Posttransplant Mortality Rates at 1 Year: Donor KDPI

Posttransplant Mortality Rates by Donor KDPI: Kidney
Posttransplant Mortality Rates at 1 Year: DCD Donor

Posttransplant Mortality Rates by DCD Donor: Kidney

Posttransplant Mortality Rates by DCD Donor: Kidney
**Posttransplant Mortality Rates at 1 Year: Number of DR mismatches**

*Posttransplant Mortality Rates by Number of DR mismatches: Kidney*

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*Posttransplant Mortality Rates by Number of DR mismatches: Kidney*
Posttransplant Graft Failure Rates at 1 Year

**Posttransplant Graft Failure Rates at 1 Year: Age at Transplant 0-17**

*Posttransplant Graft Failure Rates by Age at Transplant 0-17: Kidney*
Posttransplant Graft Failure Rates at 1 Year: Age at Transplant 18+

Posttransplant Graft Failure Rates by Age at Transplant 18+: Kidney

Posttransplant Graft Failure Rates by Age at Transplant 18+: Kidney
Posttransplant Graft Failure Rates by Age at Transplant 18+: Kidney-Pancreas
Posttransplant Graft Failure Rates by Age at Transplant 18+: Pancreas
Posttransplant Graft Failure Rates at 1 Year: Race

Posttransplant Graft Failure Rates by Race: Kidney

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Posttransplant Graft Failure Rates by Race: Kidney
Posttransplant Graft Failure Rates by Race: Kidney-Pancreas
Posttransplant Graft Failure Rates by Race: Pancreas
Posttransplant Graft Failure Rates at 1 Year: Ethnicity

Posttransplant Graft Failure Rates by Ethnicity: Kidney
Posttransplant Graft Failure Rates by Ethnicity: Kidney-Pancreas
Posttransplant Graft Failure Rates by Ethnicity: Pancreas
Posttransplant Graft Failure Rates at 1 Year: Sex

Posttransplant Graft Failure Rates by Sex: Kidney
Posttransplant Graft Failure Rates by Sex: Kidney-Pancreas
Posttransplant Graft Failure Rates by Sex: Pancreas
Posttransplant Graft Failure Rates at 1 Year: ABO Group

Posttransplant Graft Failure Rates by ABO Group: Kidney
Posttransplant Graft Failure Rates by ABO Group: Kidney-Pancreas
Posttransplant Graft Failure Rates by ABO Group: Pancreas
Posttransplant Graft Failure Rates at 1 Year: Diagnosis

Posttransplant Graft Failure Rates by Diagnosis: Kidney

Posttransplant Graft Failure Rates by Diagnosis: Kidney

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**SRTR, KI2019_01 Analysis Report Update Appendix 1**

version 1, 6/21/2019
Posttransplant Graft Failure Rates by Diagnosis: Kidney-Pancreas

![Graph showing posttransplant graft failure rates by diagnosis for Kidney-Pancreas.](image)

**Posttransplant Graft Failure Rates by Diagnosis: Kidney-Pancreas**
Posttransplant Graft Failure Rates by Diagnosis: Pancreas
Posttransplant Graft Failure Rates at 1 Year: Dialysis Time

Posttransplant Graft Failure Rates by Dialysis Time: Kidney
Posttransplant Graft Failure Rates at 1 Year: cPRA

Posttransplant Graft Failure Rates by cPRA: Kidney

Posttransplant Graft Failure Rates by cPRA: Kidney
Posttransplant Graft Failure Rates by cPRA: Kidney-Pancreas
Posttransplant Graft Failure Rates by cPRA: Pancreas
Posttransplant Graft Failure Rates at 1 Year: Payment Status

Posttransplant Graft Failure Rates by Payment Status: Kidney

Posttransplant Graft Failure Rates by Payment Status: Kidney
Posttransplant Graft Failure Rates by Payment Status: Kidney-Pancreas
Posttransplant Graft Failure Rates by Payment Status: Pancreas
Posttransplant Graft Failure Rates at 1 Year: Urbanicity

Posttransplant Graft Failure Rates by Urbanicity: Kidney
Posttransplant Graft Failure Rates by Urbanicity: Kidney-Pancreas
Posttransplant Graft Failure Rates by Urbanicity: Pancreas
Posttransplant Graft Failure Rates at 1 Year: Local/Regional/National

**Posttransplant Graft Failure Rates by Local/Regional/National: Kidney**

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*Posttransplant Graft Failure Rates by Local/Regional/National: Kidney*
Posttransplant Graft Failure Rates by Local/Regional/National: Kidney-Pancreas
Posttransplant Graft Failure Rates by Local/Regional/National: Pancreas
Posttransplant Graft Failure Rates at 1 Year: Region

Posttransplant Graft Failure Rates by Region: Kidney

Posttransplant Graft Failure Rates by Region: Kidney
Posttransplant Graft Failure Rates by Region: Kidney-Pancreas
Posttransplant Graft Failure Rates by Region: Pancreas
Posttransplant Graft Failure Rates at 1 Year: EPTS

Posttransplant Graft Failure Rates by EPTS: Kidney

Posttransplant Graft Failure Rates by EPTS: Kidney
Posttransplant Graft Failure Rates at 1 Year: Median Household Income by Zip Code

Posttransplant Graft Failure Rates by Median Household Income by Zip Code: Kidney

Posttransplant Graft Failure Rates by Median Household Income by Zip Code: Kidney
Posttransplant Graft Failure Rates by Median Household Income by Zip Code: Kidney-Pancreas
Posttransplant Graft Failure Rates by Median Household Income by Zip Code: Pancreas
Posttransplant Graft Failure Rates at 1 Year: Donor KDPI

Posttransplant Graft Failure Rates by Donor KDPI: Kidney

Posttransplant Graft Failure Rates by Donor KDPI: Kidney
Posttransplant Graft Failure Rates at 1 Year: DCD Donor

Posttransplant Graft Failure Rates by DCD Donor: Kidney

Posttransplant Graft Failure Rates by DCD Donor: Kidney
Posttransplant Graft Failure Rates at 1 Year: Number of DR mismatches

Posttransplant Graft Failure Rates by Number of DR mismatches: Kidney