Analysis Report

Data request from the OPTN Liver and Intestinal Organ Transplantation Committee

March 31, 2016

Meeting: June 23, 2015 (In-person meeting)

This report was provided to HRSA by SRTR in support of ongoing policy consideration by the OPTN Liver and Intestinal Organ Transplantation Committee. The analysis described herein was conducted at the specific request of the OPTN Committee and does not represent a full or final analysis related to the policy issue under consideration.

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Data Request ID#: LI2015_02 (Data Request 2 & 3)

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Background

The analysis presented in this report relates to the ongoing work of the OPTN Liver and Intestinal Organ Transplantation Committee (the Committee). Alternatives to the current liver transplant allocation and distribution system are being examined by the Committee, with a goal of decreasing geographic disparities in liver transplant.

During the June 23, 2015 in-person OPTN Liver and Intestinal Organ Transplantation Committee meeting, Committee members asked for additional outputs that would help to determine the effects of MELD/PELD exceptions on the various scenarios previously modeled in preparation for the June 22, 2015, Forum. The Committee requested further modeling, as shown in this report.

Data Request

The full OPTN data request to which this analysis responds is shown in **Appendix A: OPTN Committee Data Request**. The request was for additional Liver Simulated Allocation Model (LSAM) analysis of a 500-mile circle from the donor hospital as the distribution area, with inclusion of proximity circles of 150 or 250 miles which convey either 3 or 5 additional allocation MELD/PELD points. The request specified that several sets of 500-mile circle scenarios be tested, with proximity points being awarded to either all candidates, all candidates without exception points, or all candidates without HCC exception points.

Study Population

This analysis was based on actual patient data for transplant candidates listed on the liver waiting lists as of December 31, 2006, and candidates added to those waiting lists and organs donated between January 1, 2007, and December 31, 2011. We used donor and candidate generator software to combine these actual patient data into independent donor and candidate populations used in each of the multiple LSAM iterations involved in simulating each allocation scenario.

Analytical Approach

To assess the effect of 500-mile radius circles with proximity points for candidates, we simulated multiple allocation scenarios with LSAM and compared the results. Each simulation was repeated 10 times to provide an estimate of variability. Each of the 10 iterations for each scenario used independent sets of organ and waitlist arrivals and distinct random number seeds. Each scenario simulated 5 years of transplants.

For the current request, the Committee identified 12 new scenarios that include a 500-mile radius circle as the local distribution area with combinations of: (a) 3 or 5 proximity points for (b) candidates within a 150- or 250-mile radius of the donor hospital and (c) proximity points awarded to all candidates, all candidates with no MELD/PELD exception points, or all candidates with no MELD/PELD hepatocellular carcinoma (HCC) exception points. The LSAM input files include indicators for HCC exception status that were used to identify recipients with HCC exceptions. Recipients with no exceptions were identified as those having identical laboratory and allocation MELD/PELD scores.

For comparison purposes, we include 4 additional scenarios in the data output to compare with the 12 500-mile circle scenarios. These scenarios include: current policy, national allocation with 3 proximity points for candidates within a 150-mile radius of the donor hospital, 4 districts with in-district proximity circles awarding 3 proximity points to candidates within a 150-mile radius of the donor hospital, and 8 districts with in-district proximity circles awarding 3 proximity points to candidates within a 150-mile radius of the donor hospital. The 2 4- and 8-district "redistricting"" scenarios with proximity points have also been previously examined in response to several data requests. We present a national allocation scenario as a point of comparison.

The current policy scenario uses the current 11 regions with current allocation ordering as of June 2015, including Share 35/Share 15 allocation ordering, but without consideration of the MELD-NA, Cap HCC, or HCC policies. **Table 1** shows the full list of all 16 scenarios simulated and analyzed in this report.

The terms "in-district" and "out-district" refer to the treatment of proximity circles in redistricting scenarios. Previous Committee requests compared either in-district or out-district proximity circles. In both cases, proximity points are awarded to candidates who are within the proximity circle, whether they are in the same district as the donor or not. With in-district circles, only candidates who are within the district are treated as being in-district for the purposes of distribution. With out-district circles, candidates who are within the proximity circle but outside the district are included at the same level of distribution as other in-district candidates. In other words, with out-district circles, any candidate within the proximity circle of the recovery hospital, even if they are not geographically located in the same district as the recovery hospital, are treated as being in that district and receive offers within the first round of in-district allocation.

Some data quality and interpretation issues should be noted when reviewing this report:

1. LSAM analysis is based on national data and as such is best used to estimate overall nationwide trends. LSAM can predict the overall direction and magnitude of change in the transplant system overall. Due to variability in the underlying data and in transplant program and OPO behavior, LSAM cannot predict outcomes at a transplant program level.
2. Estimates of variance are highly influenced by the number of allocation units used. Analyses of variance in this report use the donation service area (DSA) as the standard unit of analysis.
3. This report does not provide an analysis of the exception system for liver allocation.

Table 1. Modeling Scenarios used in LI2015_02 Data Request 2 and 3

Run #	Modeling Scenario Districts	# of Proximity Points	Proximity Points Radius	Candidate Designation (in- or out-district)	How Proximity Points are Assigned
1	500-mile Circles	3	150	N/A	Allocation MELD
2	500-mile Circles	3	250	N/A	Allocation MELD
3	500-mile Circles	5	150	N/A	Allocation MELD
4	500-mile Circles	5	250	N/A	Allocation MELD
5	500-mile Circles	3	150	N/A	Allocation MELD for all but Exceptions
6	500-mile Circles	3	250	N/A	Allocation MELD for all by Exceptions
7	500-mile Circles	5	150	N/A	Allocation MELD for all but Exceptions
8	500-mile Circles	5	250	N/A	Allocation MELD for all but Exceptions
9	500-mile Circles	3	150	N/A	Allocation MELD for all but HCC Exceptions
10	500-mile Circles	3	250	N/A	Allocation MELD for all but HCC Exceptions
11	500-mile Circles	5	150	N/A	Allocation MELD for all but HCC Exceptions
12	500-mile Circles	5	250	N/A	Allocation MELD for all but HCC Exceptions
13	Current System	None	None	N/A	N/A
14	National	3	150	N/A	Allocation MELD
15	4 Districts	3	150	In district	Allocation MELD
16	8 Districts	3	150	In district	Allocation MELD

Results and Discussion

Figure Layout

Results for the simulated scenarios are reported primarily in the form of plots, with each plot displaying the values for a given metric across the 16 scenarios tested. Each scenario was simulated 10 times, and the plot displays this range of variability as a vertical line extending from the minimum value to the maximum value for that metric. The point that appears on this line marks the mean value of the metric across the 10 iterations for each scenario.

All plots show the scenarios along the x-axis in the same order, starting with comparison scenarios (current policy and national allocation) on the left side of the axis and moving through redistricting scenarios, 500-mile circles for all candidates, 500-mile circles for candidates with no exception points, and finally 500-mile circles for candidates with no HCC exception points on the right side of the x-axis. The key next to the plot indicates the point shape that corresponds to each scenario type (e.g., a solid square indicates a scenario using 150-mile proximity circles awarding 3 MELD/PELD points).

Results figures and discussion begin on the following page.

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Disparity Metrics

Figure 1. Variance in median allocation MELD/PELD at transplant by DSA

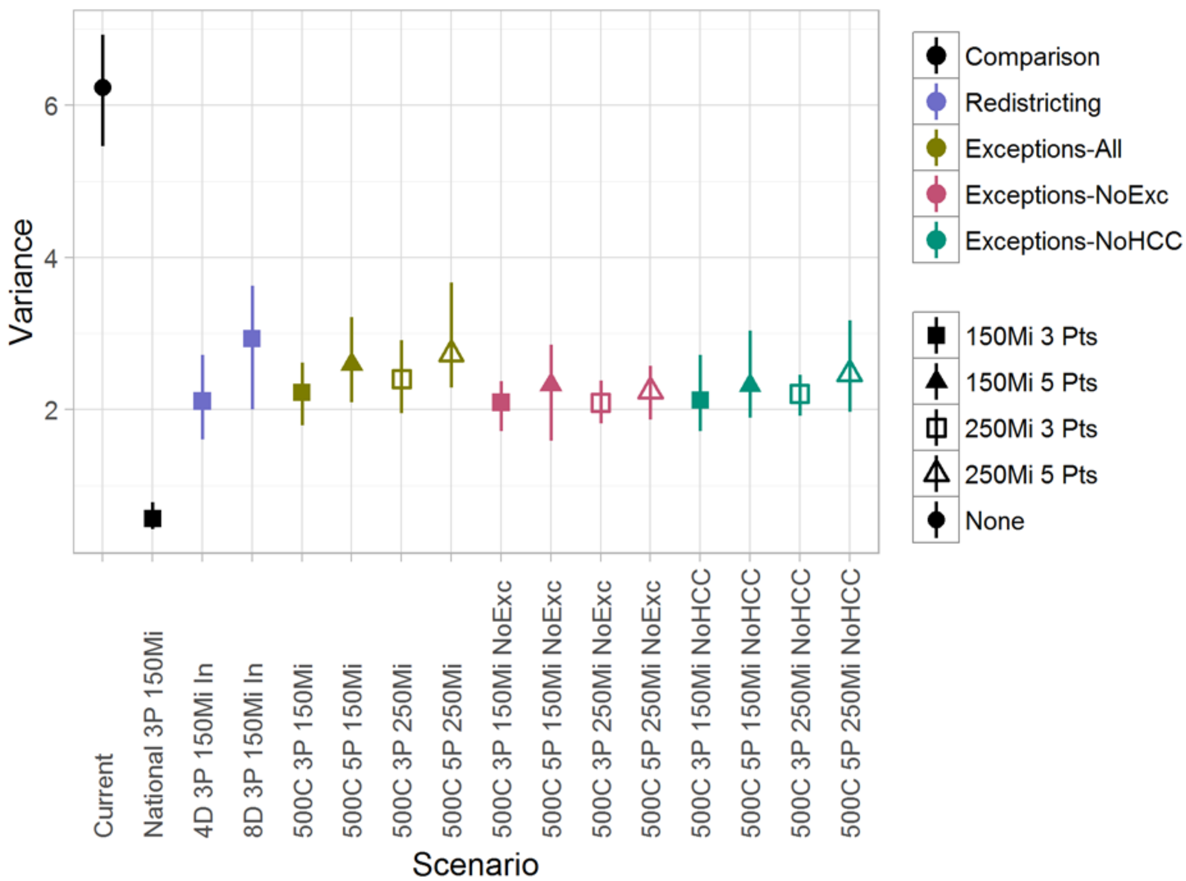

Figure 1 shows that the current variation in median MELD/PELD value at transplant would be noticeably decreased with any of the examined redistricting or circle scenarios. The scenarios that appear to have the greatest effect on decreasing disparity in median MELD/PELD at transplant include (a) 4 districts with 150-mile in-district proximity circles awarding 3 allocation MELD/PELD points and (b) 500-mile circles with 150-mile proximity circles awarding 3 allocation MELD/PELD points for all patients, patients with no exceptions, or patients with no HCC exceptions. However, the min-max ranges of many of these estimates overlap, indicating little difference in the decrease in disparity between the overlapping scenarios. The national allocation comparison scenario is an "ideal" scenario in which livers would be allocated to the candidates with the most need nationwide. This scenario shows the largest decrease in variation in MELD/PELD at transplant.

Figure 2. Median MELD at transplant maps

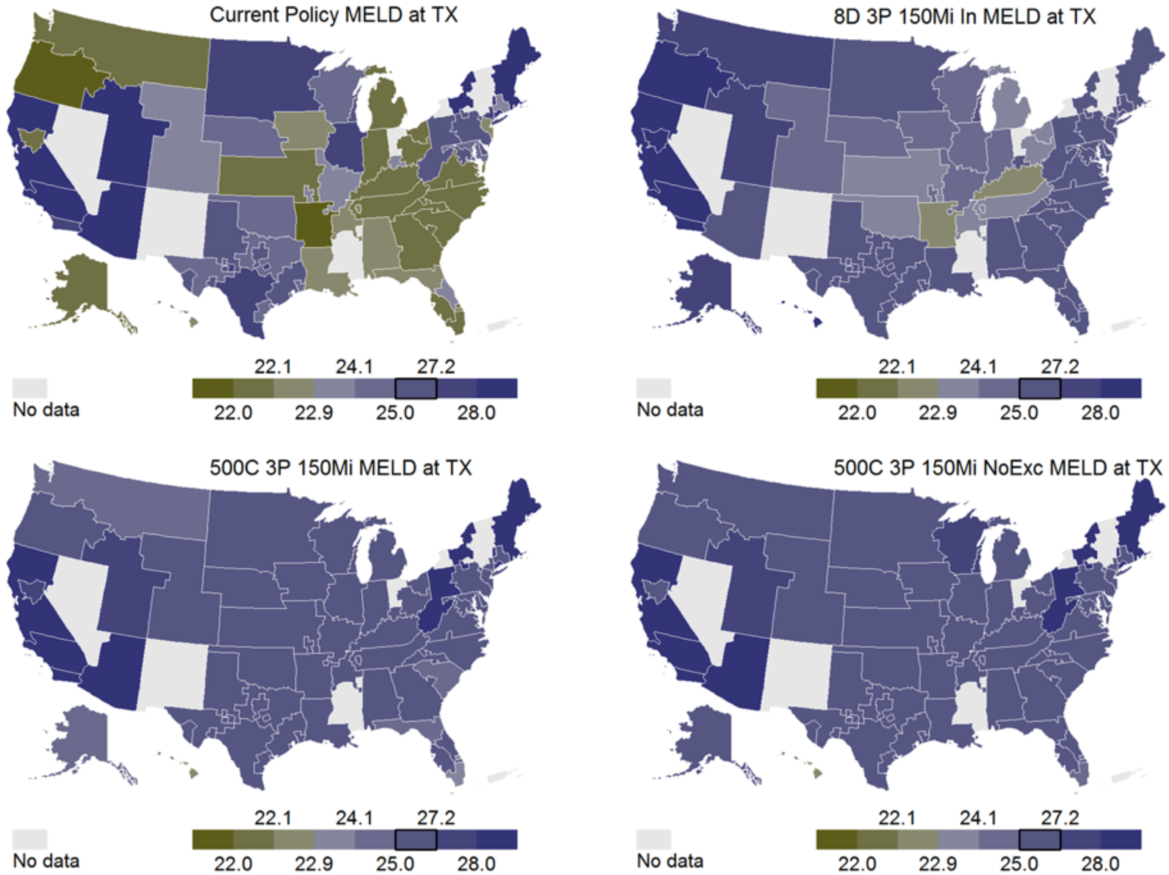

Figure 2 displays maps of the United States, showing the median MELD/PELD at transplant for each DSA under each simulated scenario. The outlined box in the key below the maps shows the national median MELD/PELD at transplant value for each scenario. DSAs without active waitlisted candidates during the LSAM cohort period are shown in gray. For the current policy simulation, the national median is 25. In the 8 district scenario shown above, the median is also 25; in the 500-mile circle for all candidates, the median is 26.3; and in the 500-mile circle for candidates with no exceptions, the median is 26.6.

The current policy simulation map in the upper left shows considerable variation in median MELD/PELD at transplant per DSA under current policy. The colors in the alternative scenario maps become more uniform, indicating that variation in median MELD/PELD at transplant decreases in the modeled 8 district scenario, 500-mile circle scenario for all patients, and in the 500-mile circle scenario for patients with no exceptions.

Figure 3. Variance in pretransplant mortality rates

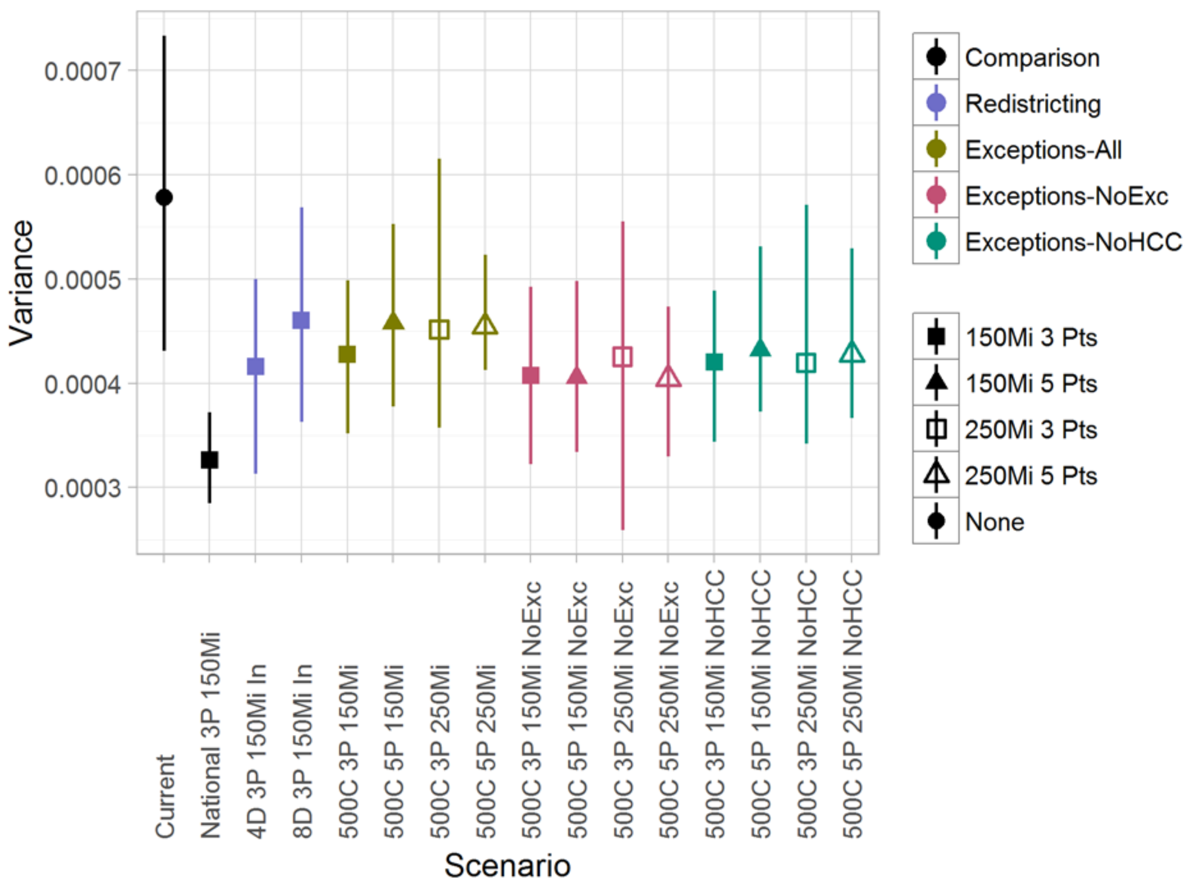

Figure 3 shows the variance in pretransplant mortality rates (including deaths on the waiting list and deaths after removal from the waiting list) among the examined scenarios. Overall variance in pretransplant mortality decreases slightly with all redistricting or circle scenarios compared with current policy.

Figure 4. Pretransplant mortality maps

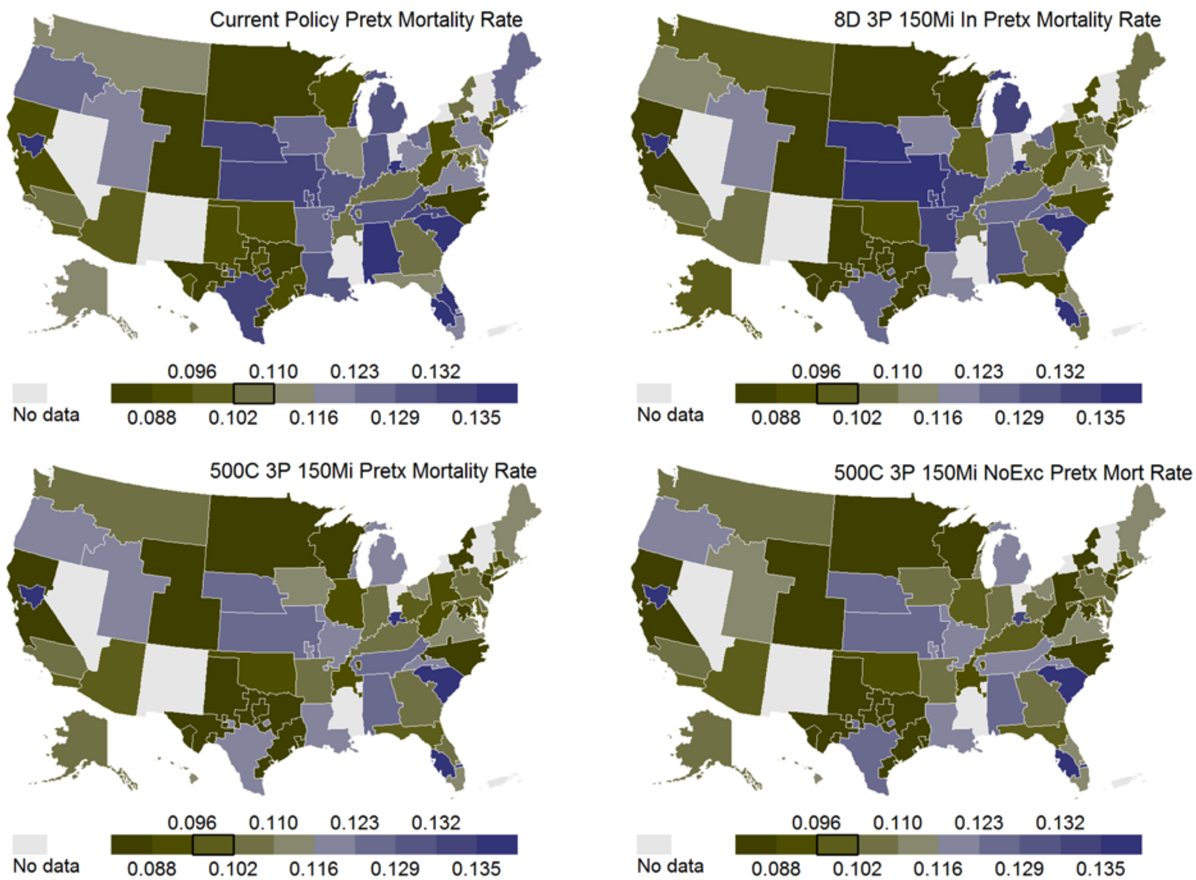

Figure 4 displays maps of the United States, showing the pretransplant mortality rate for each DSA under each simulated scenario. The pretransplant mortality rate includes deaths on the waiting list and after removal from the waiting list, per person-year on the list.

Comparing these maps shows that the various alternative scenarios appear to have little effect on the variance in pretransplant mortality across the country. The national median pretransplant mortality rate does not increase between current policy and alternative policy scenarios. Under current policy, the national pretransplant mortality rate is 0.105 (indicating that over the course of 1 patient-year on the waitlist, we would expect to see 0.105 patient deaths, or over the course of 100 patient-years, we would expect to see 10.5 patient deaths). In the 8 district scenario, the rate is 0.101; in the 500-mile circles for all candidates scenario, it is 0.099; and in the 500-mile circles for all candidates with no exceptions scenario, it is 0.098.

Figure 5. Variance in transplant rates

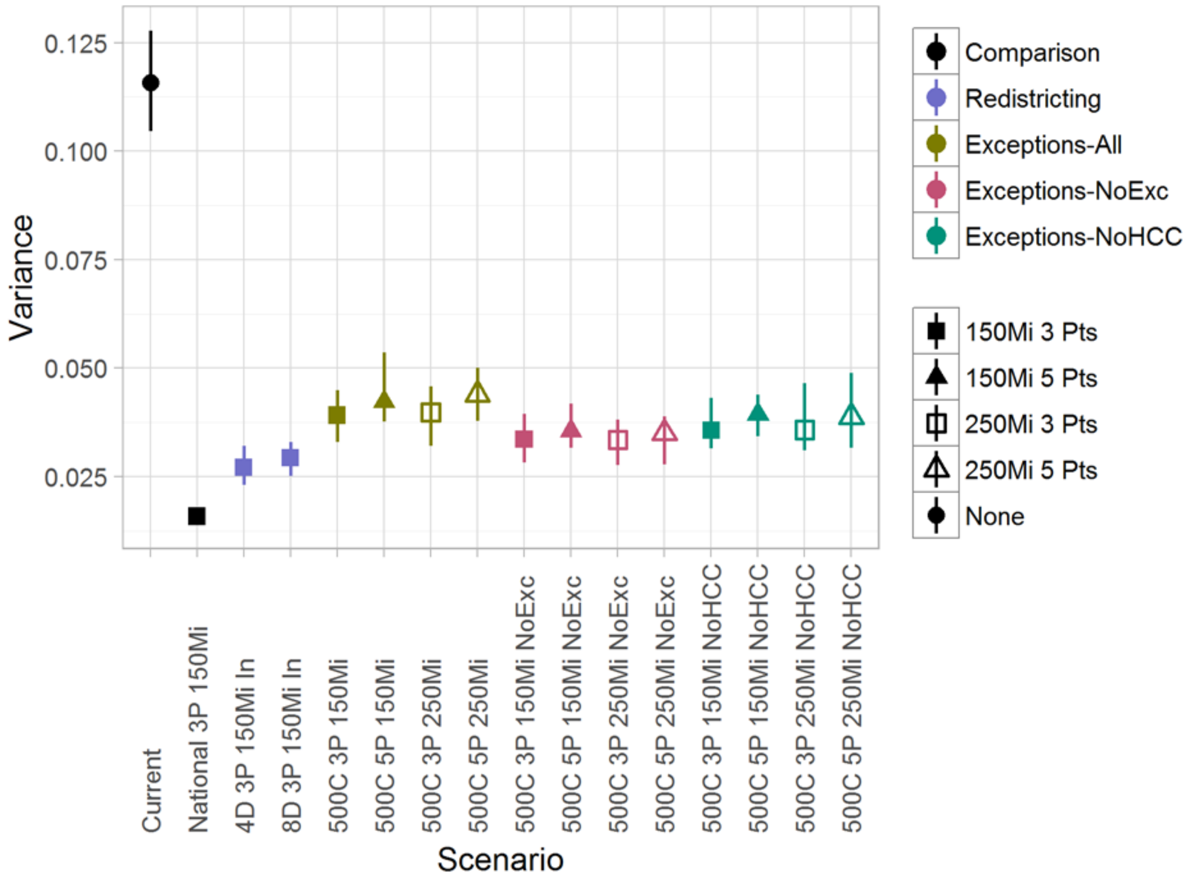

Figure 5 shows the variance in transplant rates among the examined scenarios. Overall variance in transplant rates decreases with all redistricting or circle scenarios compared with current policy. The 2 redistricting scenarios examined (4 and 8 districts with 150-mile in-district proximity circles awarding 3 additional allocation MELD/PELD points) appear to have the greatest effect on decreasing the variance in transplant rates.

Figure 6. Variance in overall mortality rates (pre- and posttransplant)

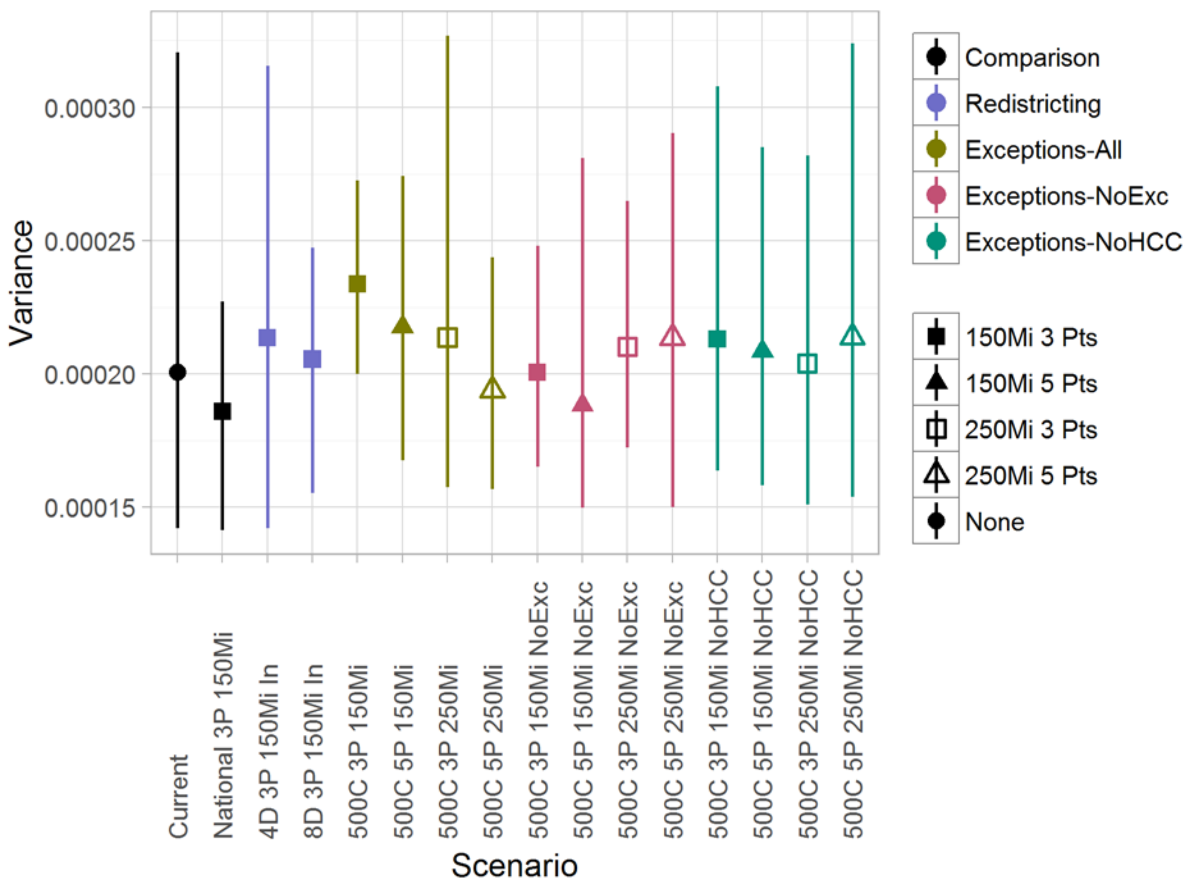

Figure 6 shows the variance in overall mortality rates pre- and post-transplant. Variation in the estimates of variance across the simulations is too wide to determine any discernable patterns of increase or decrease in variance in overall mortality rates compared with current policy in any of the examined scenarios.

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Summative Metrics

Figure 7. Pretransplant deaths prevented per year

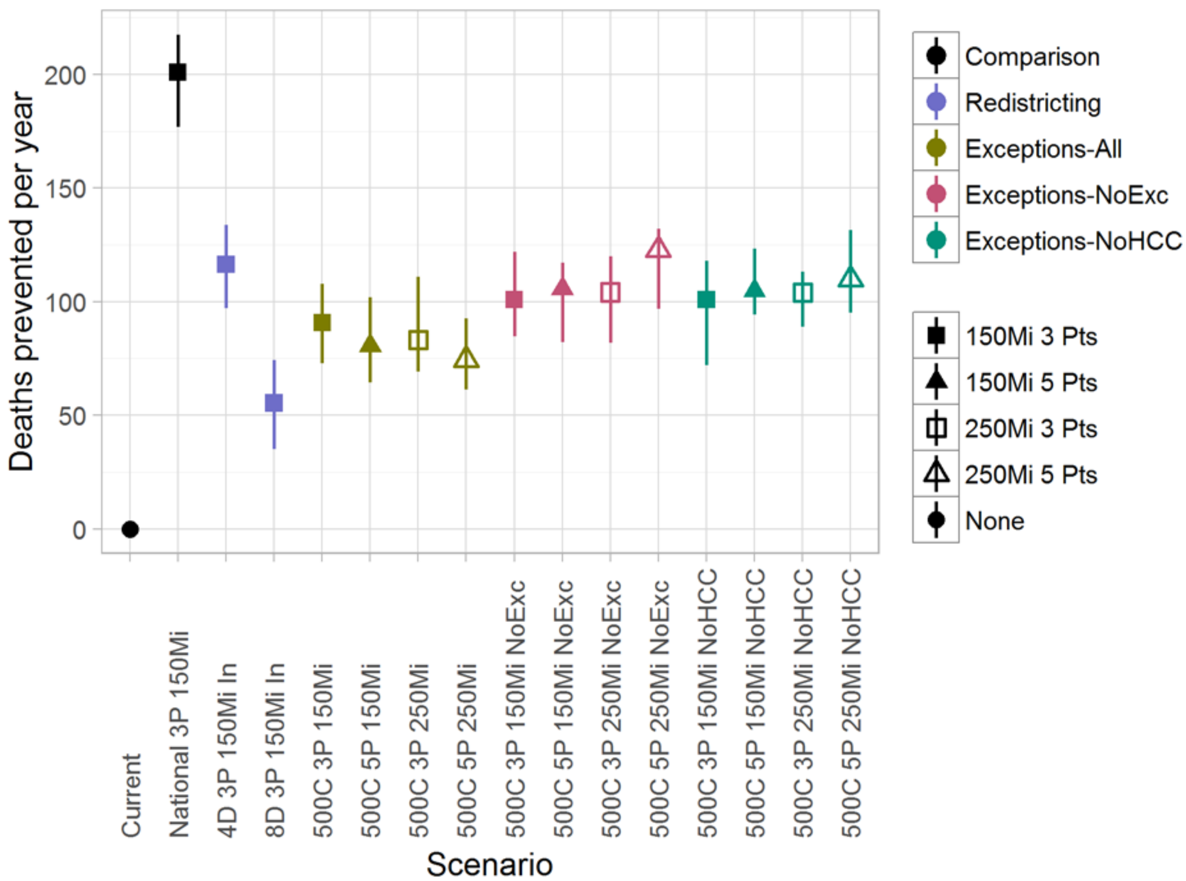

Figure 7 shows the number of pretransplant deaths (waiting list deaths and deaths after removal from the waiting list) prevented per year in each of the examined scenarios compared with the current policy scenario. The comparison scenario of nationwide sharing with 150-mile proximity circles decreases deaths the most, at 201 deaths prevented. All of the redistricting or circle scenarios reduce pretransplant deaths compared with the current scenario, ranging from about 55 to about 125 deaths prevented. The 8 district 150-mile proximity circles with 3 points scenario decreases deaths the least of the alternative scenarios, at 55 deaths prevented, but still shows a marked improvement over the current scenario. (Details of counts for pretransplant deaths prevented are shown in Appendix C, **Table 2**.)

Figure 8. Waitlist deaths prevented per year

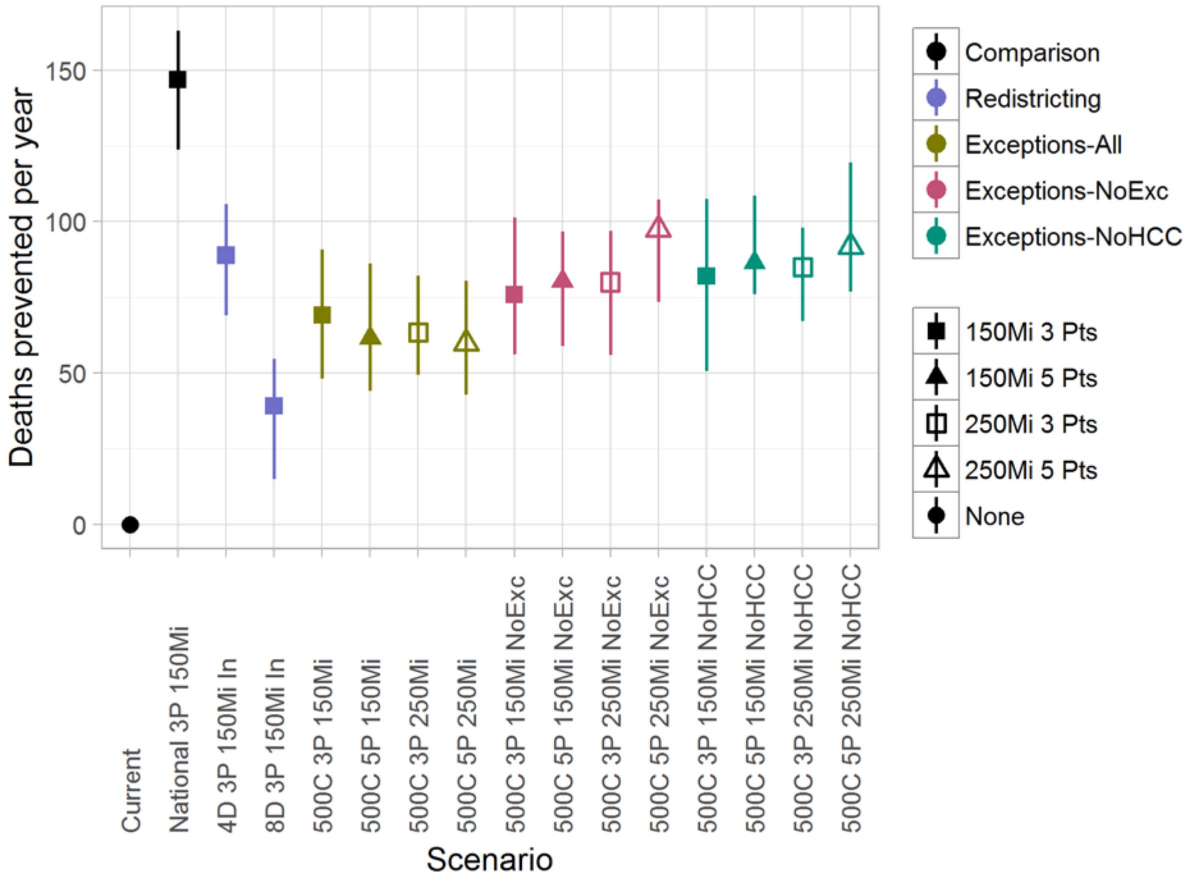

Figure 8 shows waitlist deaths prevented per year in each of the examined scenarios compared with the current policy scenario. The comparison scenario of nationwide sharing with 150-mile proximity circles decreases deaths the most, at 147 deaths prevented. All of the redistricting or circle scenarios reduce deaths compared with the current scenario, ranging from about 39 to about 100 deaths prevented. The 8 district 150-mile proximity circles with 3 points scenario decreases deaths the least, at 39 deaths prevented, but still shows a marked improvement over the current scenario. (Details of counts for waitlist deaths prevented are shown in Appendix C, **Table 2**.)

Figure 9. Posttransplant deaths prevented

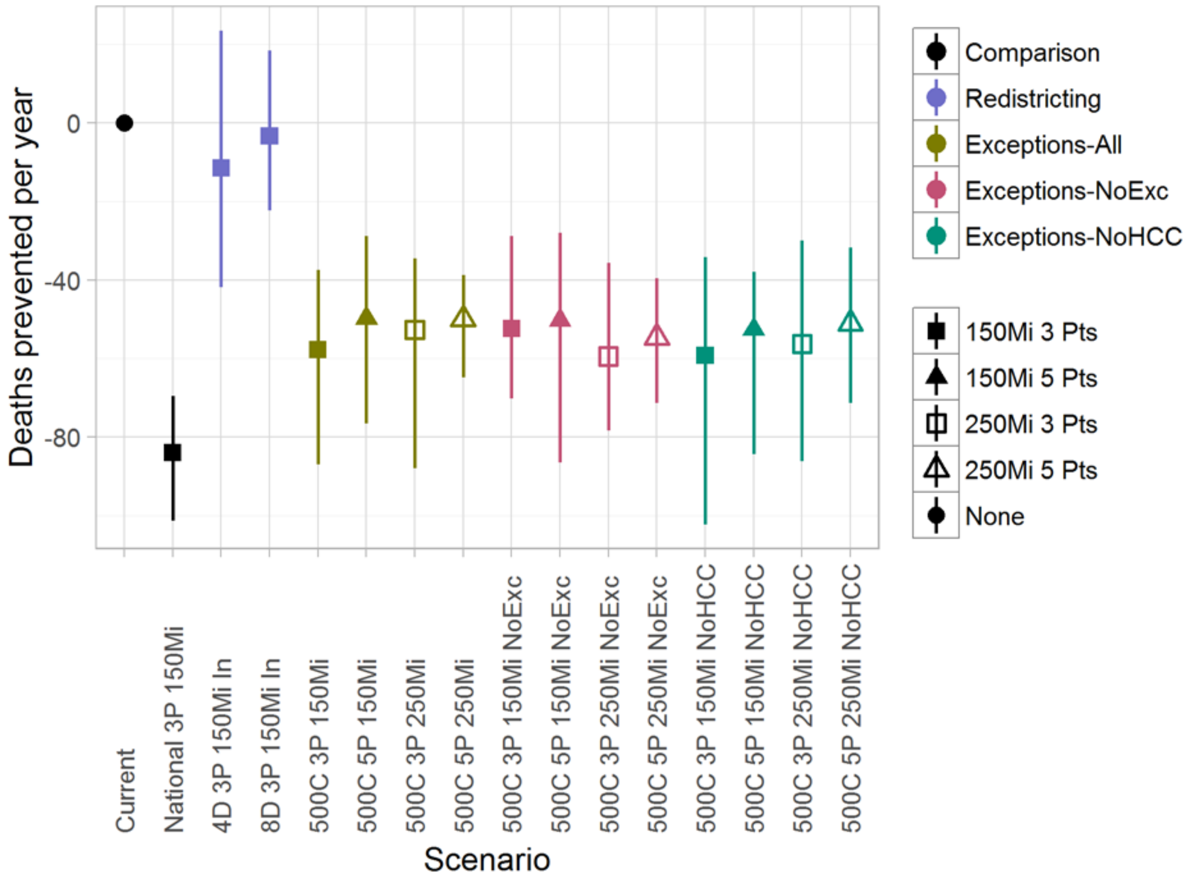

Figure 9 shows posttransplant deaths prevented per year in each of the examined scenarios compared with the current policy scenario. The 500-mile circle scenarios are estimated to increase the number of posttransplant deaths per year, at an estimated 50-60 more posttransplant deaths annually than in the current policy scenario.

Redistricting scenarios may also increase posttransplant deaths or perform similarly to current policy; ranges of estimates for redistricting scenarios overlap with the estimated annual posttransplant death in current policy. (Details of counts for posttransplant deaths prevented are shown in Appendix C **Table 2**.)

Figure 10. Overall deaths prevented per year

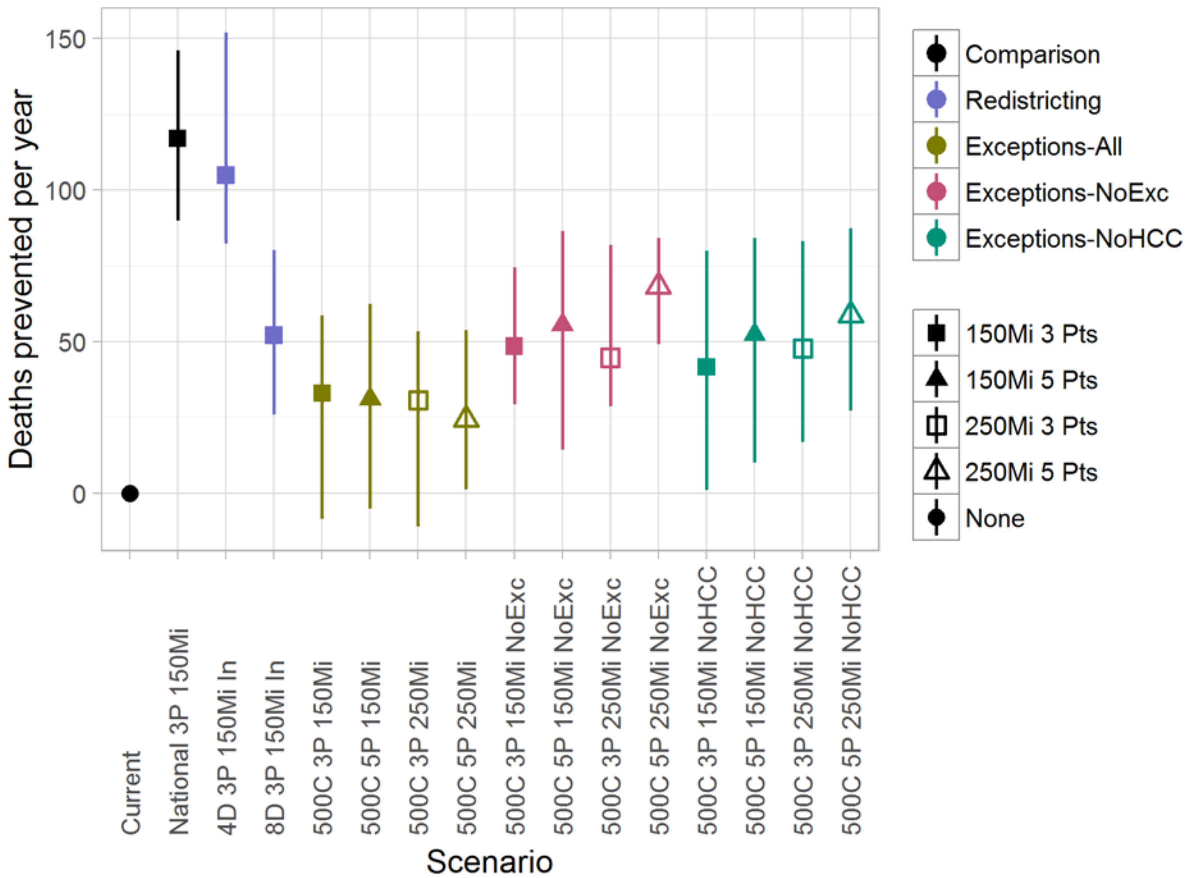

Figure 10 shows overall deaths prevented per year in each of the examined scenarios compared with the current policy scenario (including pretransplant and posttransplant deaths prevented). All redistricting or circle scenarios show an improvement in deaths prevented per year compared with the current scenario. The 4 district scenario has the largest effect, with 105 overall deaths prevented. The 8 district and circle scenarios are in a similar range of effect to each other, with about 30 to 60 deaths prevented. (Details of counts for overall deaths prevented are shown in Appendix C, **Table 2**.)

Figure 11. Transplant rates

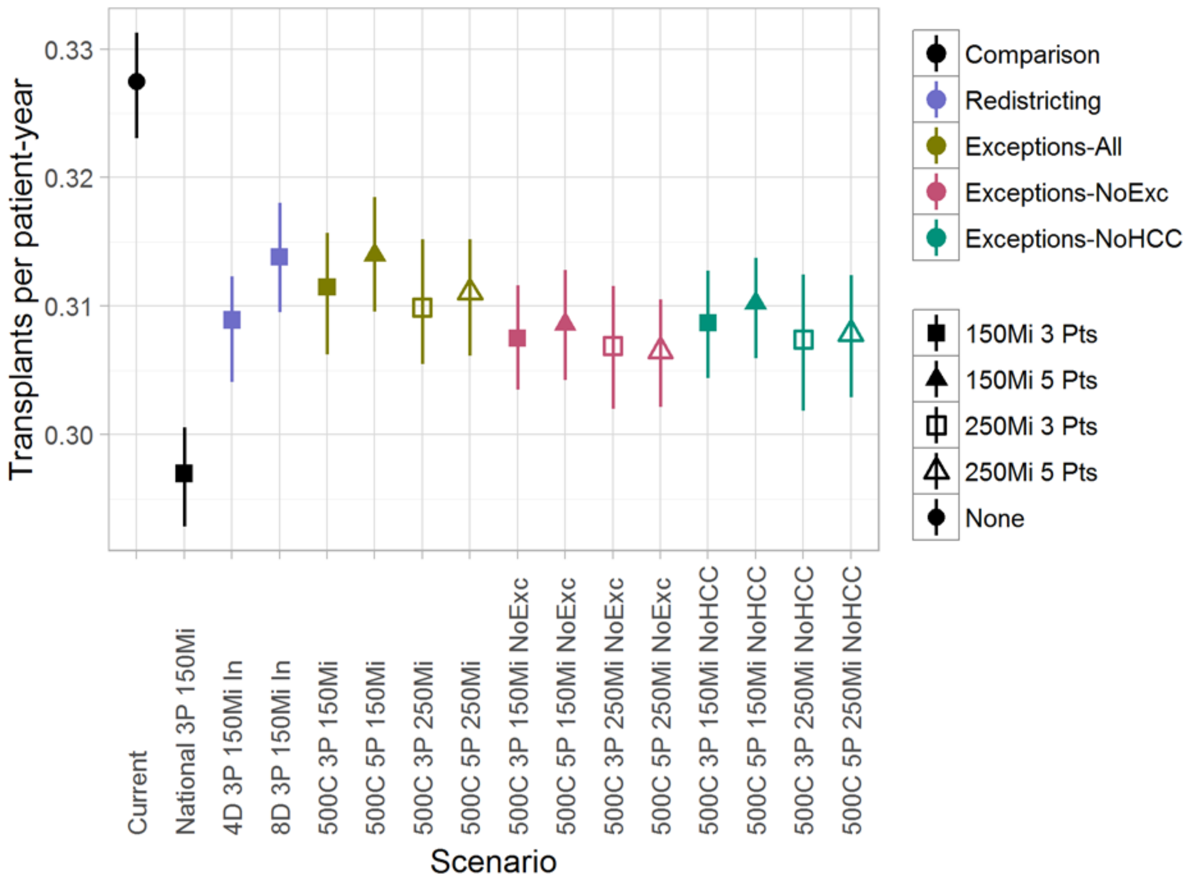

Figure 11 shows transplant rates as transplants per patient-year in the examined scenarios compared with the current scenario. All redistricting and circle scenarios are estimated to decrease transplant rates somewhat, from just under 0.33 transplants per patient-year to around 0.31 transplants per patient-year. (Details of counts of transplants per year under each scenario are shown in Appendix C, **Table 3**.)

Transport Metrics

Figure 12. Percentage of transplants performed locally (within DSA)

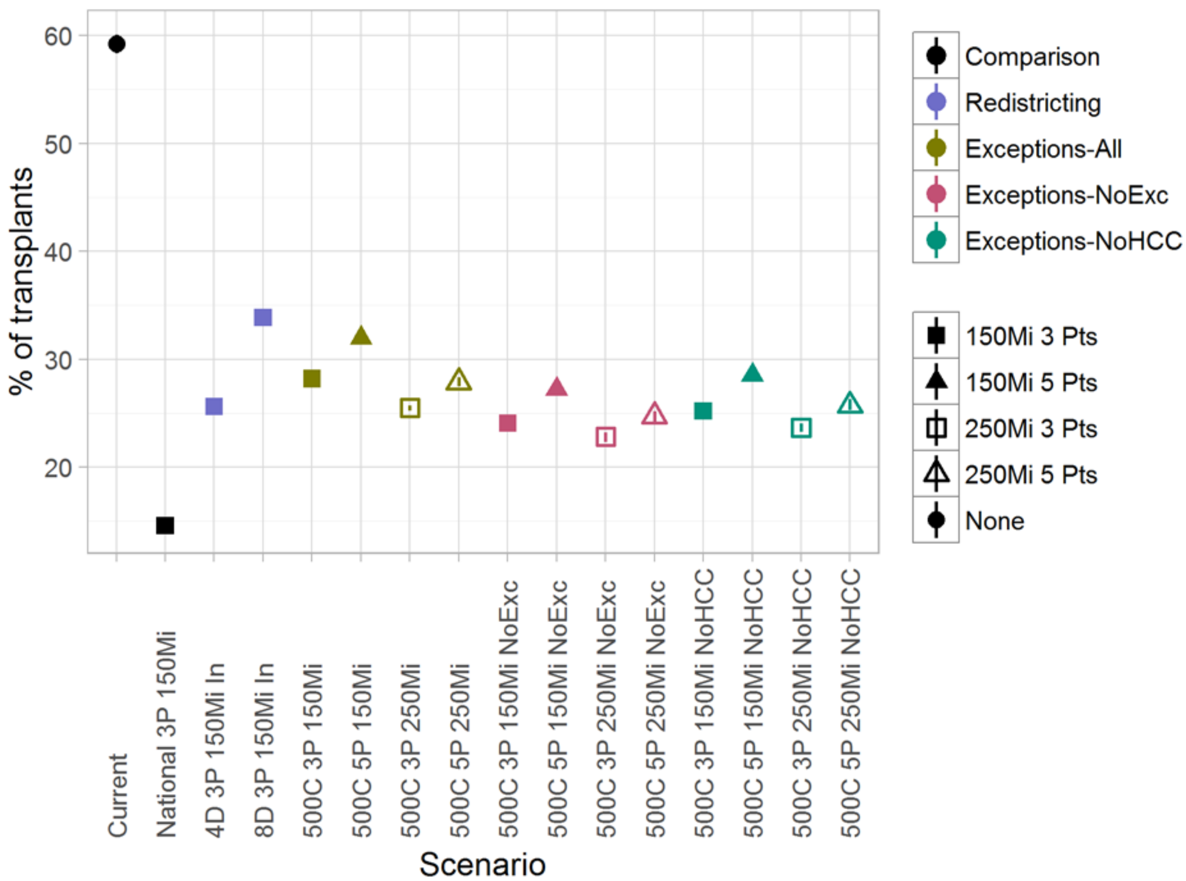

Figure 12 shows the percentage of transplants performed locally (within the recovery DSA) in a year for each of the examined scenarios. Note that this measure does not imply that the DSA was the first unit of allocation; the first unit of allocation for alternative scenarios was either the district or the 500-mile circle. (See details of the allocation order used in simulations in **Appendix B: Allocation Order for Modeled Scenarios.**)

Approximately 60% of transplants are performed within the recovery DSA in the current scenario, and all redistricting and circle scenarios are estimated to noticeably decrease the percentage of in-DSA transplants to around 25% to 35%. In the redistricting and circle scenarios, 8 districts with 150-mile in-district proximity circles awarding 3 points and 500-mile circles with proximity circles awarding 5 points show a somewhat higher percentage of in-DSA transplants. (Details shown in tabular format in Appendix C, **Table 4**.)

Figure 13. Median transport time (hours)

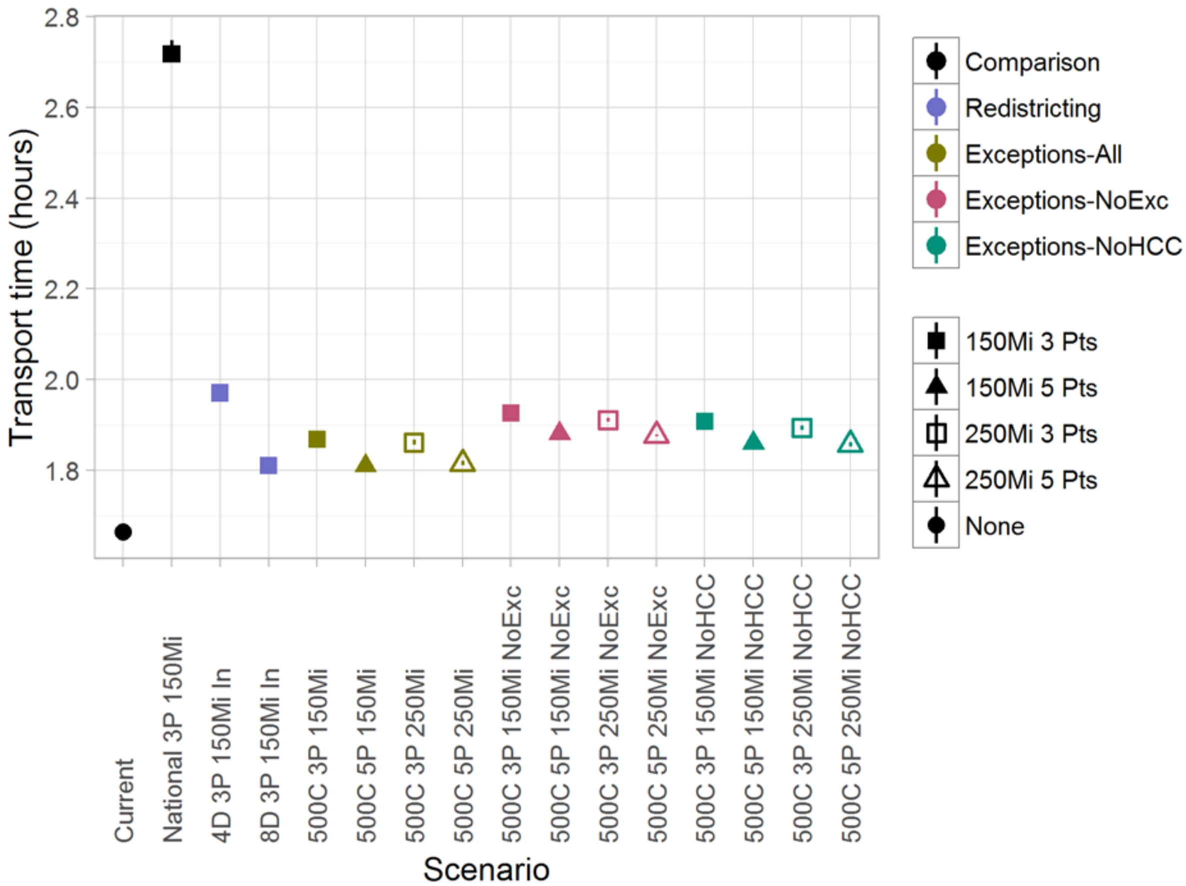

Figure 13 shows the median transport time in hours for each examined scenario. Median transport time is approximately 1.7 hours in the current scenario. All redistricting and circle scenarios increase median transport time somewhat to 1.8 to 2 hours. The smallest apparent increase in median transport time (from 1.7 to 1.8 hours) is shared by three scenarios: 8 districts with proximity circles, 500-mile circles with 150-mile 5 point proximity circles, and 500-mile circles with 250-mile 5 point proximity circles. (Details shown in tabular format in Appendix C, **Table 4**.)

Figure 14. Median transport distance (miles)

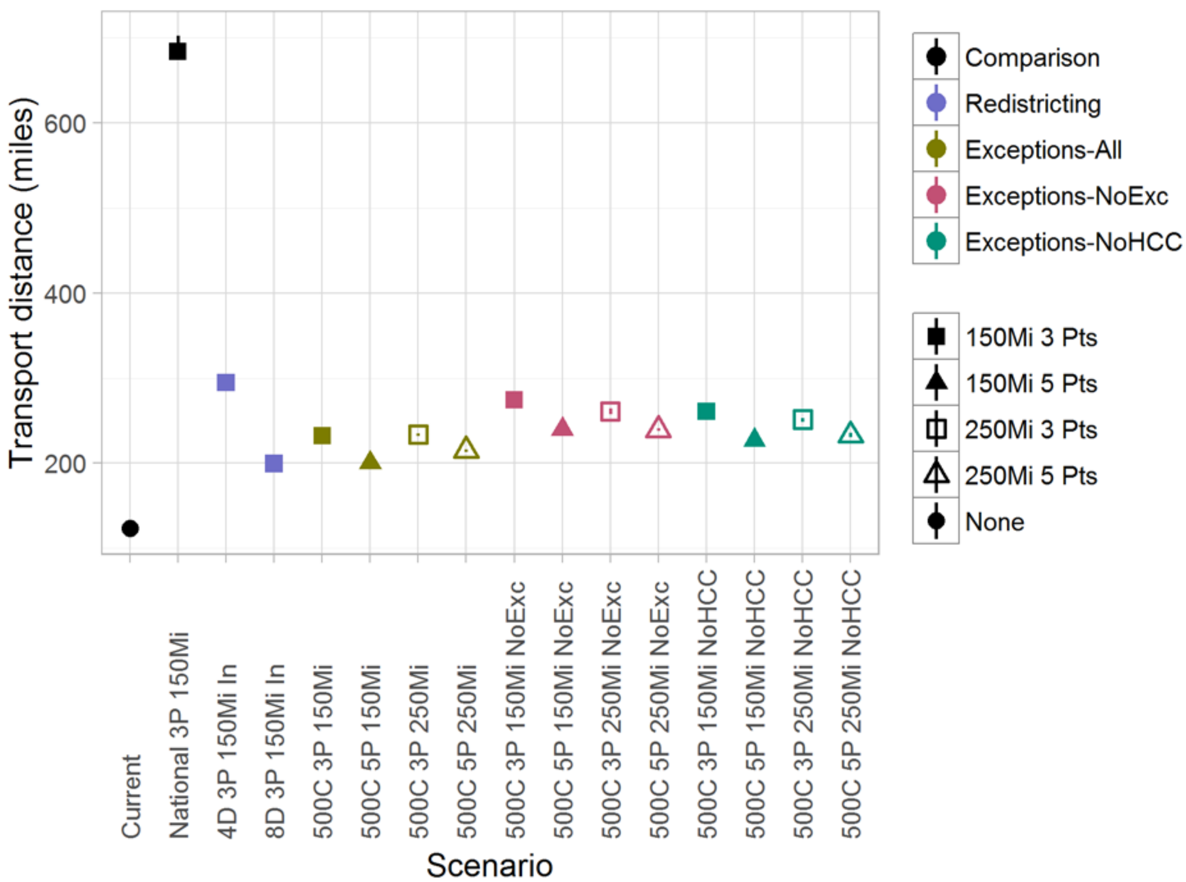

Figure 14 shows the median transport distance in miles for each of the examined scenarios. Median transport distance is approximately 125 miles in the current scenario. All redistricting and circle scenarios increase median transport distance somewhat to 200 to 300 miles.

In the redistricting and circle scenarios, median transport distance is somewhat lower in scenarios with 8 districts with 150-mile in-district proximity circles awarding 3 points and 500-mile circles with proximity circles awarding 5 points. (Details shown in tabular format in Appendix C, **Table 4**.)

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Figure 15. Percentage of organs flown

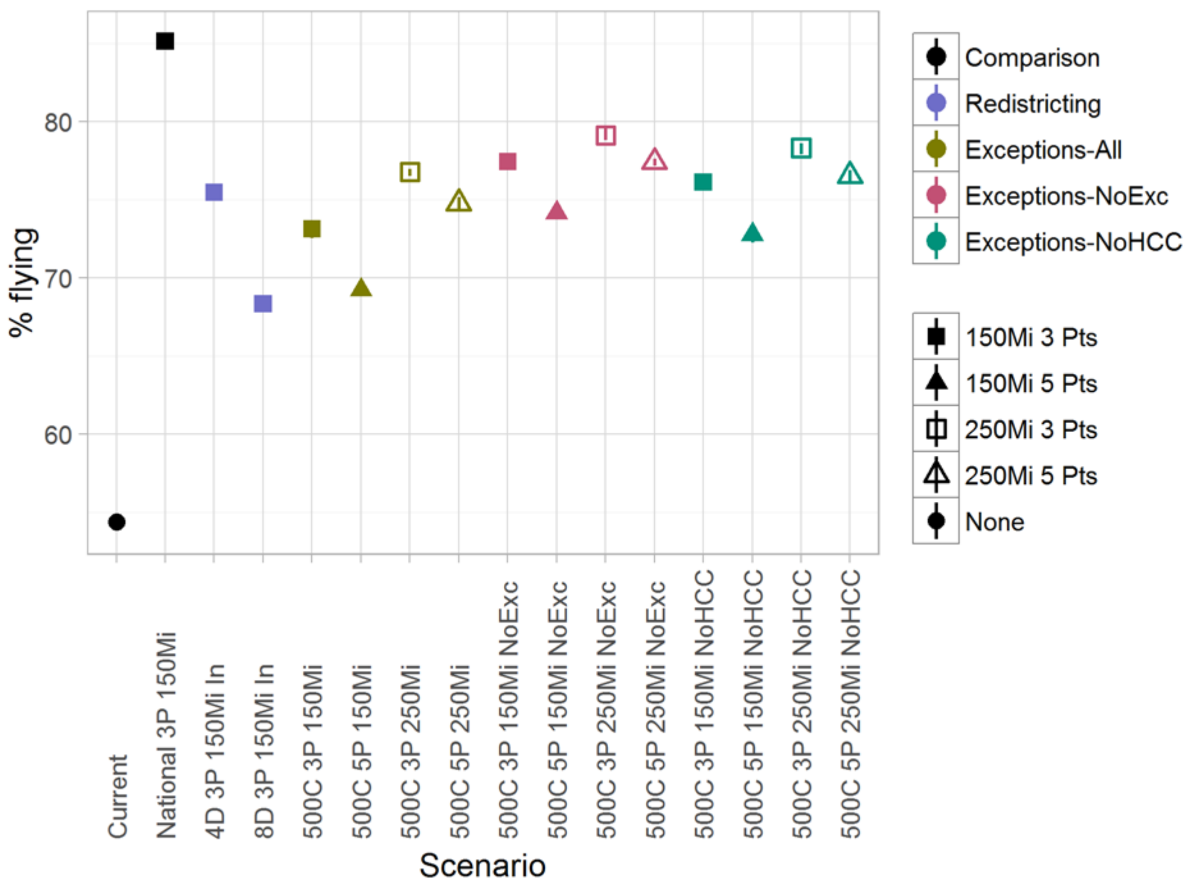

Figure 15 shows the percentage of organs estimated to be flown instead of driven as the transport mode for each of the examined scenarios. In the current scenario, 55% of organs are flown. All redistricting and circle scenarios increase that percentage to about 70% to 80%. Among the alternative scenarios, the 8 district with 150-mile in-district proximity circles awarding 3 points scenario shows the lowest percentage of flying at 68%. (Details shown in tabular format in Appendix C, **Table 4**.)

Transplants by Exception Status

Figure 16. Percentage of recipients by exception status

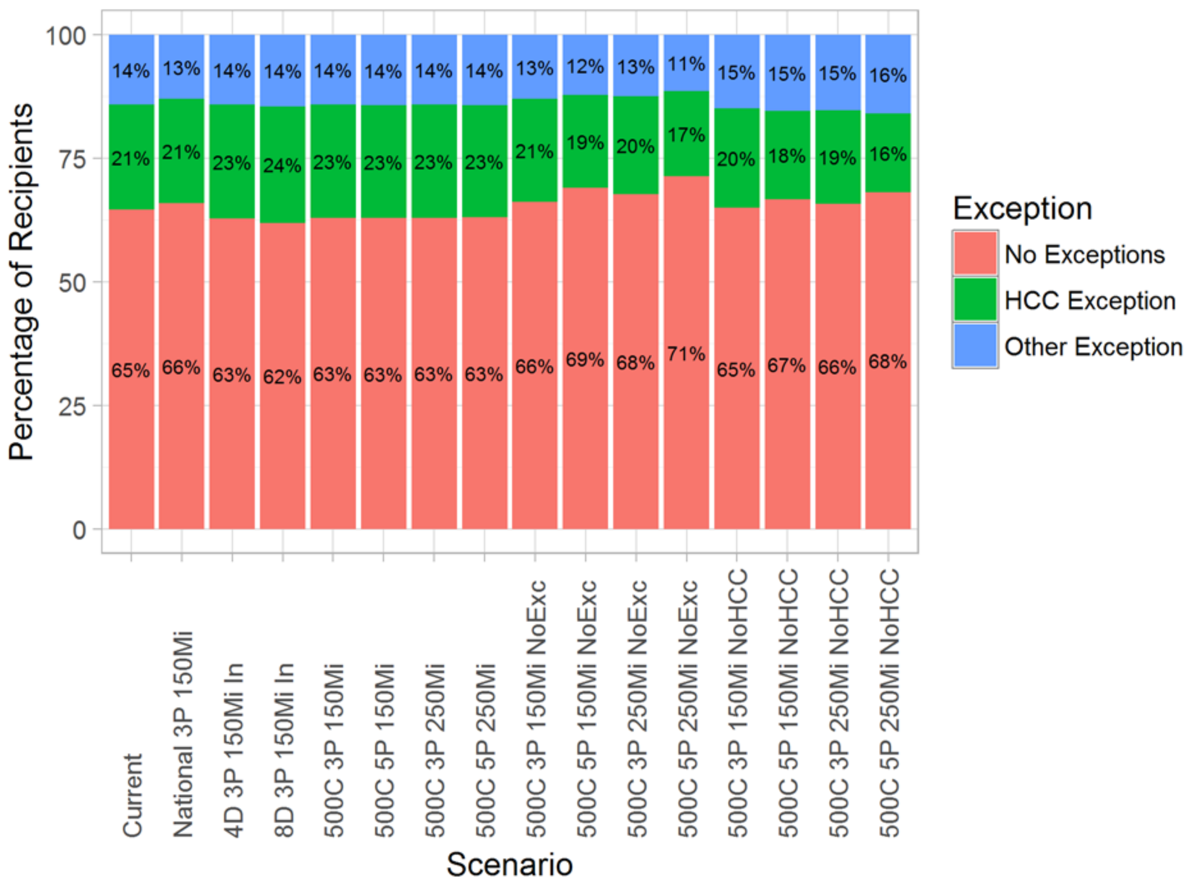

Figure 16 shows the percentage of transplant recipient in each modeled scenario with no exceptions, HCC exceptions, or non-HCC ("Other") exceptions. In the current policy scenario, 65% of transplant recipients have no exceptions. The redistricting and 500-mile circle scenarios for all patients retain this balance of exception recipients, with 62% to 63% of transplant recipients having no exceptions. The 500-mile circle scenarios which exclude recipients with any exception or with HCC exceptions from receiving proximity points slightly increase the percentage of recipients with no exceptions to between 66% and 71%. Comparing between the 500-mile circle scenarios excluding exception recipients from receiving proximity points, the 5 proximity point scenarios have a 2 to 3 percentage point higher proportion of no exception transplants than the 3 proximity point scenarios.

The mean percentages for each of the 10 iterations of the scenario are shown in **Figure 16**. **Table 5** in Appendix C shows the details of the mean, minimum, and maximum estimates of percentage of transplant recipients by exception status.

Subgroup Analyses

Analyses examining all metrics reported above by subgroups are shown in **Appendix D: Subgroup Analyses**. The examined subgroups include pediatric age groups, female sex, and racial/ethnic groups (African American, Hispanic/Latino, and Asian).

Variance in median allocation MELD/PELD at transplant by sex and race/ethnicity decreased in the redistricting or circle scenarios compared with current policy. For pediatric patients, the range of variance between current policy, redistricting, and circles scenarios overlaps, suggesting little change between these scenarios.

Variance in pretransplant mortality rates and variance in transplant rates by the subgroups (pediatric status, sex, and race/ethnicity) was relatively stable or slightly decreased for all redistricting and circle scenarios compared with current policy. The number of pretransplant deaths and waitlist deaths prevented in all subgroups increased for all redistricting and circle scenarios compared with current policy for pediatric status, sex, and race/ethnicity subgroups.

The number of posttransplant deaths prevented by pediatric status was relatively similar for all circle scenarios compared with current policy. Posttransplant deaths prevented for pediatric patients were slightly lower in the redistricting scenarios compared with current policy. The number of posttransplant deaths prevented by sex and race/ethnicity decreased slightly compared with current policy, indicating that redistricting and circle scenarios may increase the number of posttransplant deaths. The redistricting scenarios have the smallest effect on the number of increased posttransplant deaths for sex and race/ethnicity subgroups. The number of overall deaths prevented by pediatric status, sex, and race/ethnicity was relatively stable or slightly increased for all redistricting and circle scenarios compared with current policy.

Transplant rates by pediatric status were slightly higher for all redistricting and circle scenarios compared with current policy. Transplant rates by race/ethnicity were relatively stable or increased for all redistricting and circle scenarios compared with current policy. Transplant rates by sex decreased slightly for all redistricting and circle scenarios compared with current policy, but the estimates across the 10 different simulations overlap, suggesting high variability across the simulations within each scenario.

The percentage of transplants performed locally for all subgroups decreased among all redistricting and circle scenarios compared with current policy. The median transport time and distance for all subgroups increased slightly for all redistricting and circle scenarios compared with current policy. In addition, the percentage of organs flown for all subgroups increased among all redistricting and circle scenarios compared with current policy. The lowest percentage of organs flown for pediatric and female candidates appears to be in the 8 district scenario as compared with the other alternative policy scenarios.

Overall, the outcome metrics showed no major differences by pediatric age group, sex, or race/ethnicity that would indicate that a subset of the population would be disadvantaged by any of the redistricting or circle alternative policy scenarios.

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Conclusions

The main metric of disparity selected by the Committee is variance in median allocation MELD/PELD at transplant nationwide. This analysis indicates that any of the examined alternative scenarios, including redistricting or 500-mile circles with proximity points, would noticeably decrease disparities in median MELD at transplant across the nation. The range of estimates for the alternative scenarios overlaps, indicating that no individual scenario stands out as the single best scenario for reducing disparities; any of the examined scenarios is predicted to produce a similar disparity benefit in reducing geographic variation in median MELD at transplant. The median MELD at transplant map (**Figure 2**) indicates that while the disparity in MELD at transplant across the country is anticipated to decrease with redistricting or circle scenarios, the nationwide median MELD/PELD at transplant would remain relatively stable.

The variance in pretransplant mortality decreases slightly for all the alternative scenarios compared with the current policy scenario. The variance in transplant rates also decreases for all alternative scenarios. There is no indicated change in the variance in overall mortality rates (pre- and post-transplant) for redistricting or circle policies compared with current policy.

Regarding decreasing geographic disparities, all of the metrics analyzed indicate that the redistricting with proximity points or 500-mile circles with proximity points scenarios are estimated to decrease disparity in median MELD/PELD at transplant, have minimal effect on variance in overall mortality and pretransplant mortality, and slightly decrease the variance in transplant rates nationwide. The alternative scenarios tested all perform similarly in decreasing disparities.

Considering summative metrics, we see that all of the alternative scenarios tested are estimated to decrease pretransplant and waitlist deaths. Circle scenarios are estimated to increase posttransplant deaths, and redistricting scenarios may perform similarly to current policy or slightly increase posttransplant deaths. Overall, all alternative scenarios increase the net number of pre- and posttransplant deaths prevented, and the 4-district proximity points scenario prevents the most overall deaths. Transplant rates also decrease slightly for all alternative scenarios compared with current policy.

For transport metrics, all alternative policy scenarios are estimated to decrease the percentage of transplants performed locally, slightly increase the median transport time for transplanted organs, and increase the median distance traveled. More than half (55%) of all organs are estimated to be flown for transport (rather than driving) under the current policy scenario, and all alternative scenarios increase the estimated percentage of organs flown to between 70% and 80%.

In summary, this analysis indicates that any of the redistricting or circle scenarios examined are estimated to notably decrease geographic disparities in median MELD/PELD at transplant nationwide, with a slight decrease in disparities in transplant rates nationwide and a slight net decrease in overall (pre- and post-transplant) deaths. All redistricting and circle scenarios also decrease the percentage of transplants performed within the recovering DSA while increasing the median transport time and distance.

Tradeoffs between the different scenarios presented in this analysis are apparent. Scenarios that decrease geographic disparities the most, such as the 4-district with proximity points scenario, also have a larger effect on increasing travel time and distance. No standout scenario clearly decreases geographic disparities with no effect on transport. However, this analysis suggests that many different specific policy options are available to substantially decrease the current burden of geographic disparities in liver distribution nationwide.

Appendix A: OPTN Committee Data Request

OPTN Committee Data Analysis Request Form

Date Form Submitted to HRSA: July 8, 2015

Requesting Committee: Liver and Intestinal Organ Transplantation

Date Committee Met: June 23, 2015

Date of Next Meeting: TBD

OPTN staff member referring Committee's requests: Ann Harper

Chair Approval? Yes

ANALYSES REQUESTED:

- **Descriptive Statistical Requests (responsibility of OPTN contractor)**

None

- **Inferential STATISTICAL REQUESTS (RESPONSIBILITY OF SRTR CONTRACTOR)**

Data Request 1: Additional LSAM outputs for prior modeling runs

Background: During the June 23, 2015 meeting, Committee members asked for additional outputs that would help to determine the impacts of MELD/PELD exceptions on the various scenarios previously modeled in preparation for the June 22, 2015 Forum.

Strategic Goal or Committee Project Addressed: Goal #2, Provide equity in access to transplants

Request: 1. Provide the outputs of the 4 and 8 district models with the proximity circles model and the current 11 regions with proximity circles (out of region allocation) to show the impact on the variance in (1) the median allocation MELD/PELD score at transplant (2) the median lab MELD/PELD score at transplant (3) the median allocation MELD/PELD score at transplant excluding all exceptions, and (4) the median allocation MELD/PELD score at transplant excluding only HCC exceptions.

Data Request 2: Modeling of concentric circle models with proximity points

Background: During the June 23, 2015 meeting, Committee members asked for additional modeling of the concentric circle concept with proximity points.

Strategic Goal or Committee Project Addressed: Goal #2, Provide equity in access to transplants

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Request: 2. Provide outputs from 4 new modeling scenarios that incorporate a 500-mile radius concentric circle as "local," with 3 and 5 proximity points for candidates within a 150- and 250-mile radius of the donor hospital, as shown below:

Run #	# Districts	Points	Radius	How points assigned:
1	500-mile Concentric Circles	3	150	Allocation MELD
2	500-mile Concentric Circles	3	250	Allocation MELD
3	500-mile Concentric Circles	5	150	Allocation MELD
4	500-mile Concentric Circles	5	250	Allocation MELD

Data Request 3: Modeling of concentric circle models with differing proximity points based on type of MELD score

Background: During the June 23, 2015 meeting, Committee members asked for additional modeling of the concentric circle concept with proximity points.

Strategic Goal or Committee Project Addressed: Goal #2, Provide equity in access to transplants

Request: 3. Provide outputs from 4 new modeling scenarios that incorporate a 500-mile radius concentric circle as "local," with 3 and 5 proximity points for candidates within a 150- and 250-mile radius of the donor hospital, as shown below:

Run #	# Districts	Points	Radius	How points assigned:
5	500-mile Concentric Circles	3	150	Allocation MELD for all but Exceptions
6	500-mile Concentric Circles	3	250	Allocation MELD for all but Exceptions
7	500-mile Concentric Circles	5	150	Allocation MELD for all but Exceptions
8	500-mile Concentric Circles	5	250	Allocation MELD for all but Exceptions
9	500-mile Concentric Circles	3	150	Allocation MELD for all but HCC Exceptions
10	500-mile Concentric Circles	3	250	Allocation MELD all but HCC Exceptions
11	500-mile Concentric Circles	5	150	Allocation MELD all but HCC Exceptions
12	500-mile Concentric Circles	5	250	Allocation MELD all but HCC Exceptions

These examples illustrate the priority point assignments:

- Patients within 150 miles of the donor get 3 points added to their allocation MELD score.
- Patients within 150 miles of the donor get 3 points added to their allocation MELD score, but only if that score is based on lab MELD and NOT exception points; those with exceptions get no extra points
- Patients within 150 miles of the donor get 3 points added to their allocation MELD score, but only if that score is based on lab MELD or a non-HCC exception – those with HCC exceptions get no extra points

▪ OTHER Requests

None

Appendix B: Allocation Order for Modeled Scenarios

Current Allocation

For adult donors:

1. Regional Status 1A
2. Regional Status 1B
3. Local and Regional MELD/PELD >= 35 (by MELD)
4. Local MELD/PELD 15-34
5. Regional MELD/PELD 15-34
6. National Status 1A
7. National Status 1B
8. National MELD/PELD >= 15
9. Local MELD/PELD < 15
10. Regional MELD/PELD < 15
11. National MELD/PELD < 15

For child donors (0-10 years):

1. Regional Pediatric Status 1A
2. National Pediatric Status 1A, 0-11 years
3. Local Adult Status 1A
4. Regional Adult Status 1A
5. Regional Pediatric Status 1B
6. Regional Any PELD
7. Local MELD >= 15, 12-17 years
8. Local MELD >= 15, 18+ years
9. Regional MELD >= 15, 12-17 years
10. Regional MELD >= 15, 18+ years
11. Local MELD < 15, 12-17 years
12. Local MELD < 15, 18+ years
13. Regional MELD < 15, 12-17 years
14. Regional MELD < 15, 18+ years
15. National Status 1A, 12-17 years
16. National Status 1A, 18+ years
17. National Status 1B, 0-17 years
18. National Any PELD
19. National Any MELD, 12-17 years
20. National Any MELD, 18+ years

For adolescent donors (11-17 years):

1. Local Pediatric Status 1A
2. Regional Pediatric Status 1A
3. Local Adult Status 1A
4. Regional Adult Status 1A
5. Local Pediatric Status 1B
6. Regional Pediatric Status 1B
7. Local and Regional Any PELD
8. Local MELD >= 15, 12-17 years
9. Local MELD >= 15, 18+ years
10. Regional MELD >= 15, 12-17 years
11. Regional MELD >= 15, 18+ years
12. Local MELD < 15, 12-17 years
13. Local MELD < 15, 18+ years
14. Regional MELD < 15, 12-17 years
15. Regional MELD < 15, 18+ years
16. National Pediatric Status 1A
17. National Adult Status 1A
18. National Pediatric Status 1B
19. National Any PELD
20. National Any MELD, 12-17 years
21. National Any MELD, 18+ years

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National Allocation

For adult donors:
1. National Status 1A
2. National Status 1B
3. National MELD

For child donors (0-10 years):
1. National Pediatric Status 1A, 0-11 years
2. National Status 1A, 12-17 years
3. National Status 1A, 18+ years
4. National Status 1B, 0-17 years
5. National PELD
6. National MELD, 12-17 years
7. National MELD, 18+ years

For adolescent donors (11-17 years):
1. National Pediatric Status 1A
2. National Adult Status 1A
3. National Pediatric Status 1B
4. National Any PELD
5. National Any MELD, 12-17 years
6. National Any MELD, 18+ years

Redistricting Allocation

For adult donors:
1. District Status 1A
2. District Status 1B
3. District MELD/PELD >= 15
4. National Status 1A
5. National Status 1B
6. National MELD/PELD >= 15
7. District MELD/PELD < 15
8. National MELD/PELD < 15

For child donors (0-10 years):
1. District Pediatric Status 1A
2. National Pediatric Status 1A, 0-11 years
3. District Adult Status 1A
4. District Pediatric Status 1B
5. District Any PELD
6. District MELD >= 15, 12-17 years
7. District MELD >= 15, 18+ years
8. District MELD < 15, 12-17 years
9. District MELD < 15, 18+ years
10. National Status 1A, 12-17 years
11. National Status 1A, 18+ years
12. National Status 1B, 0-17 years
13. National PELD
14. National MELD, 12-17 years
15. National MELD, 18+ years

For adolescent donors (11-17 years):
1. District Pediatric Status 1A
2. District Adult Status 1A
3. District Pediatric Status 1B
4. District Any PELD
5. District MELD >= 15, 12-17 years
6. District MELD >= 15, 18+ years
7. District MELD < 15, 12-17 years
8. District MELD < 15, 18+ years
9. National Pediatric Status 1A
10. National Adult Status 1A
11. National Pediatric Status 1B
12. National Any PELD
13. National Any MELD, 12-17 years
14. National Any MELD, 18+ years

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Circle Allocation

For adult donors:

1. In-circle Status 1A
2. In-circle Status 1B
3. In-circle MELD/PELD >= 15
4. National Status 1A
5. National Status 1B
6. National MELD/PELD >= 15
7. In-circle MELD/PELD < 15
8. National MELD/PELD < 15

For child donors (0-10 years):

1. In-circle Pediatric Status 1A
2. National Pediatric Status 1A, 0-11 years
3. In-circle Adult Status 1A
4. In-circle Pediatric Status 1B
5. In-circle Any PELD
6. In-circle MELD >= 15, 12-17 years
7. In-circle MELD >= 15, 18+ years
8. In-circle MELD < 15, 12-17 years
9. In-circle MELD < 15, 18+ years
10. National Status 1A, 12-17 years
11. National Status 1A, 18+ years
12. National Status 1B, 0-17 years
13. National PELD
14. National MELD, 12-17 years
15. National MELD, 18+ years

For adolescent donors (11-17 years):

1. In-circle Pediatric Status 1A
2. In-circle Adult Status 1A
3. In-circle Pediatric Status 1B
4. In-circle Any PELD
5. In-circle MELD >= 15, 12-17 years
6. In-circle MELD >= 15, 18+ years
7. In-circle MELD < 15, 12-17 years
8. In-circle MELD < 15, 18+ years
9. National Pediatric Status 1A
10. National Adult Status 1A
11. National Pediatric Status 1B
12. National Any PELD
13. National Any MELD, 12-17 years
14. National Any MELD, 18+ years

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Appendix C: Metrics Tables

All metrics reported as *mean (min, max)* across the 10 simulation iterations.

Simulation Metrics Table

Table 2. Deaths Prevented Per Year

	Pretransplant deaths prevented per year	Waitlist deaths prevented per year	Posttransplant deaths prevented per year	Overall deaths prevented per year
Current	0 (0,0)	0 (0,0)	0 (0,0)	0 (0,0)
National 3P 150Mi	201 (176.8,217.4)	146.8 (123.8,163)	-83.9 (-101.2,-69.6)	117.1 (89.8,146)
4D 3P 150Mi In	116.4 (97.2,133.6)	88.9 (69,105.8)	-11.5 (-41.8,23.4)	104.9 (82.2,152)
8D 3P 150Mi In	55.4 (35,74.2)	39.2 (15,54.6)	-3.3 (-22.4,18.4)	52.1 (25.8,80.2)
500C 3P 150Mi	90.7 (72.8,107.8)	69.1 (48,90.8)	-57.7 (-87,-37.4)	33 (-8.6,58.6)
500C 5P 150Mi	80.7 (64.4,101.8)	61.6 (44,86.2)	-49.7 (-76.6,-28.8)	31 (-5.2,62.4)
500C 3P 250Mi	83.2 (69.2,110.8)	63.4 (49.4,82.2)	-52.6 (-88,-34.6)	30.6 (-11,53.4)
500C 5P 250Mi	74.4 (61.4,92.6)	59.9 (42.8,80.4)	-50 (-64.8,-38.8)	24.4 (1.2,53.8)
500C 3P 150Mi NoExc	100.9 (84.6,122)	75.8 (56.2,101.4)	-52.4 (-70.2,-28.8)	48.5 (29.2,74.4)
500C 5P 150Mi NoExc	105.8 (82.2,117.2)	80.3 (58.8,96.6)	-50.2 (-86.4,-28)	55.6 (14.2,86.6)
500C 3P 250Mi NoExc	104.2 (82,119.8)	80 (56,96.8)	-59.5 (-78.4,-35.6)	44.7 (28.6,81.8)
500C 5P 250Mi NoExc	122.8 (96.8,132)	97.4 (73.4,107.2)	-54.6 (-71.4,-39.6)	68.2 (49.2,84.2)
500C 3P 150Mi NoHCC	100.8 (72,118)	81.9 (50.6,107.4)	-59.2 (-102.2,-34.2)	41.7 (1,80)
500C 5P 150Mi NoHCC	105 (94.4,123.2)	86.5 (76,108.6)	-52.6 (-84.4,-38)	52.4 (10,84.2)
500C 3P 250Mi NoHCC	104 (88.8,113.2)	85 (67,98)	-56.2 (-86.2,-30)	47.7 (16.8,83.2)
500C 5P 250Mi NoHCC	109.9 (95.2,131.6)	91.8 (76.8,119.4)	-51 (-71.4,-31.8)	58.8 (27.2,87.4)

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Table 3. Summative Metric Counts

	Pretransplant death counts per year	Waitlist death counts per year	Transplant counts per year	Posttransplant death counts per year
Current	2546.6 (2501.4,2595.2)	1522.5 (1500.4,1549.2)	6025.4 (5952.4,6088.6)	1061.5 (1028.2,1081.2)
National 3P 150Mi	2345.6 (2320.4,2379)	1375.6 (1362.4,1390.4)	5840.8 (5781,5899.2)	1145.4 (1115,1178.4)
4D 3P 150Mi In	2430.2 (2404.2,2466.6)	1433.6 (1412.8,1455)	5907.1 (5832.6,5957)	1073 (1039.8,1087.4)
8D 3P 150Mi In	2491.1 (2466.4,2531.4)	1483.3 (1472.2,1497.4)	5919.1 (5851.8,5980.8)	1064.9 (1050.6,1078.6)
500C 3P 150Mi	2455.9 (2411,2493.6)	1453.4 (1438.6,1476.6)	5928.5 (5853.6,5992)	1119.2 (1095.4,1156.2)
500C 5P 150Mi	2465.8 (2431,2503.2)	1460.9 (1439.2,1482.8)	5952.8 (5879.8,6011.6)	1111.2 (1087.6,1139.4)
500C 3P 250Mi	2463.3 (2430.8,2498)	1459 (1443.2,1474.4)	5906.4 (5841.2,5971.4)	1114.2 (1093.6,1134.4)
500C 5P 250Mi	2472.2 (2431,2516.8)	1462.5 (1445,1489.4)	5912.6 (5837.6,5974)	1111.5 (1088.4,1133.2)
500C 3P 150Mi NoExc	2445.7 (2415.4,2484.2)	1446.7 (1424,1466.6)	5890.5 (5824.2,5952.4)	1113.9 (1091,1151.4)
500C 5P 150Mi NoExc	2440.8 (2400.4,2480.6)	1442.2 (1428.2,1464.6)	5902.2 (5838.2,5955.8)	1111.8 (1091.2,1132.8)
500C 3P 250Mi NoExc	2442.4 (2419.4,2477.4)	1442.5 (1428.8,1463.6)	5884.1 (5809.6,5950.8)	1121 (1093.2,1133.4)
500C 5P 250Mi NoExc	2423.8 (2401,2464.8)	1425 (1401.8,1450.4)	5885.3 (5819.2,5942.4)	1116.1 (1099.6,1138.6)
500C 3P 150Mi NoHCC	2445.7 (2414.8,2479.6)	1440.5 (1418,1460.4)	5900.3 (5834.8,5965.8)	1120.7 (1098.8,1140.8)
500C 5P 150Mi NoHCC	2441.6 (2401,2483.8)	1435.9 (1416.8,1461.4)	5919.9 (5851.6,5976.2)	1114.1 (1101.2,1140.6)
500C 3P 250Mi NoHCC	2442.6 (2412.6,2482)	1437.5 (1416,1464)	5888.2 (5807.6,5958.8)	1117.8 (1093.2,1139.2)
500C 5P 250Mi NoHCC	2436.7 (2401.2,2476)	1430.7 (1406,1453.6)	5895.7 (5816.6,5961.8)	1112.6 (1079.6,1148.6)

Table 4. Transport Metrics

	% local	Median transport time (hours)	Median transport distance (miles)	% flying
Current	59.2 (58.3,60.1)	1.7 (1.7,1.7)	123.7 (121.4,127)	54.4 (53.8,54.8)
National 3P 150Mi	14.6 (14.3,14.9)	2.7 (2.7,2.7)	684 (676.3,702.5)	85.2 (84.9,85.5)
4D 3P 150Mi In	25.6 (25.3,25.9)	2 (2,2)	294.9 (291.7,302.6)	75.5 (75.1,75.7)
8D 3P 150Mi In	33.9 (33.3,34.2)	1.8 (1.8,1.8)	199.6 (195,200.5)	68.3 (68.1,68.7)
500C 3P 150Mi	28.2 (27.7,28.8)	1.9 (1.9,1.9)	232.3 (230,235.4)	73.1 (72.5,73.4)
500C 5P 150Mi	32 (31.6,32.2)	1.8 (1.8,1.8)	200.5 (200.5,200.5)	69.2 (68.9,69.8)
500C 3P 250Mi	25.5 (25.3,25.7)	1.9 (1.9,1.9)	233.9 (232.1,235.2)	76.8 (76.5,77)
500C 5P 250Mi	27.9 (27.5,28.3)	1.8 (1.8,1.8)	214.9 (212.9,216.3)	74.8 (74.3,75.1)
500C 3P 150Mi NoExc	24.1 (23.7,24.3)	1.9 (1.9,1.9)	274.4 (270.6,279.9)	77.4 (77.1,77.8)
500C 5P 150Mi NoExc	27.2 (26.7,27.7)	1.9 (1.9,1.9)	240 (237.6,243.5)	74.2 (73.7,74.5)
500C 3P 250Mi NoExc	22.8 (22.3,23.2)	1.9 (1.9,1.9)	261.1 (257.8,264.4)	79.1 (78.8,79.6)
500C 5P 250Mi NoExc	24.7 (24.2,25.2)	1.9 (1.9,1.9)	239.4 (238,241.2)	77.4 (77.2,77.6)
500C 3P 150Mi NoHCC	25.2 (24.9,25.4)	1.9 (1.9,1.9)	260.9 (255,265.8)	76.1 (75.8,76.4)
500C 5P 150Mi NoHCC	28.5 (28.1,29)	1.9 (1.9,1.9)	227.4 (224.1,231.6)	72.8 (72.3,73.4)
500C 3P 250Mi NoHCC	23.6 (23.3,24)	1.9 (1.9,1.9)	251.6 (248.9,253)	78.3 (77.9,78.6)
500C 5P 250Mi NoHCC	25.7 (25.3,26.3)	1.9 (1.9,1.9)	232.8 (230.5,235.4)	76.6 (76,76.9)

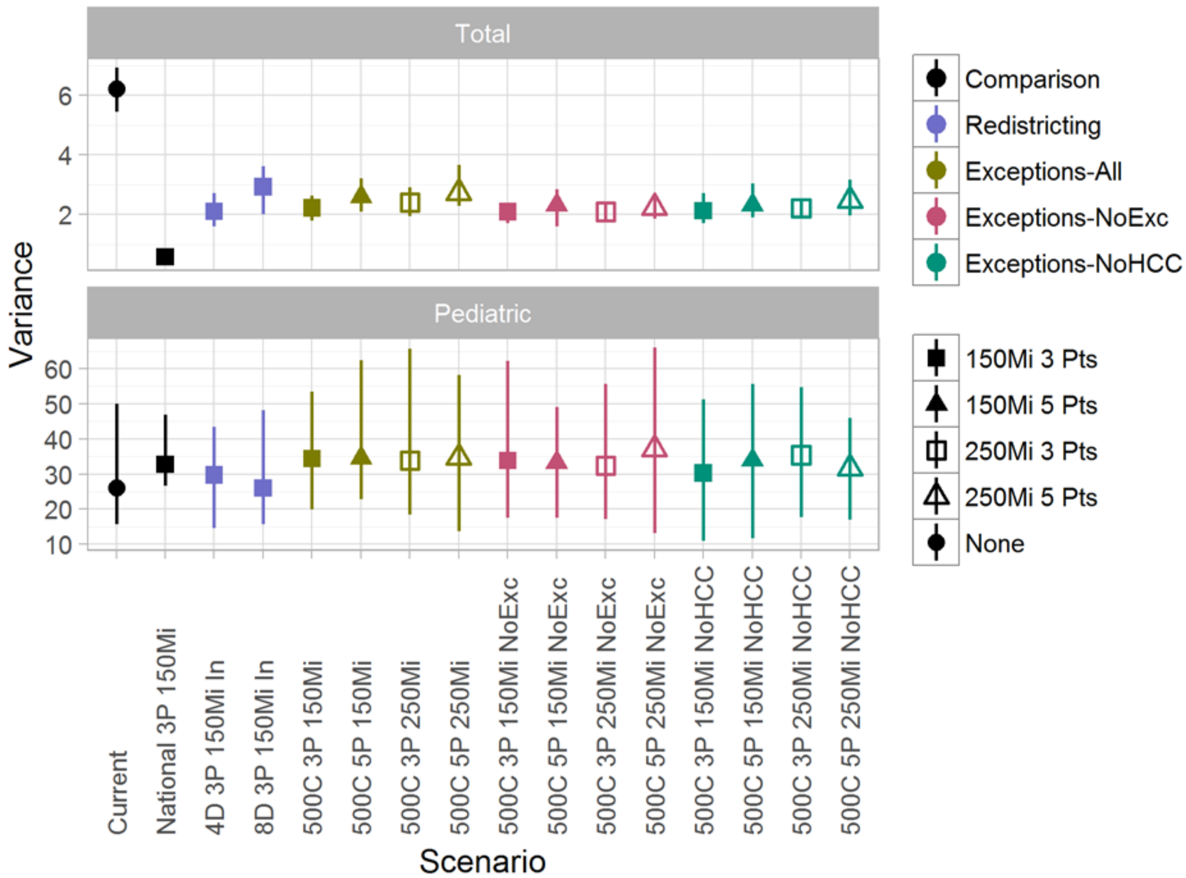
Table 5. Transplant Recipients by Exception Status

Scenario	No Exceptions (%)	HCC Exception (%)	Other Exception (%)
Current	64.6 (64.3, 65)	21.2 (21, 21.7)	14.2 (13.9, 14.4)
National 3P 150Mi	66 (65.6, 66.4)	21 (20.6, 21.4)	13 (12.8, 13.3)
4D 3P 150Mi In	62.8 (62.5, 63)	23.1 (22.8, 23.3)	14.2 (13.8, 14.5)
8D 3P 150Mi In	62 (61.6, 62.3)	23.5 (23, 23.8)	14.5 (14.1, 14.7)
500C 3P 150Mi	62.9 (62.8, 63.1)	23 (22.7, 23.2)	14.1 (13.9, 14.4)
500C 5P 150Mi	62.9 (62.5, 63.4)	22.8 (22.5, 23.2)	14.3 (14.1, 14.5)
500C 3P 250Mi	62.9 (62.8, 63)	22.9 (22.7, 23.2)	14.2 (13.9, 14.4)
500C 5P 250Mi	63 (62.8, 63.3)	22.7 (22.5, 23)	14.2 (14, 14.4)
500C 3P 150Mi NoExc	66.2 (66, 66.7)	20.8 (20.3, 21.1)	13 (12.6, 13.2)
500C 5P 150Mi NoExc	69 (68.9, 69.3)	18.8 (18.3, 19)	12.2 (11.7, 12.5)
500C 3P 250Mi NoExc	67.7 (67.4, 67.9)	19.8 (19.6, 20.1)	12.5 (12, 12.8)
500C 5P 250Mi NoExc	71.4 (71.1, 71.6)	17.3 (17, 17.5)	11.4 (11, 11.5)
500C 3P 150Mi NoHCC	64.9 (64.6, 65.3)	20.1 (19.6, 20.6)	15 (14.5, 15.2)
500C 5P 150Mi NoHCC	66.7 (66.4, 67)	17.9 (17.6, 18.1)	15.4 (15.2, 15.6)
500C 3P 250Mi NoHCC	65.8 (65.5, 66.1)	18.9 (18.5, 19.3)	15.3 (15, 15.5)
500C 5P 250Mi NoHCC	68.1 (67.8, 68.4)	16 (15.6, 16.4)	15.9 (15.3, 16.1)

Appendix D: Subgroup Analyses

Disparity Metrics

Figure 17. Variance in median allocation MELD/PELD at transplant by DSA (all transplants by pediatric status)



For **Figure 17**, small numbers of pediatric transplants take place in some DSAs, resulting in a large overall variance in median allocation MELD/PELD at transplant. The variation in the estimates of variance across the 10 different iterations overlaps in all scenarios, suggesting that the variability across simulations within a scenario was greater than the differences between the scenarios.

Figure 18. Variance in median allocation MELD/PELD at transplant by DSA (all transplants by sex)

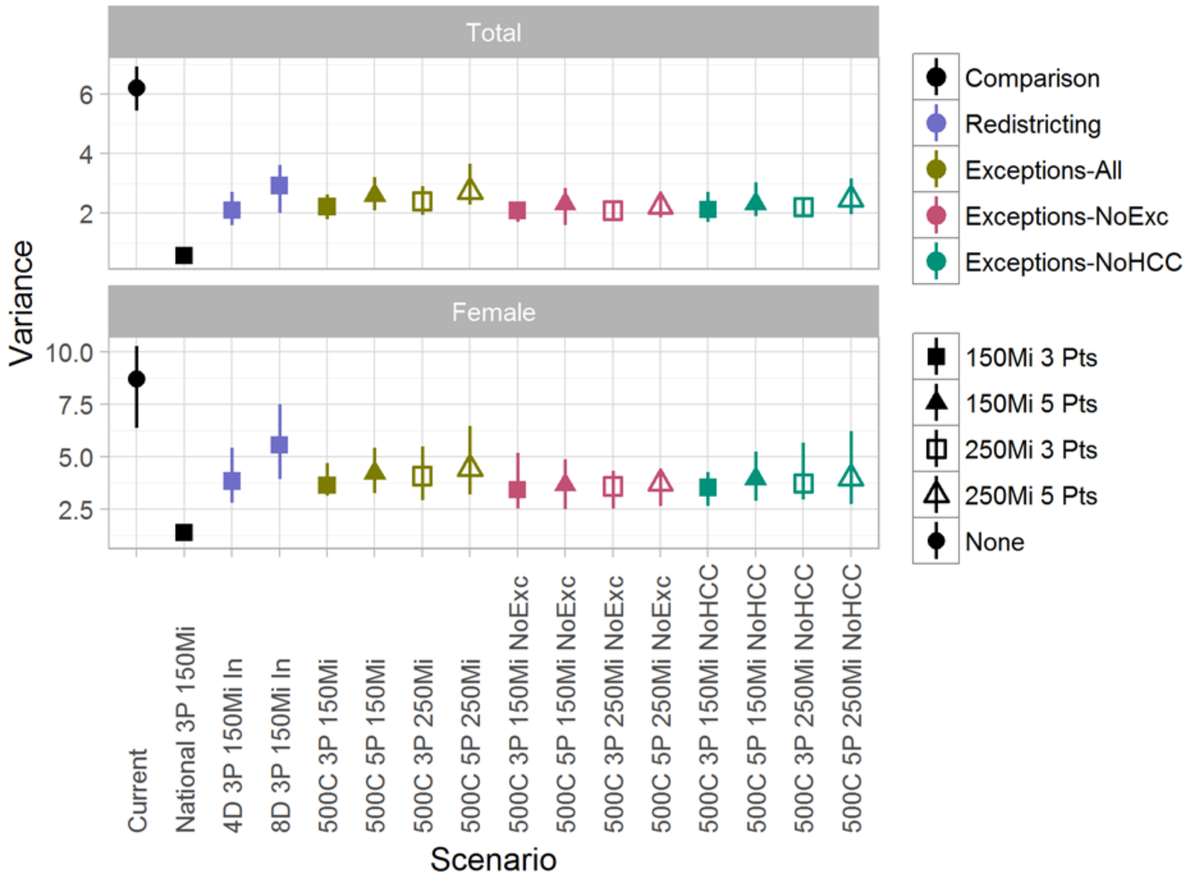


Figure 19. Variance in median allocation MELD/PELD at transplant by DSA (all transplants by race/ethnicity)

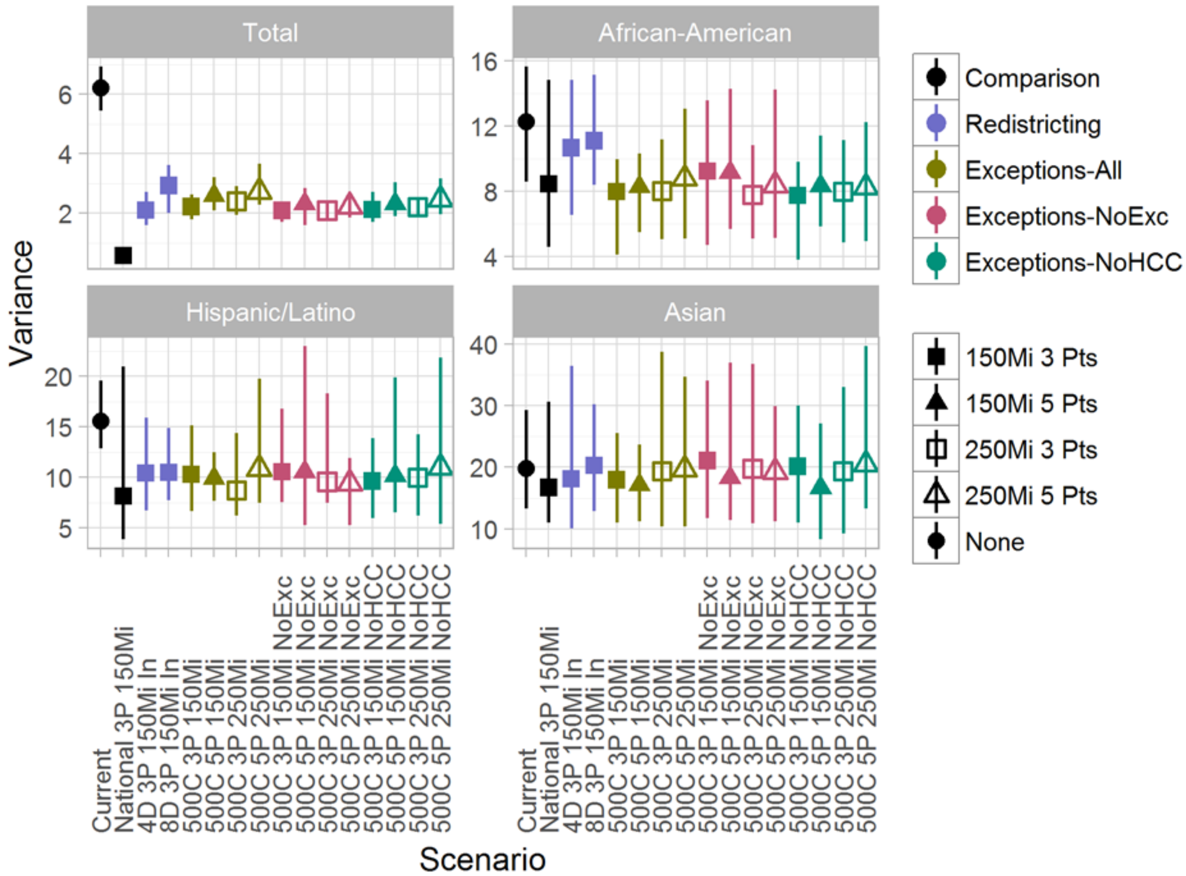
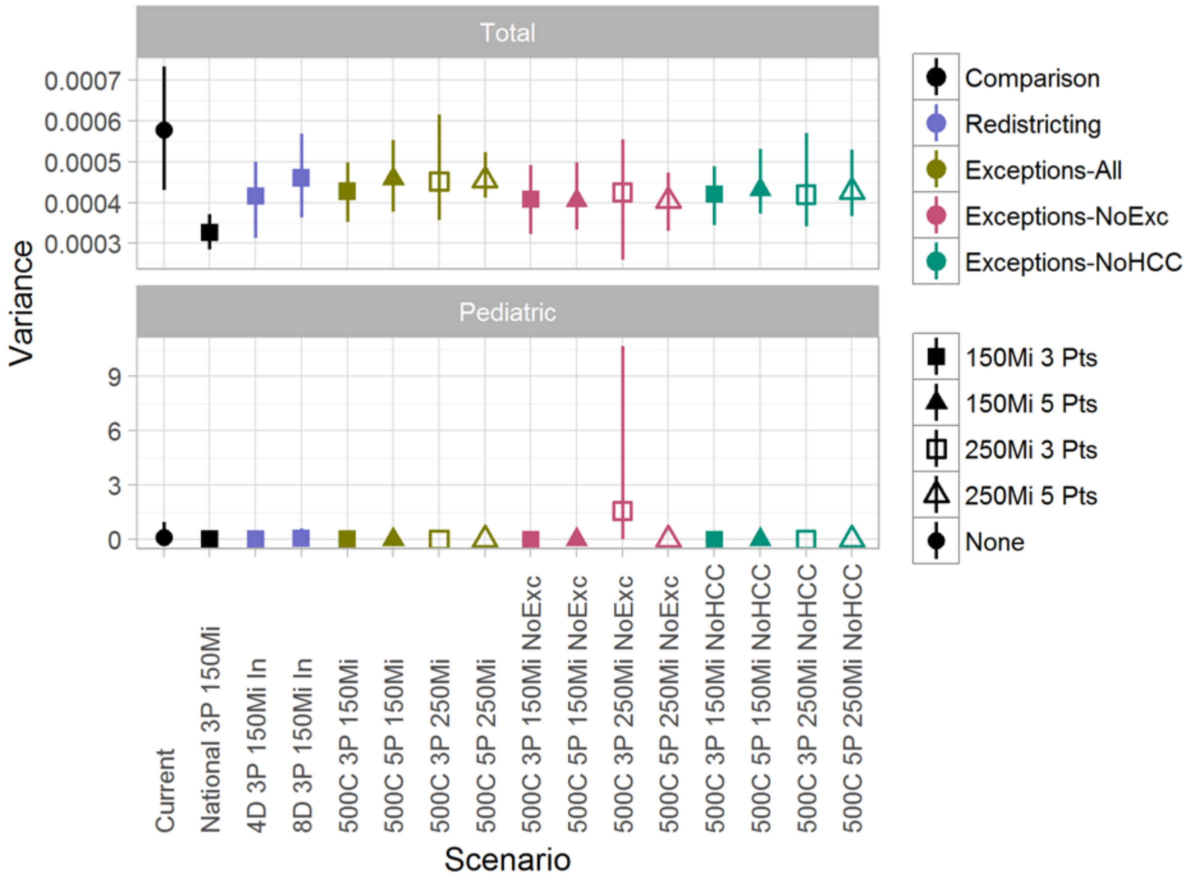


Figure 20. Variance in pretransplant mortality rates by DSA (all transplants by pediatric status)



In **Figure 20**, large variance is shown in the 500-mile circle with 250-mile 3 point proximity circle with proximity points awarded to candidates without exceptions. This variance is due to small numbers of pediatric transplants in some DSAs.

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Figure 21. Variance in pretransplant mortality rates by DSA (all transplants by sex)

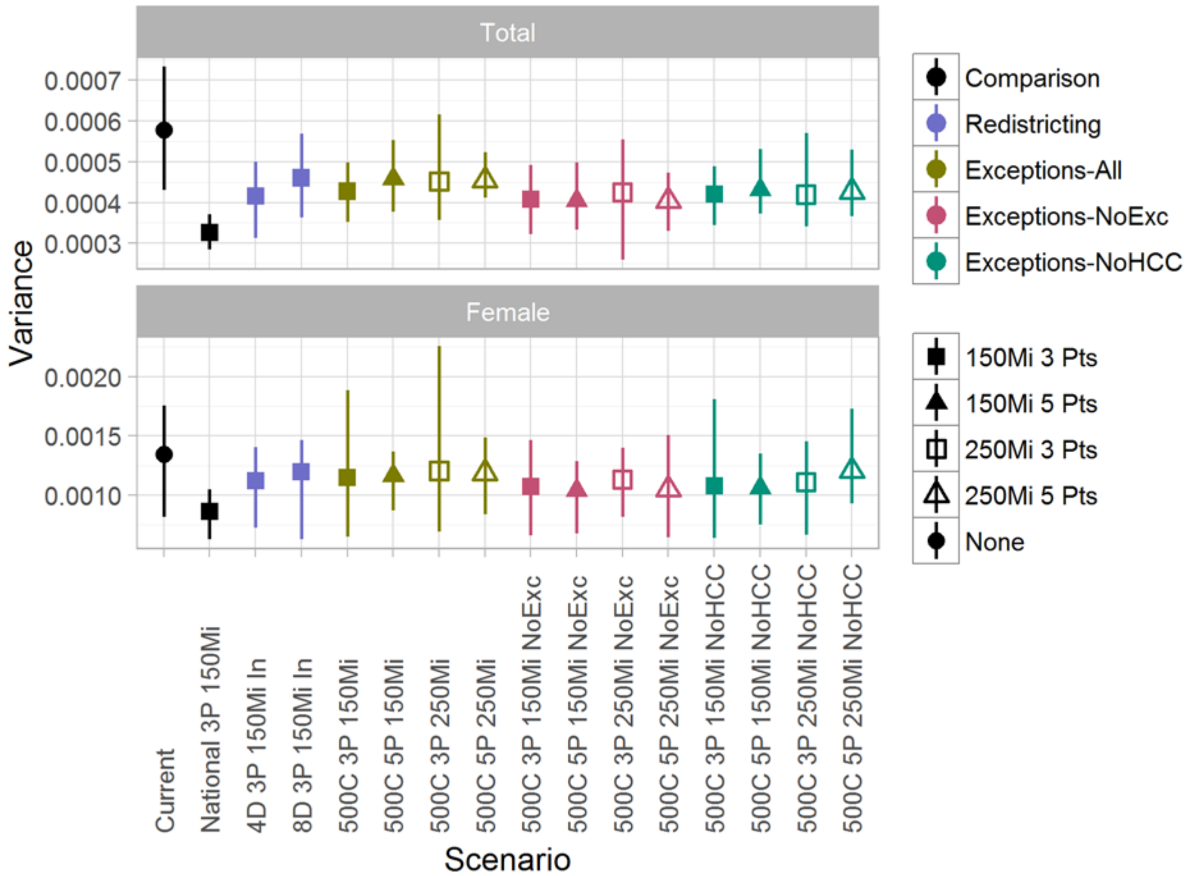


Figure 22. Variance in pretransplant mortality rates by DSA (all transplants by race/ethnicity)

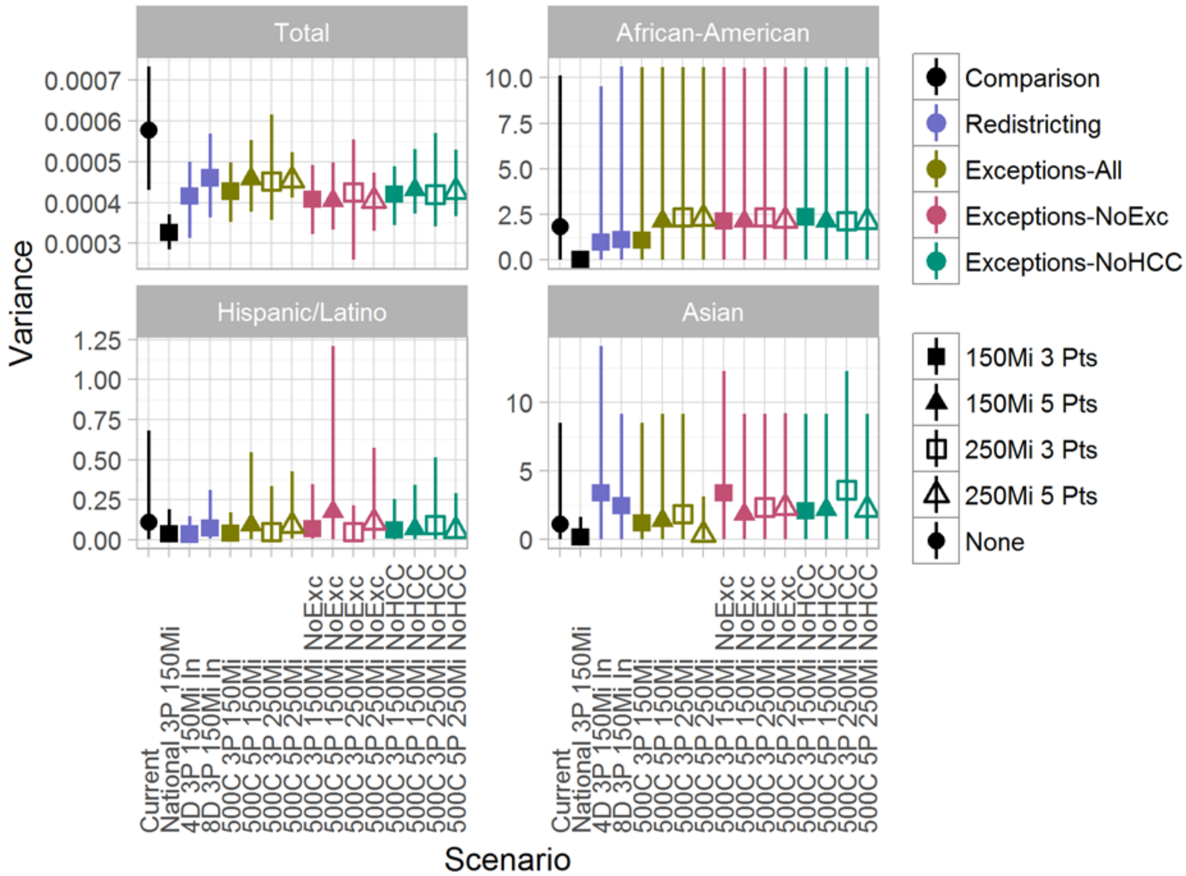
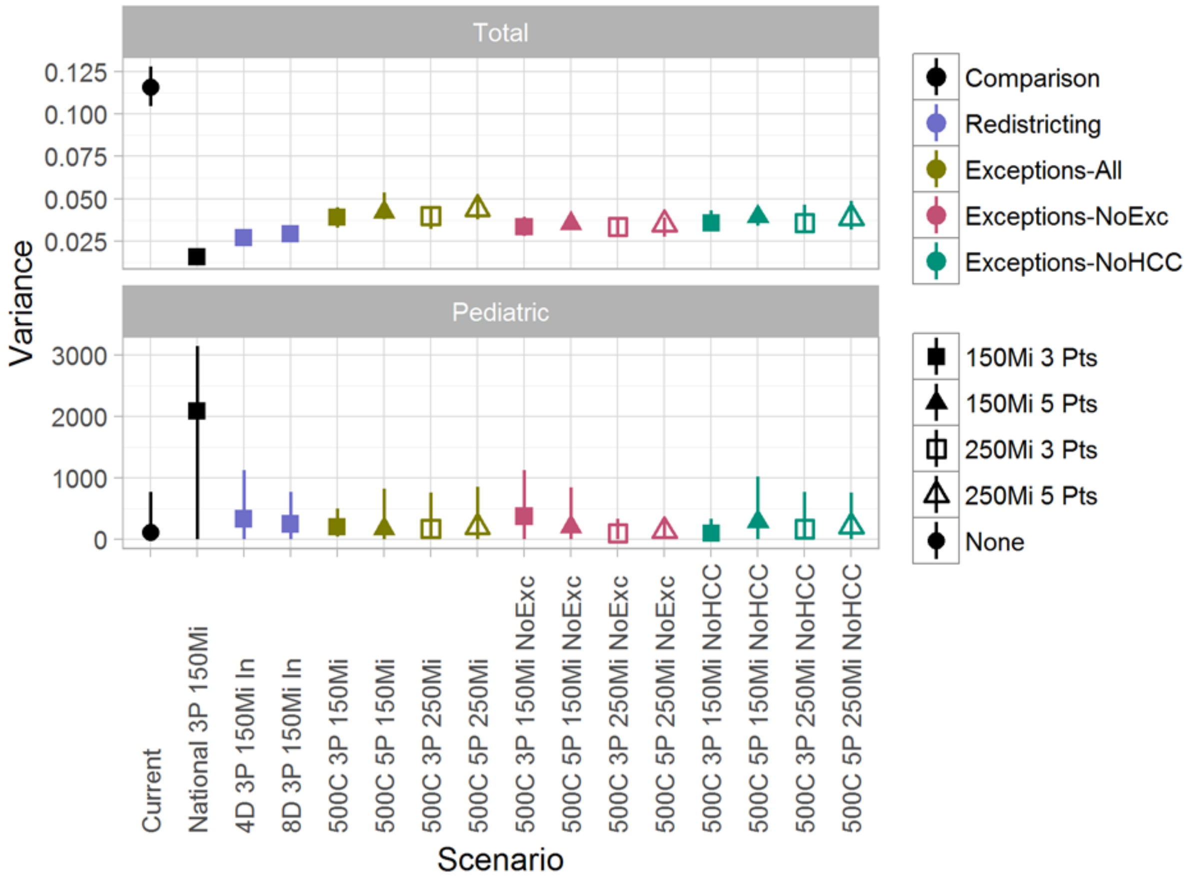


Figure 23. Variance in transplant rates by DSA (all transplants by pediatric status)



In **Figure 23**, large variance is shown in the National scenario with 150-mile proximity circle awarding 3 proximity points. This variance is due to small numbers of pediatric transplants in some DSAs.

Figure 24. Variance in transplant rates by DSA (all transplants by sex)

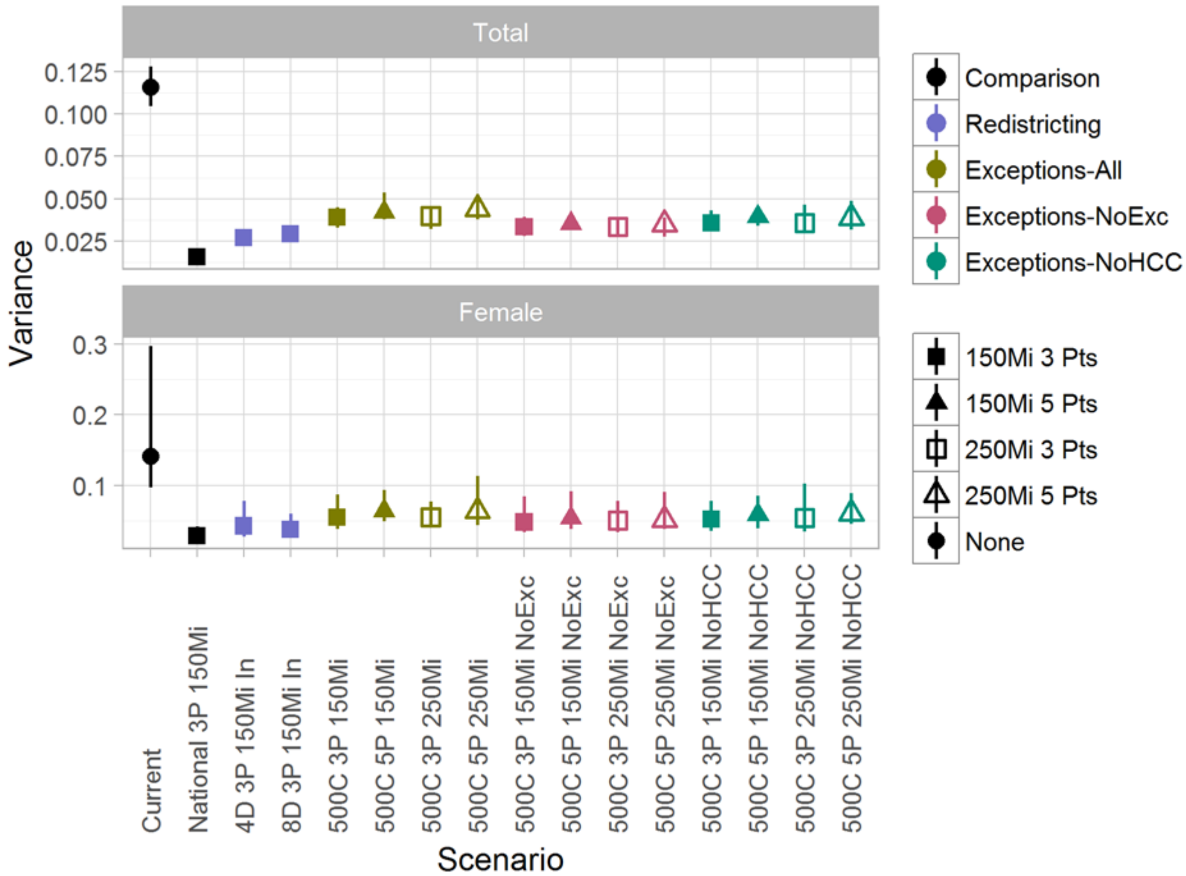


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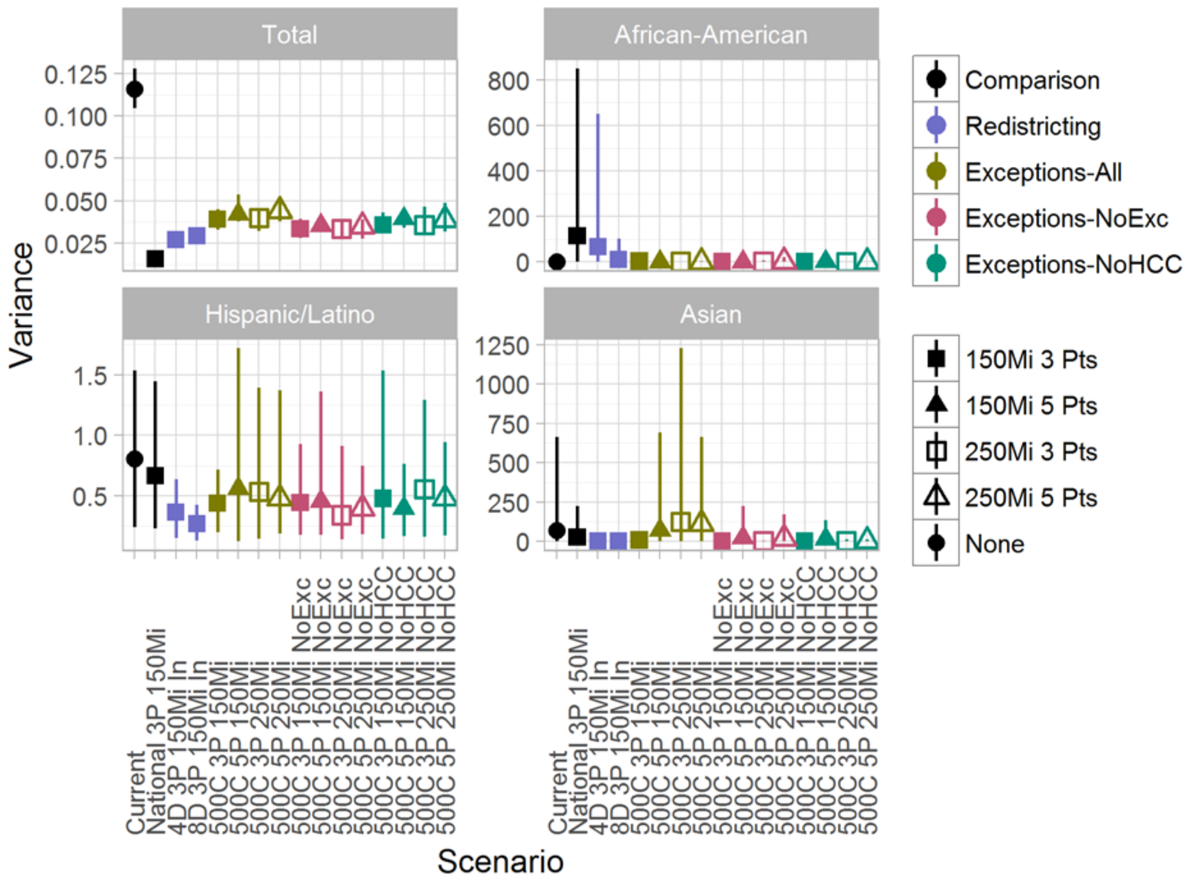
Figure 25. Variance in transplant rates by DSA (all transplants by race/ethnicity)



In **Figure 25**, large variance is shown in some scenarios for African-American and Asian patients. This variance is due to small numbers of these transplants in some DSAs.

Summative Metrics

Figure 26. Pretransplant deaths prevented (all transplants by pediatric status)

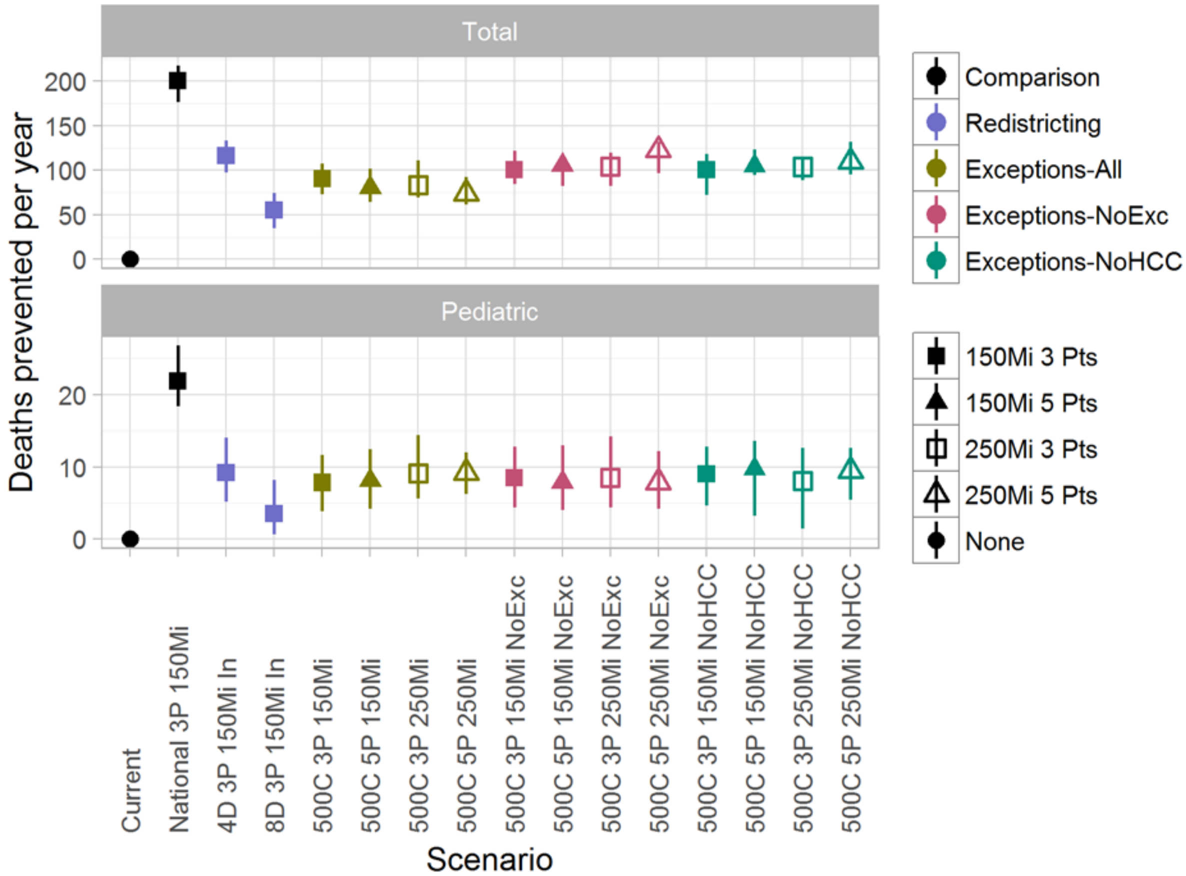


Figure 27. Pretransplant deaths prevented (all transplants by sex)

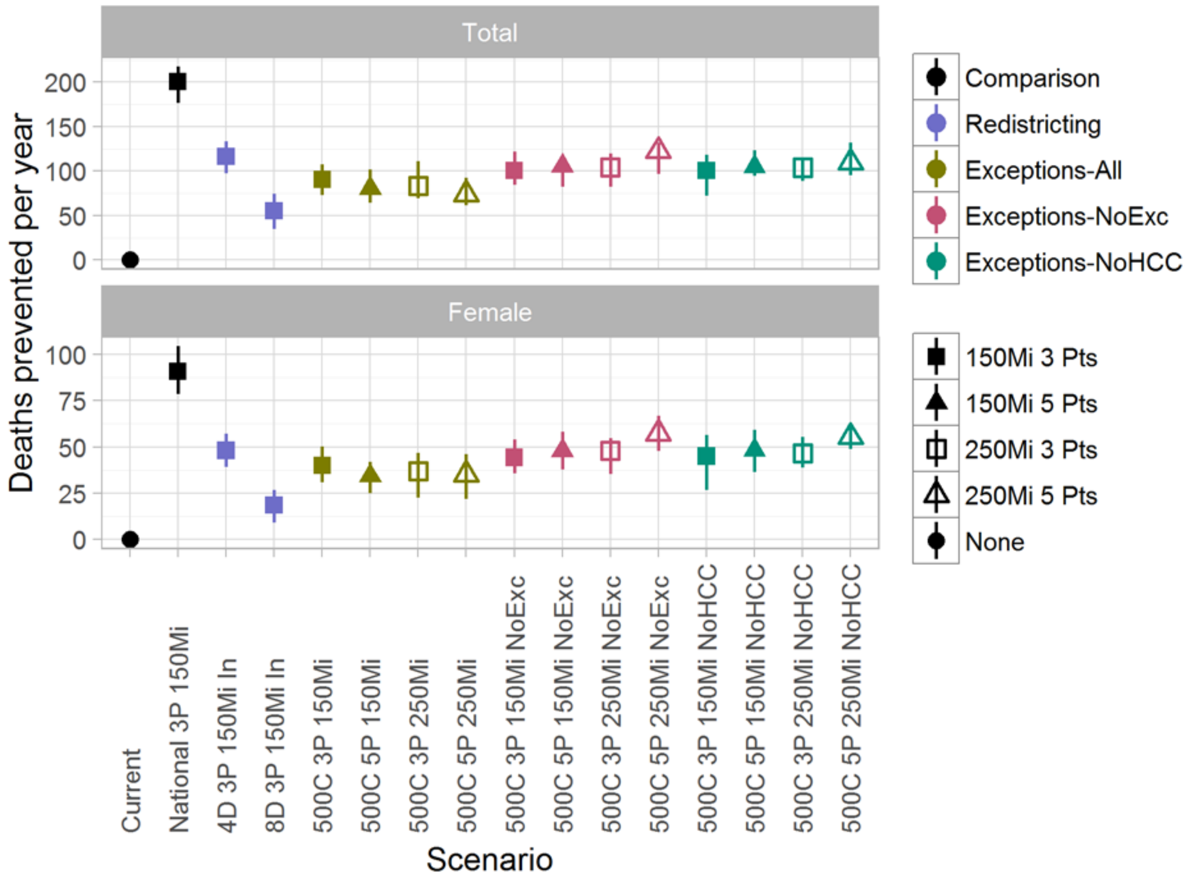


Figure 28. Pretransplant deaths prevented (all transplants by race/ethnicity)

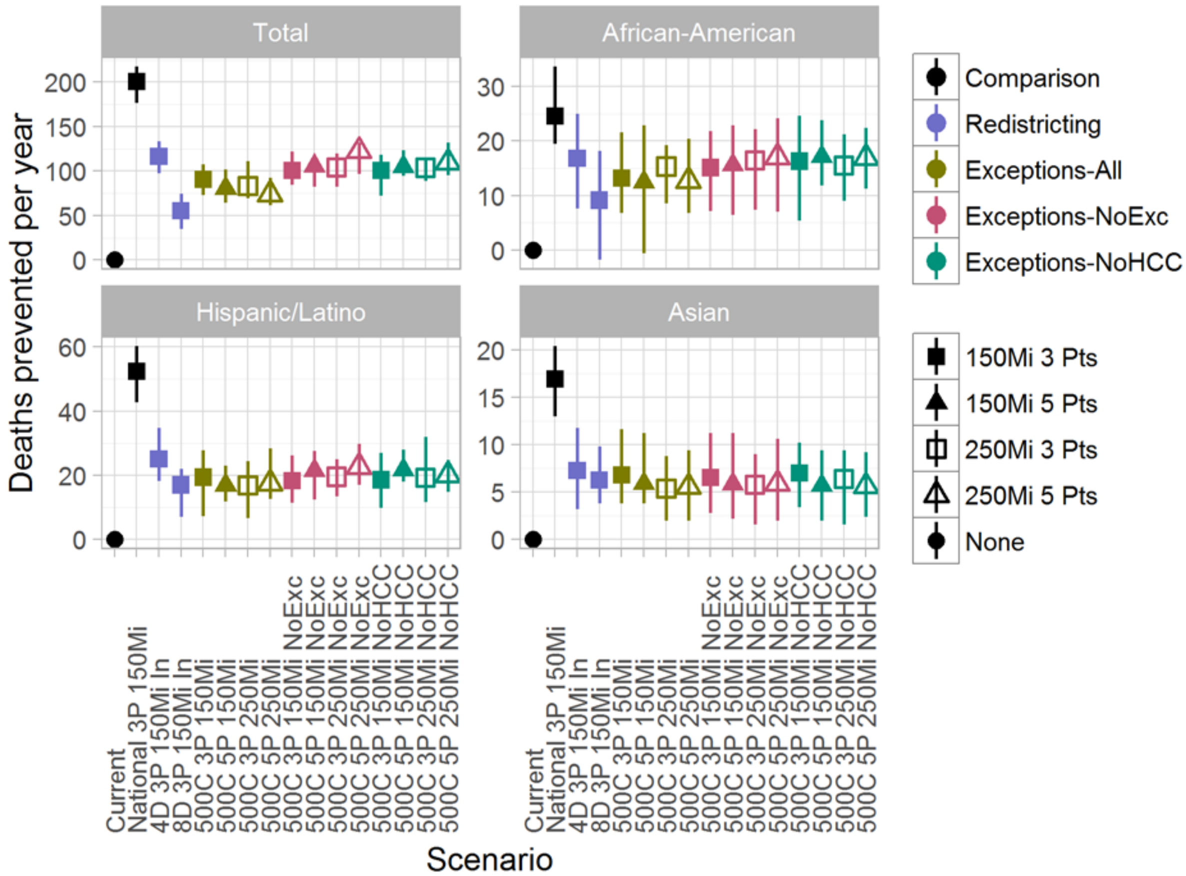


Figure 29. Waitlist deaths prevented (all transplants by pediatric status)

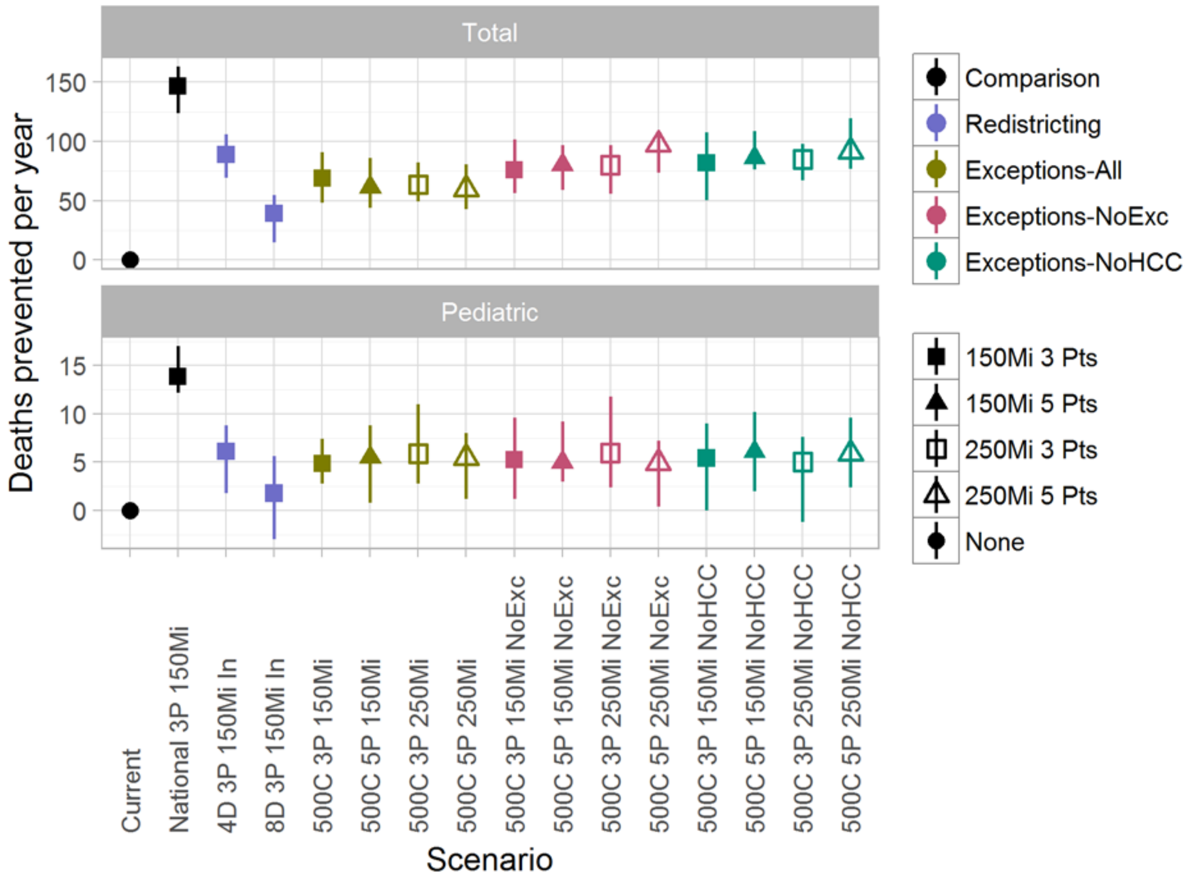


Figure 30. Waitlist deaths prevented (all transplants by sex)

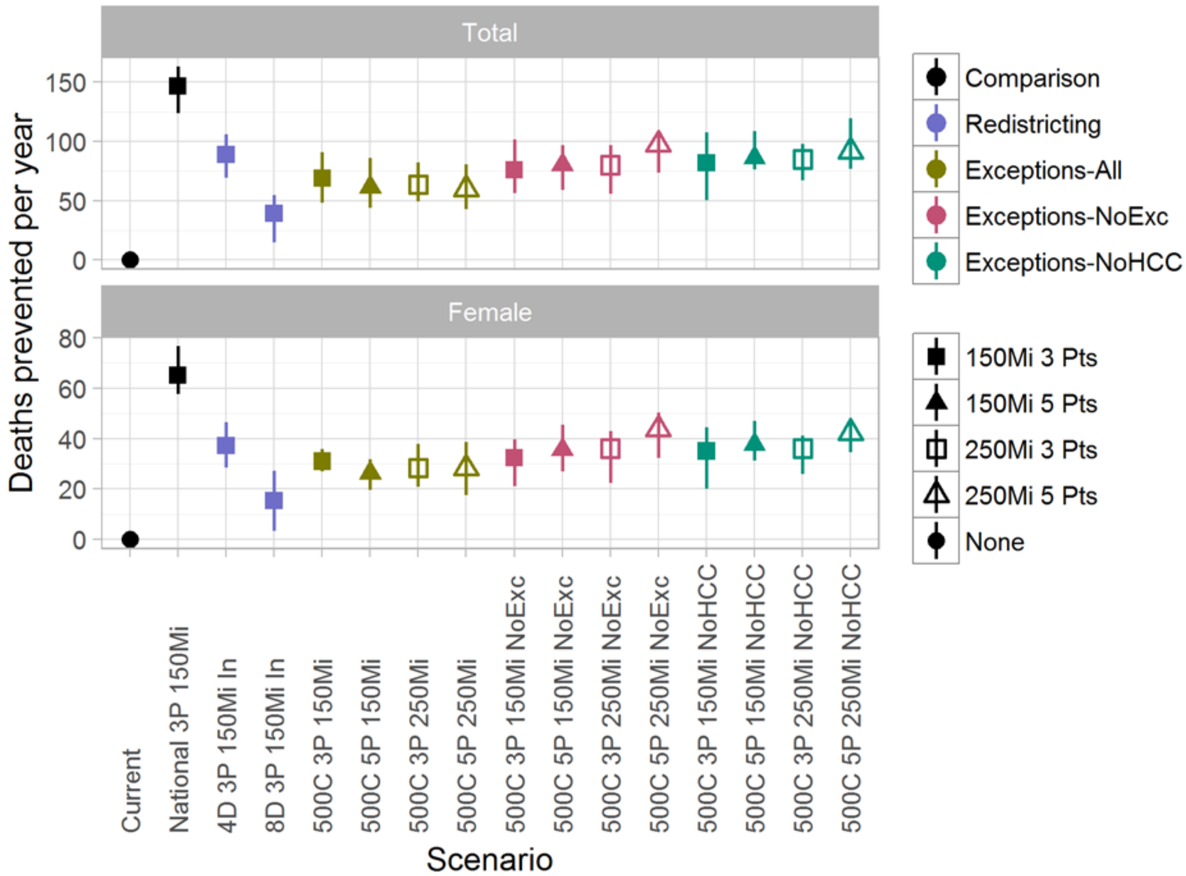


Figure 31. Waitlist deaths prevented (all transplants by race/ethnicity)

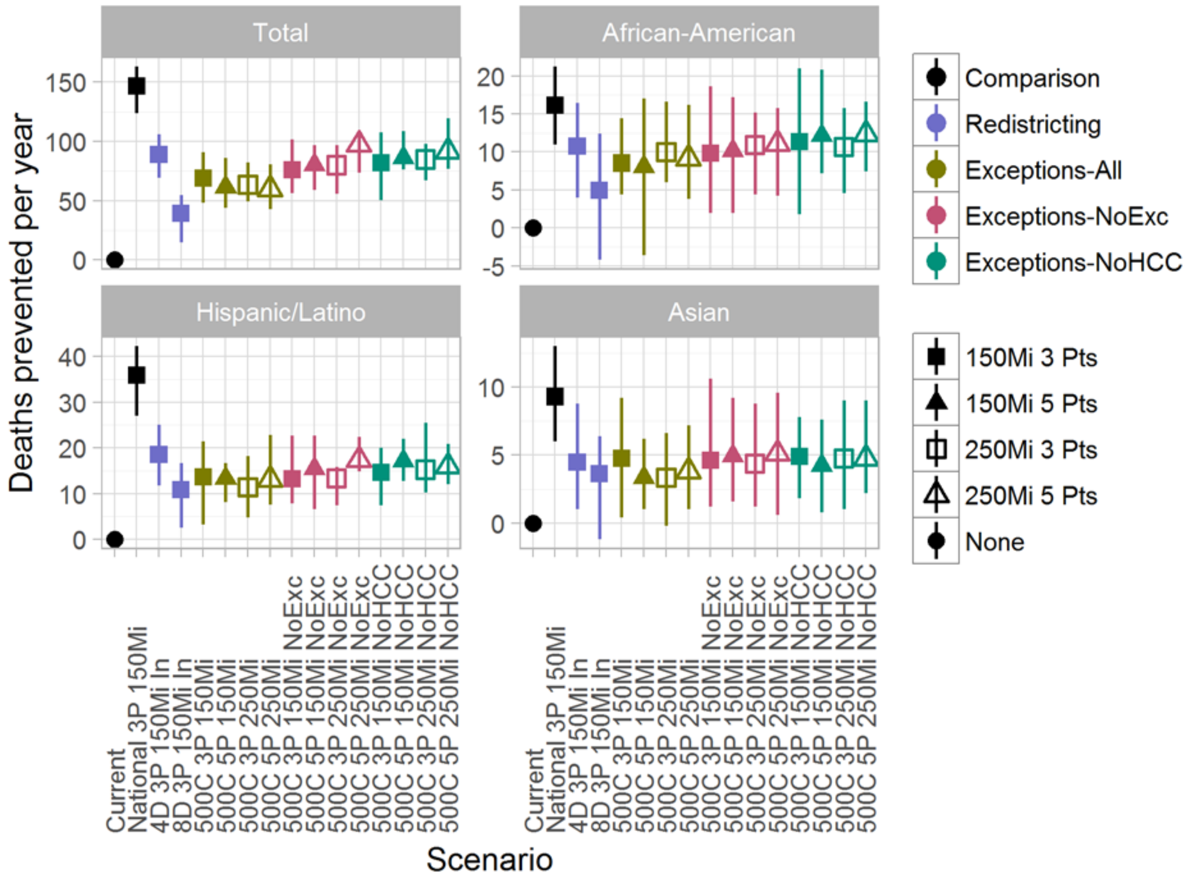


Figure 32. Posttransplant deaths prevented (all transplants by pediatric status)

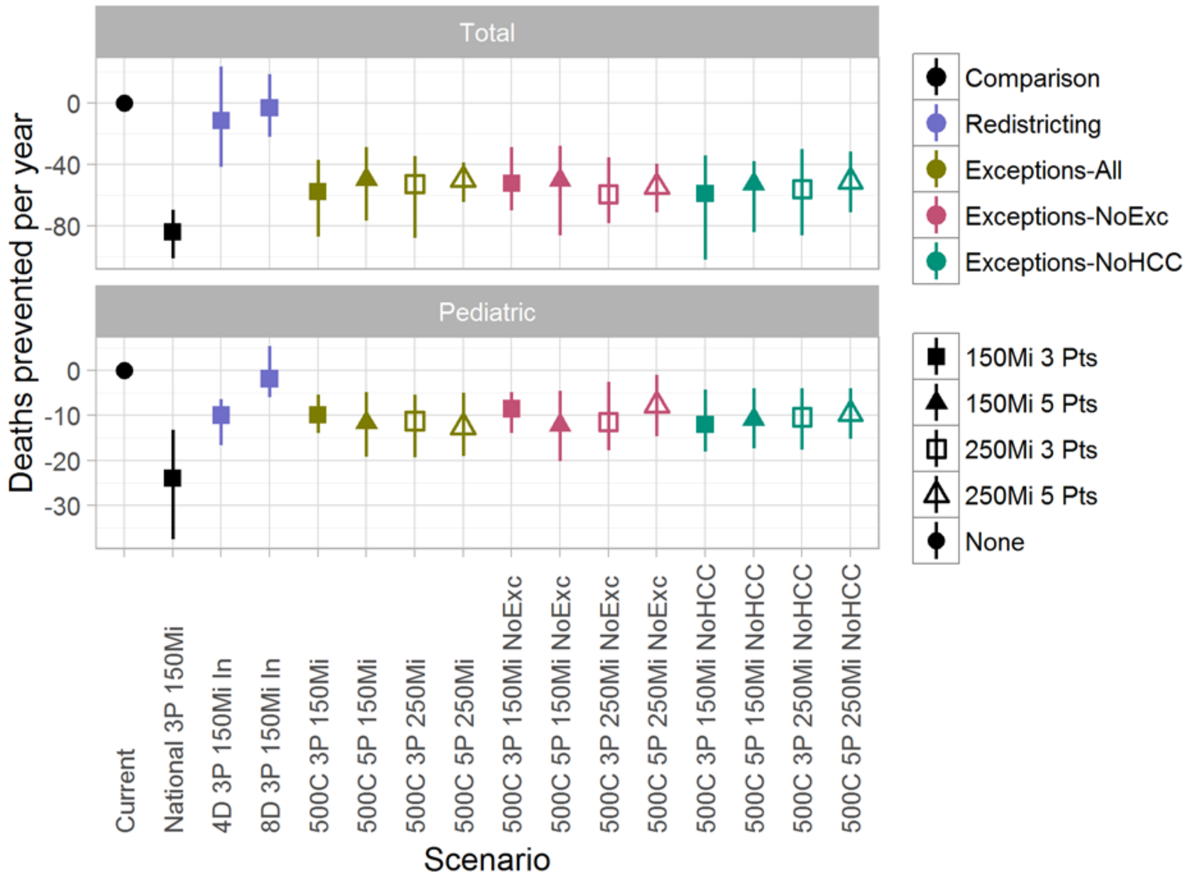


Figure 33. Posttransplant deaths prevented (all transplants by sex)

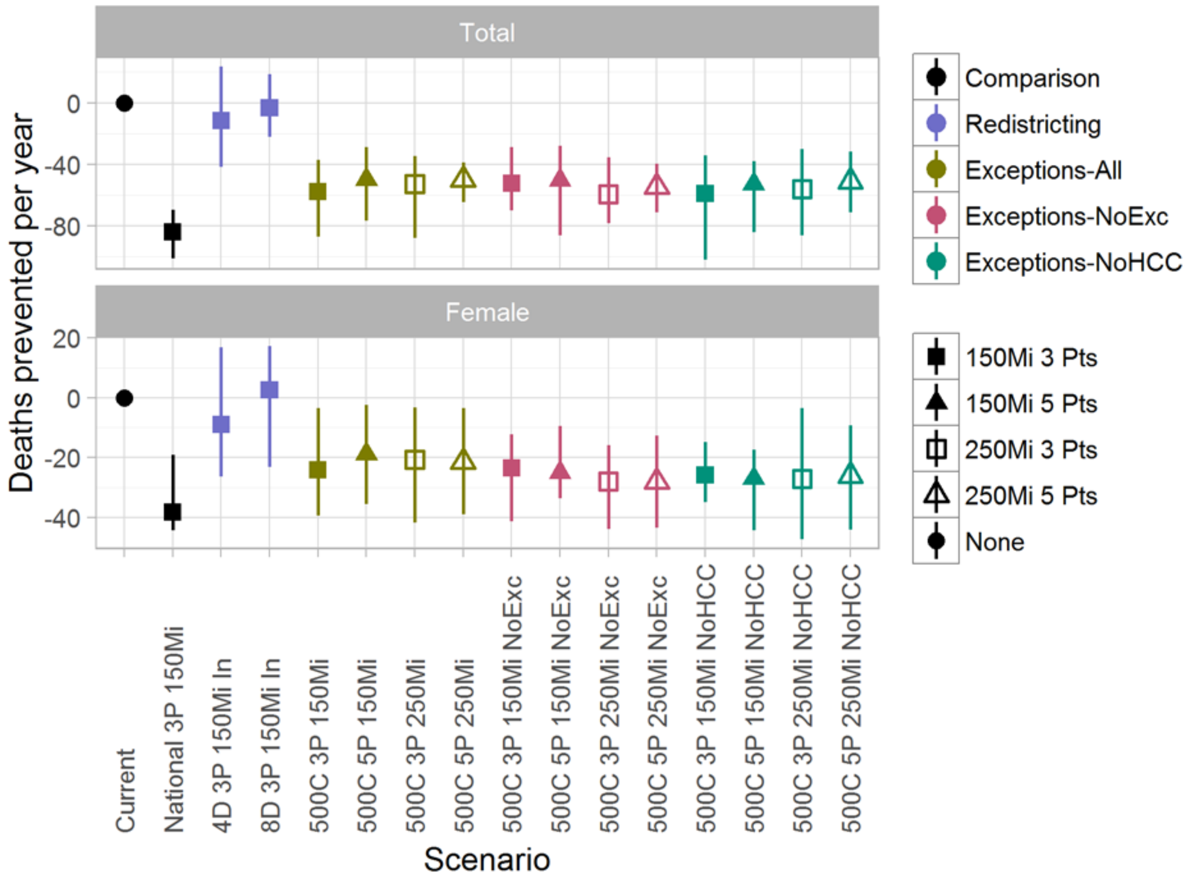


Figure 34. Posttransplant deaths prevented (all transplants by race/ethnicity)

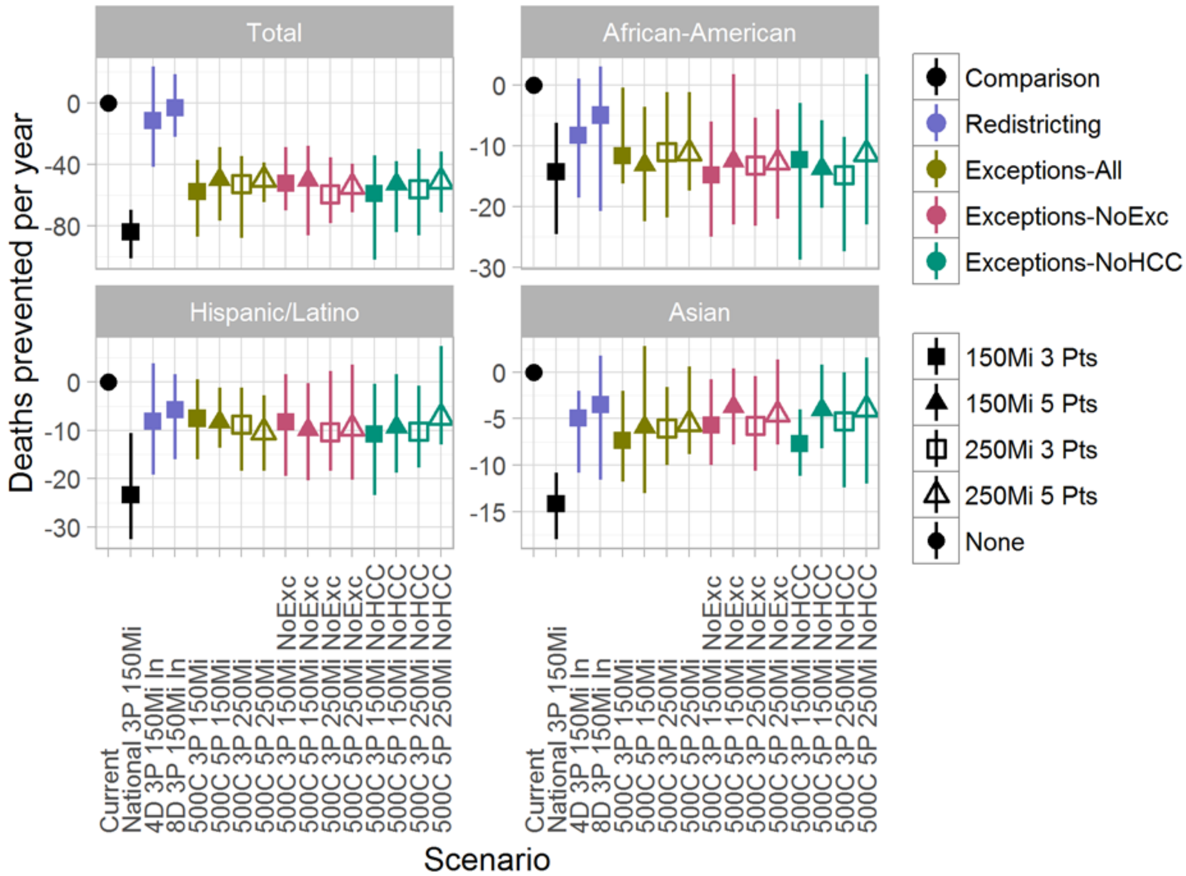


Figure 35. Overall deaths prevented (all transplants by pediatric status)

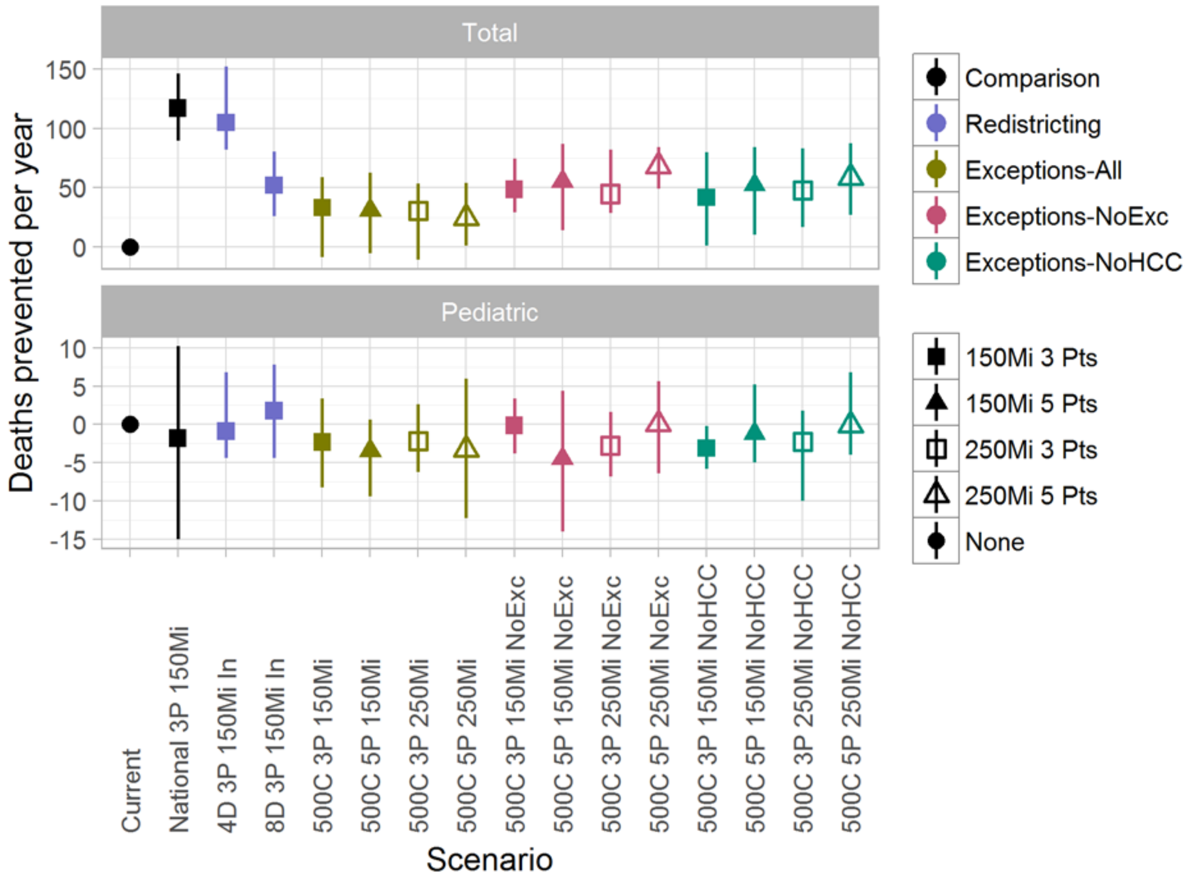


Figure 36. Overall deaths prevented (all transplants by sex)

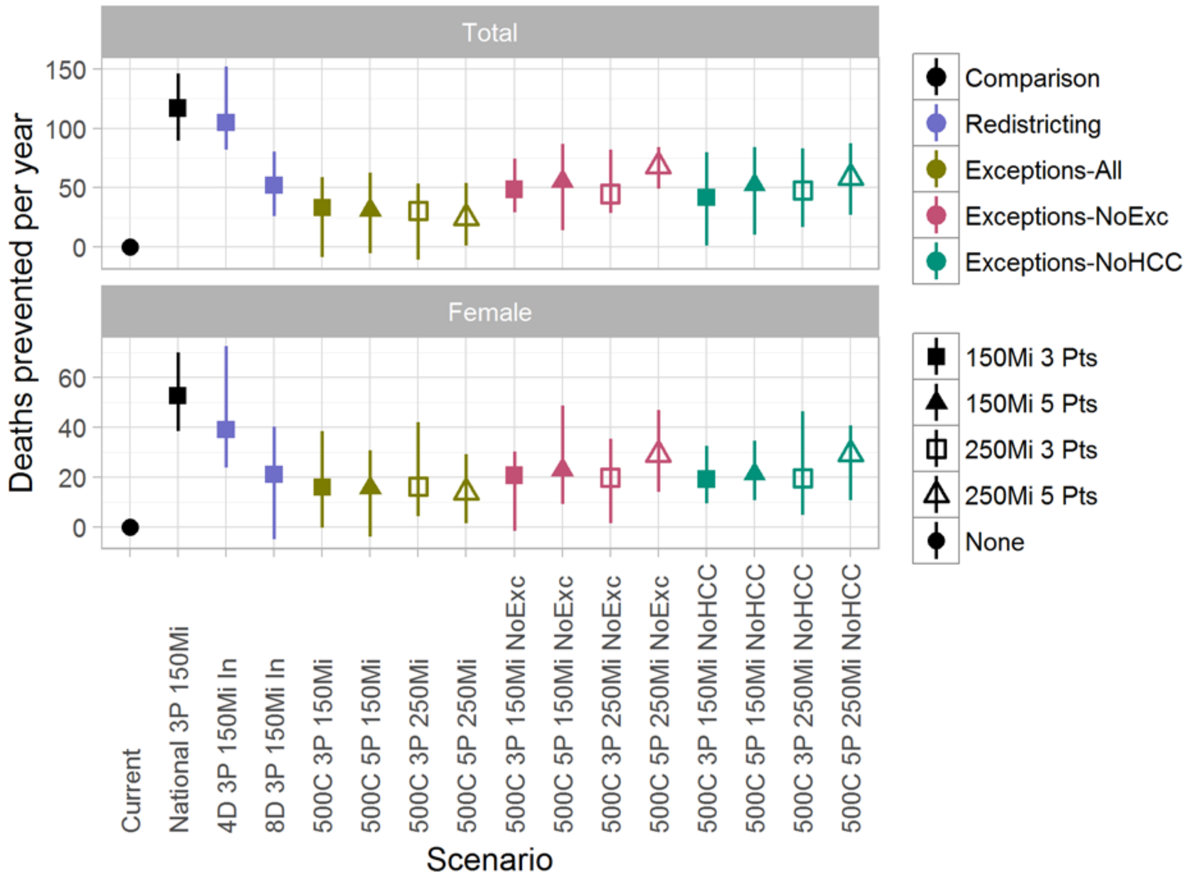


Figure 37. Overall deaths prevented (all transplants by race/ethnicity)

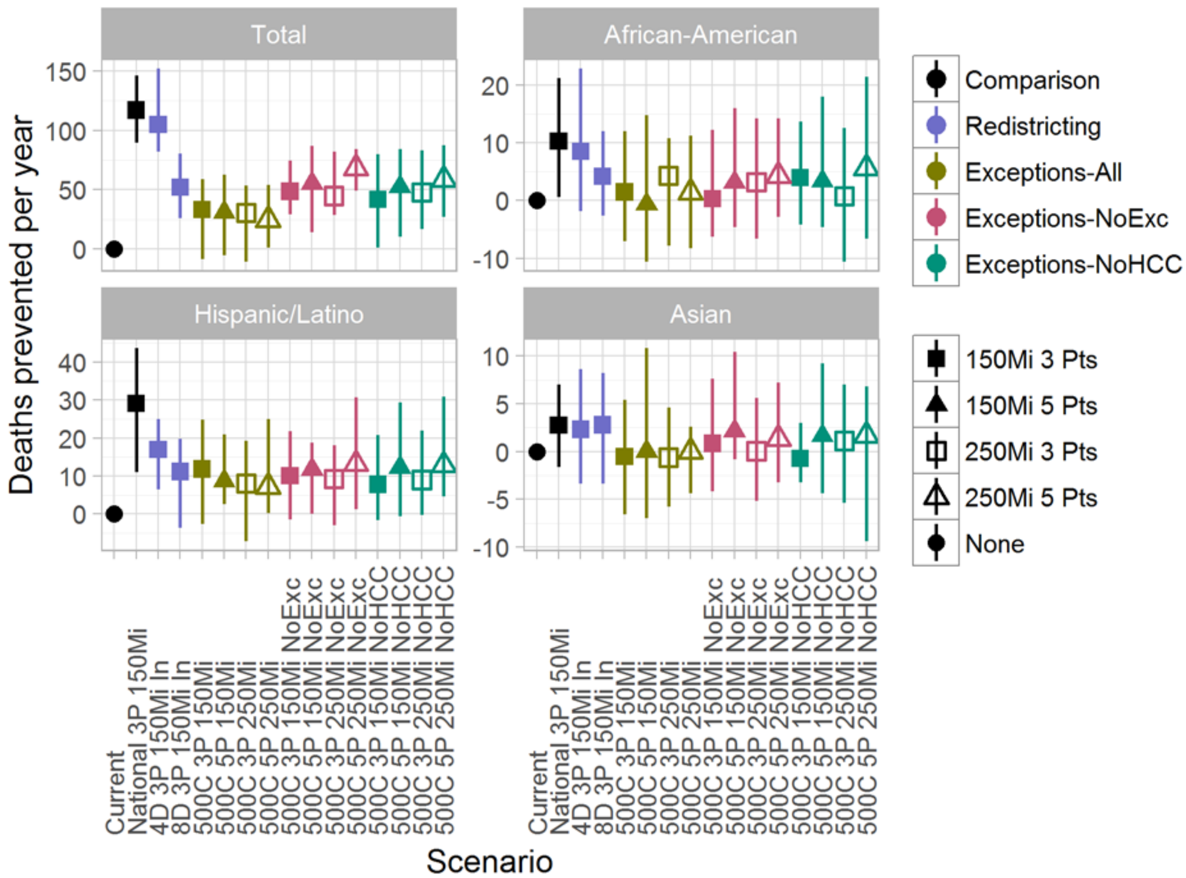


Figure 38. Transplant rates (all transplants by pediatric status)

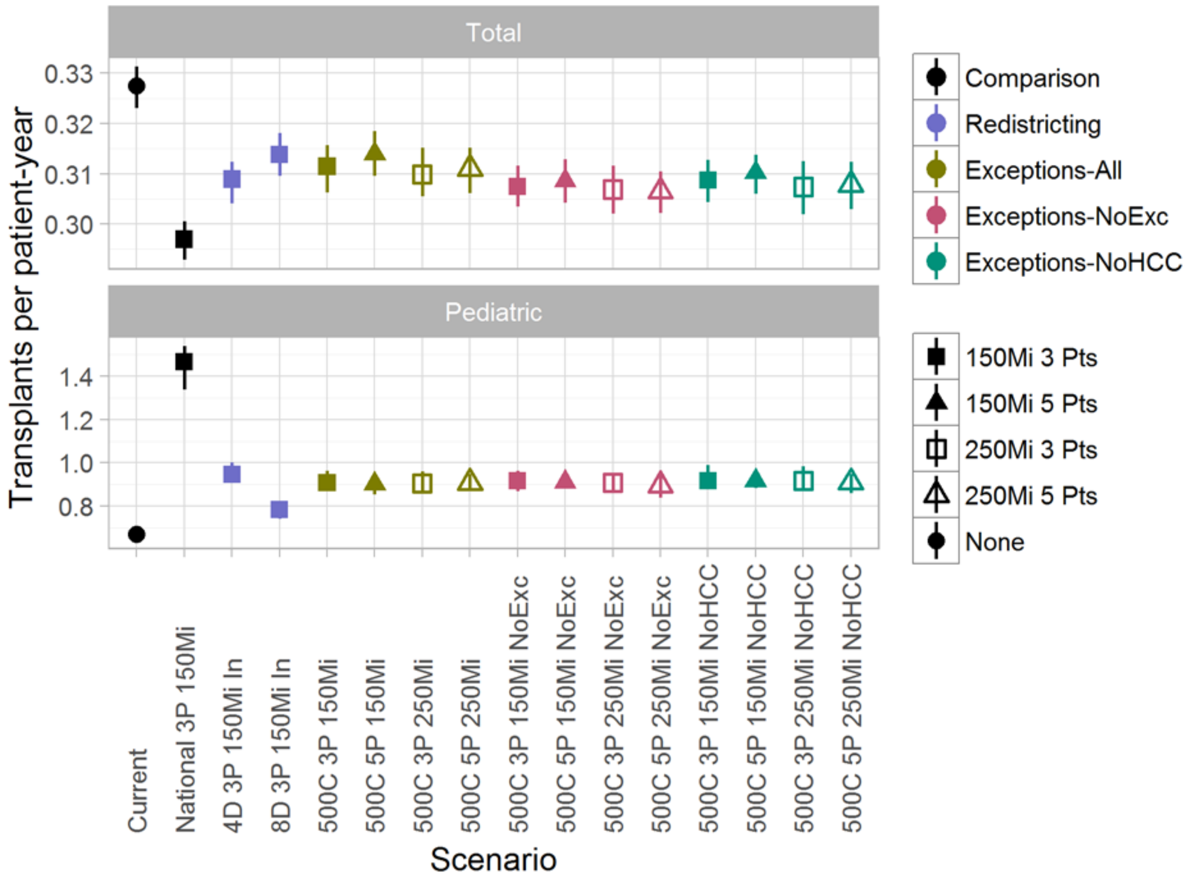


Figure 39. Transplant rates (all transplants by sex)

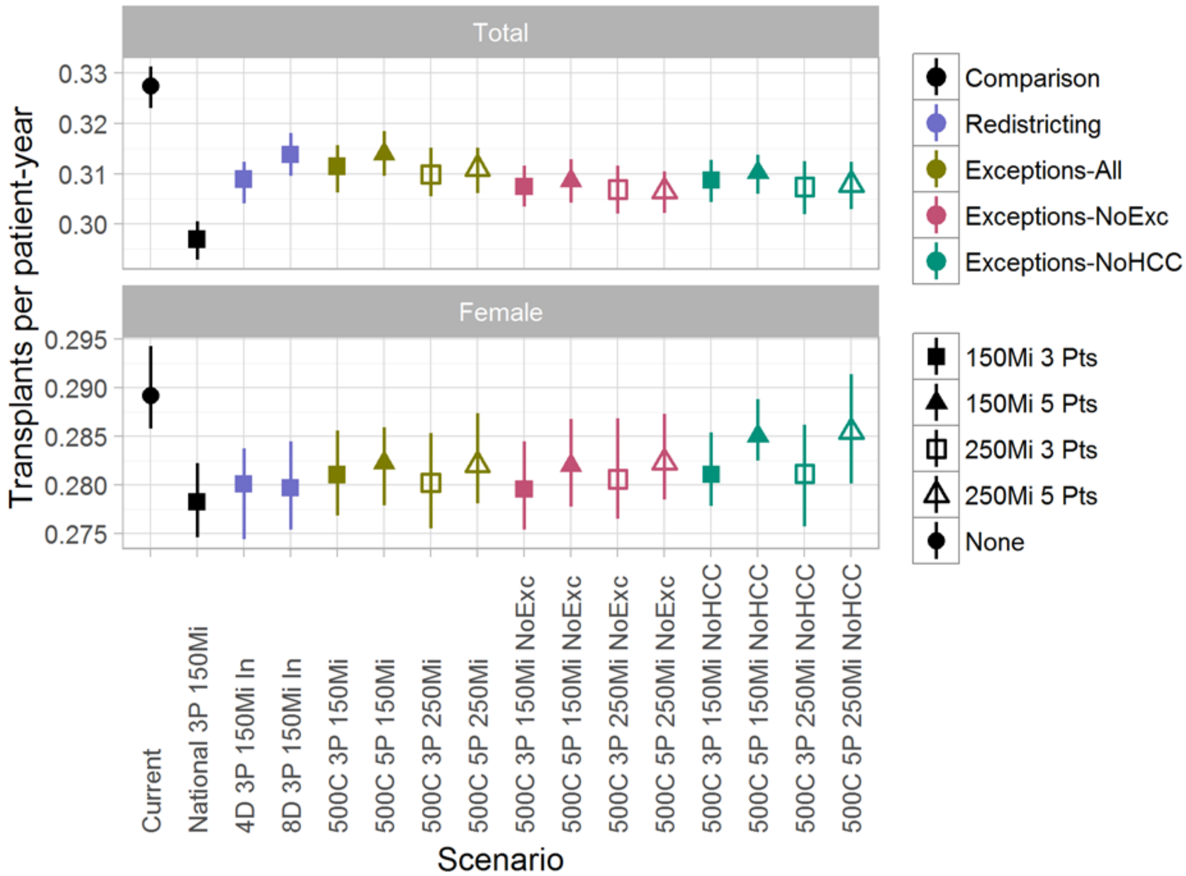
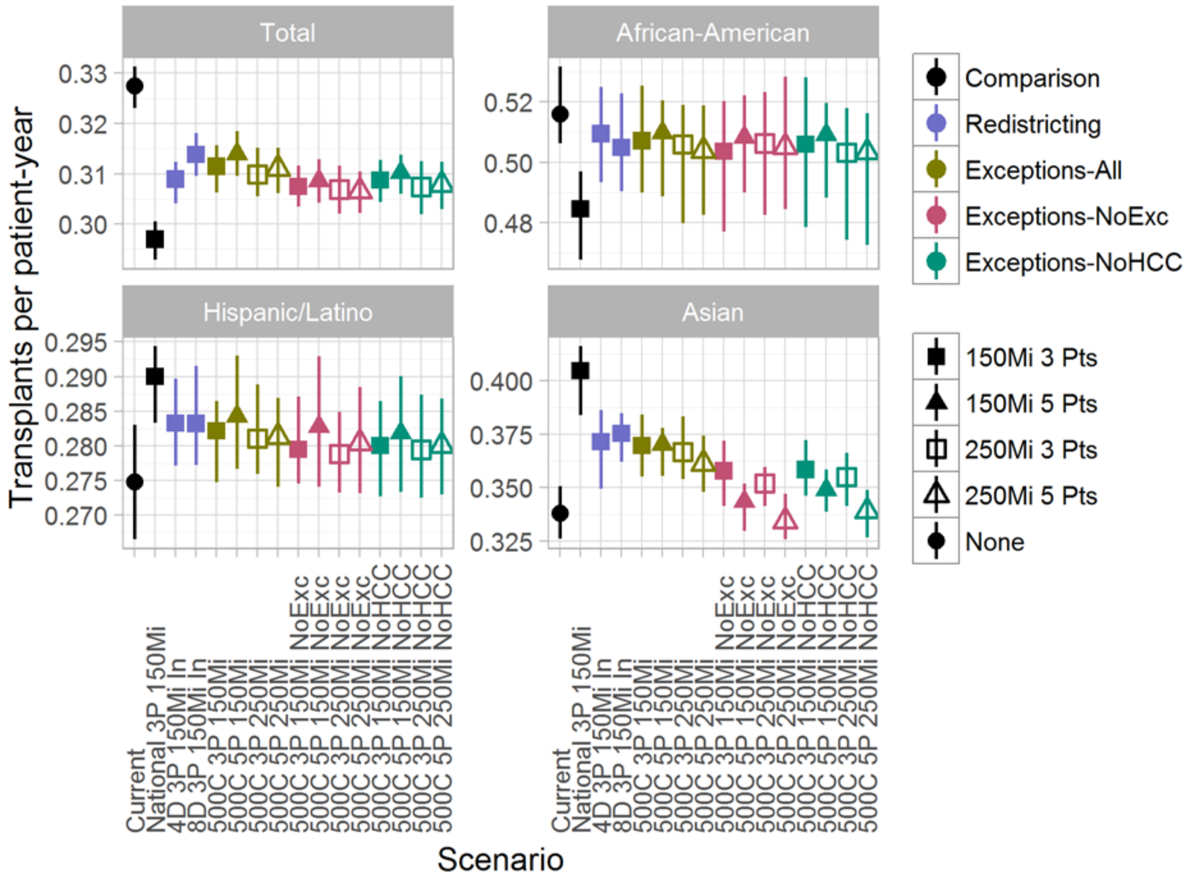


Figure 40. Transplant rates (all transplants by race/ethnicity)



Transport Metrics

Figure 41. Percentage of transplants performed locally (all transplants by pediatric status)

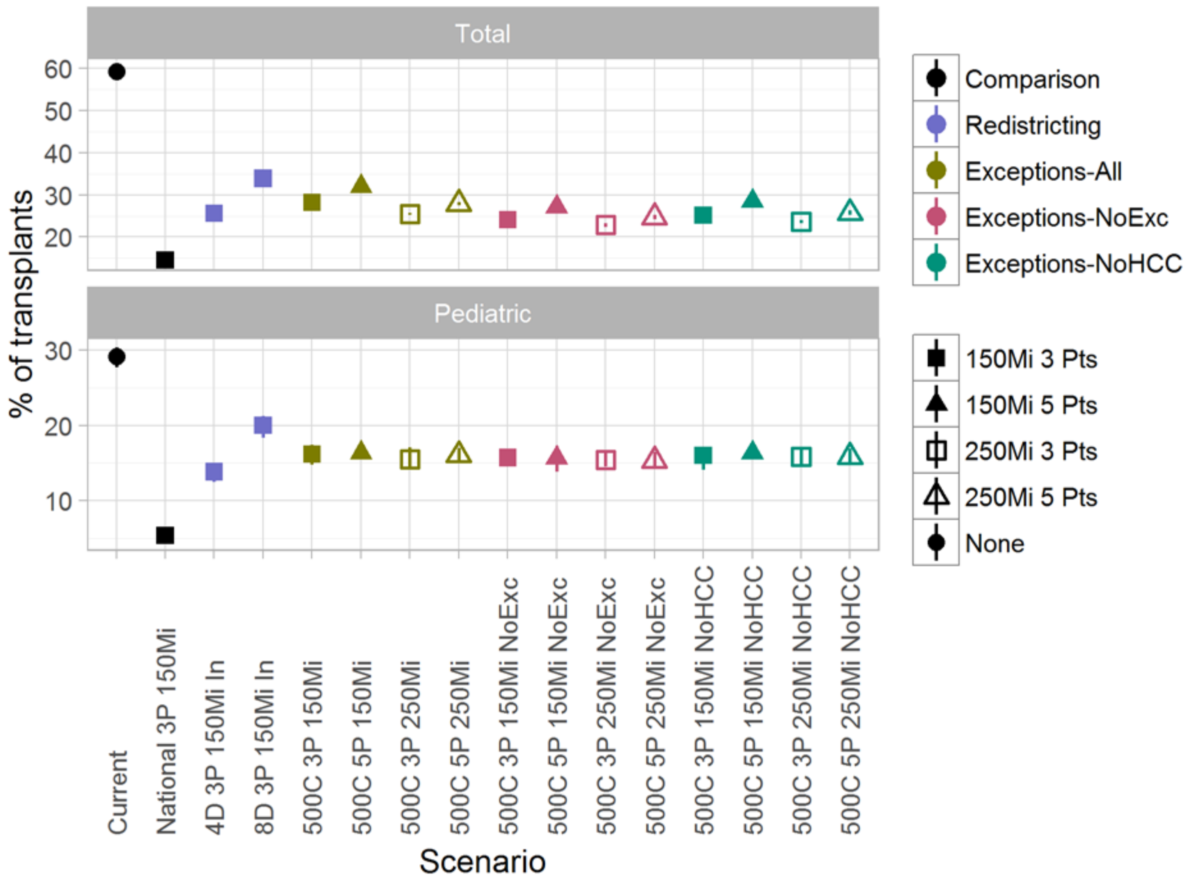


Figure 42. Percentage of transplants performed locally (all transplants by sex)

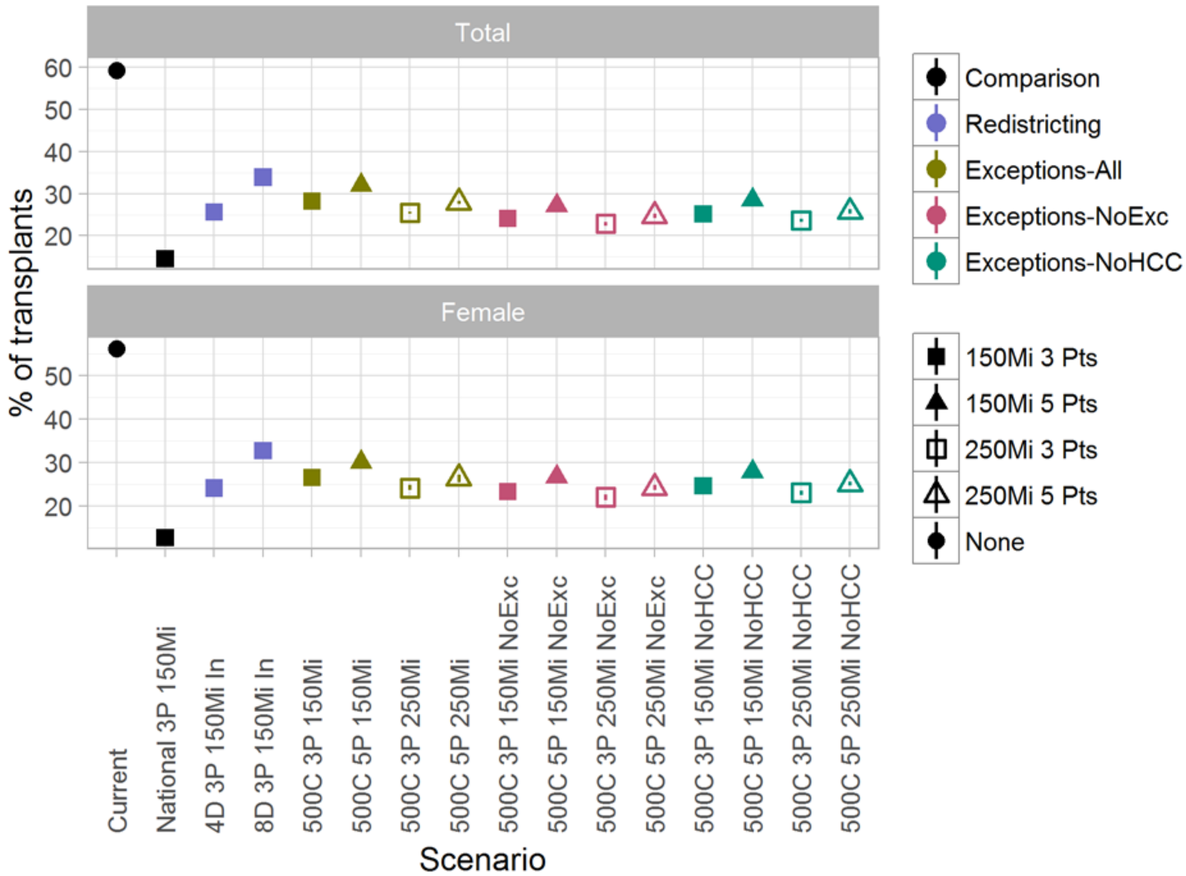


Figure 43. Percentage of transplants performed locally (all transplants by race/ethnicity)

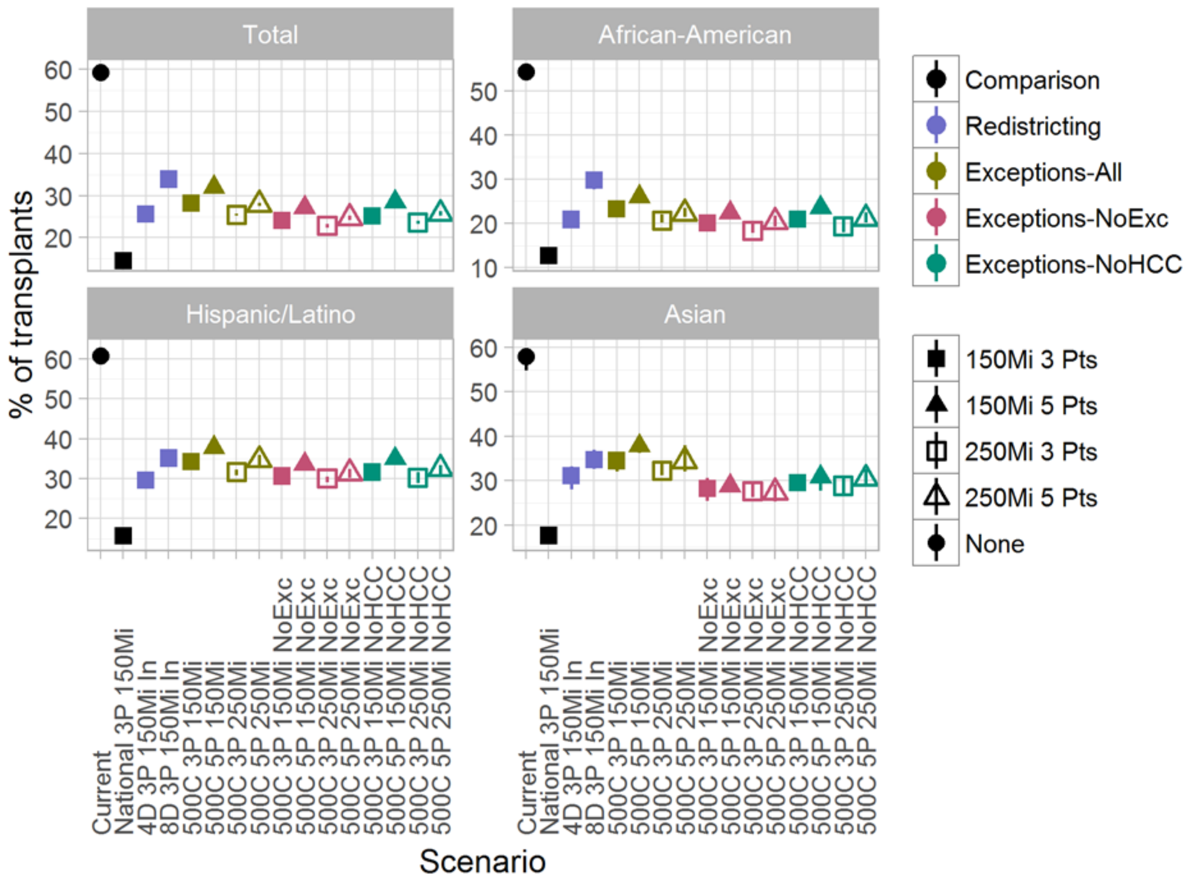


Figure 44. Median transport time (all transplants by pediatric status)

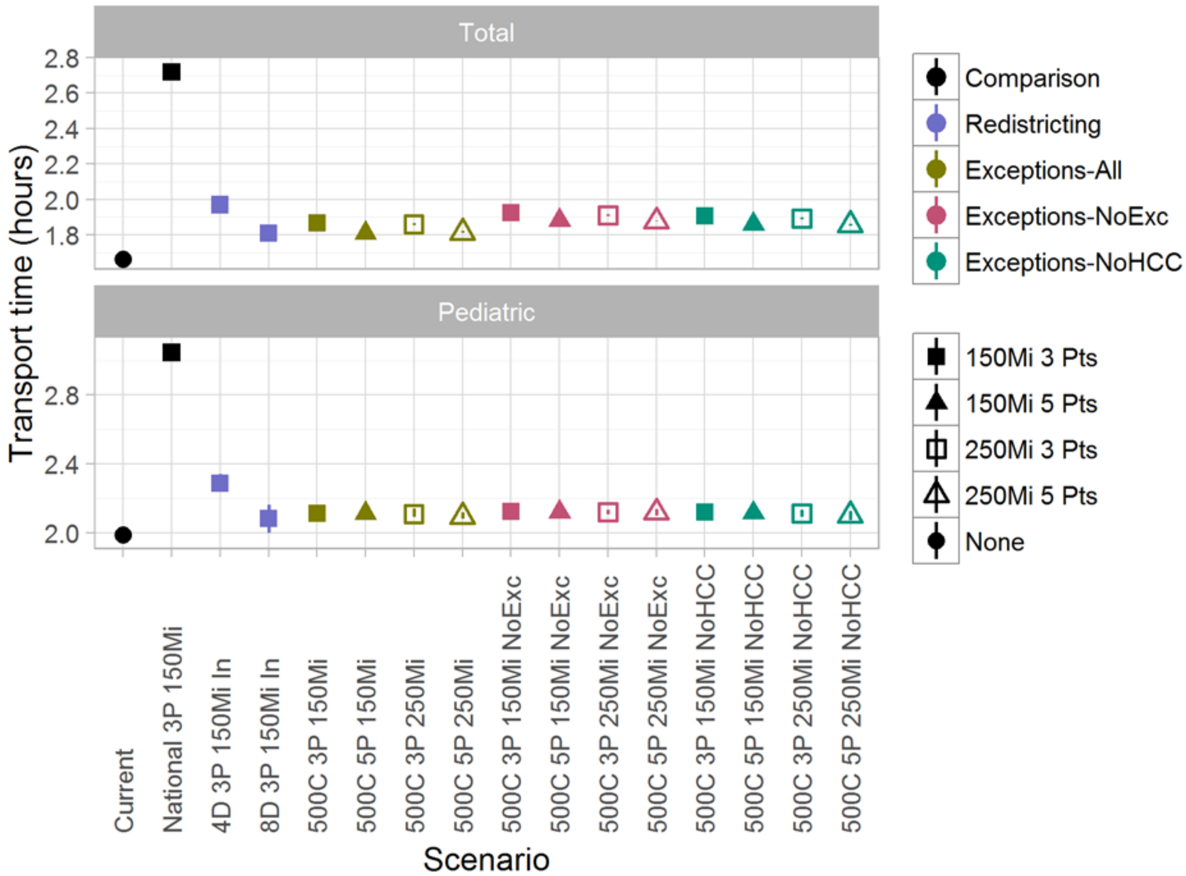


Figure 45. Median transport time (all transplants by sex)

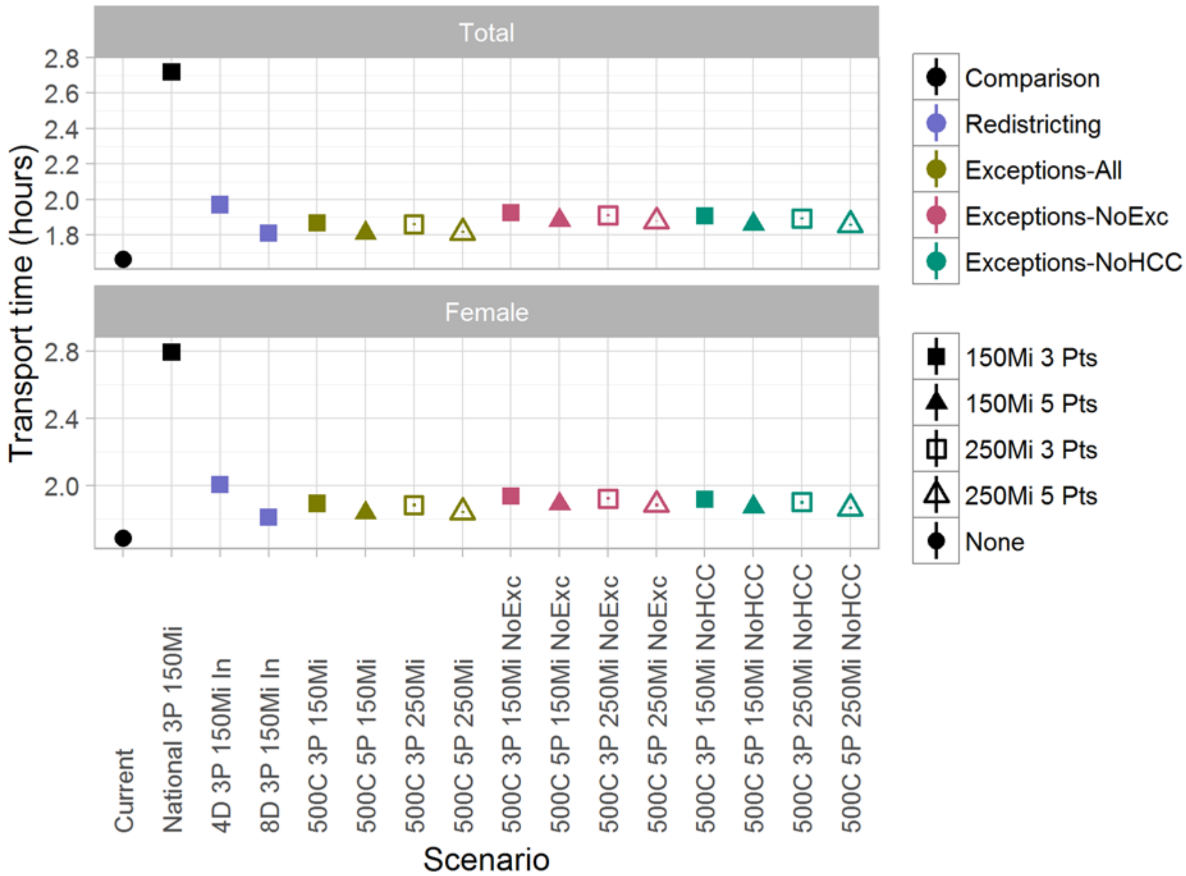


Figure 46. Median transport time (all transplants by race/ethnicity)

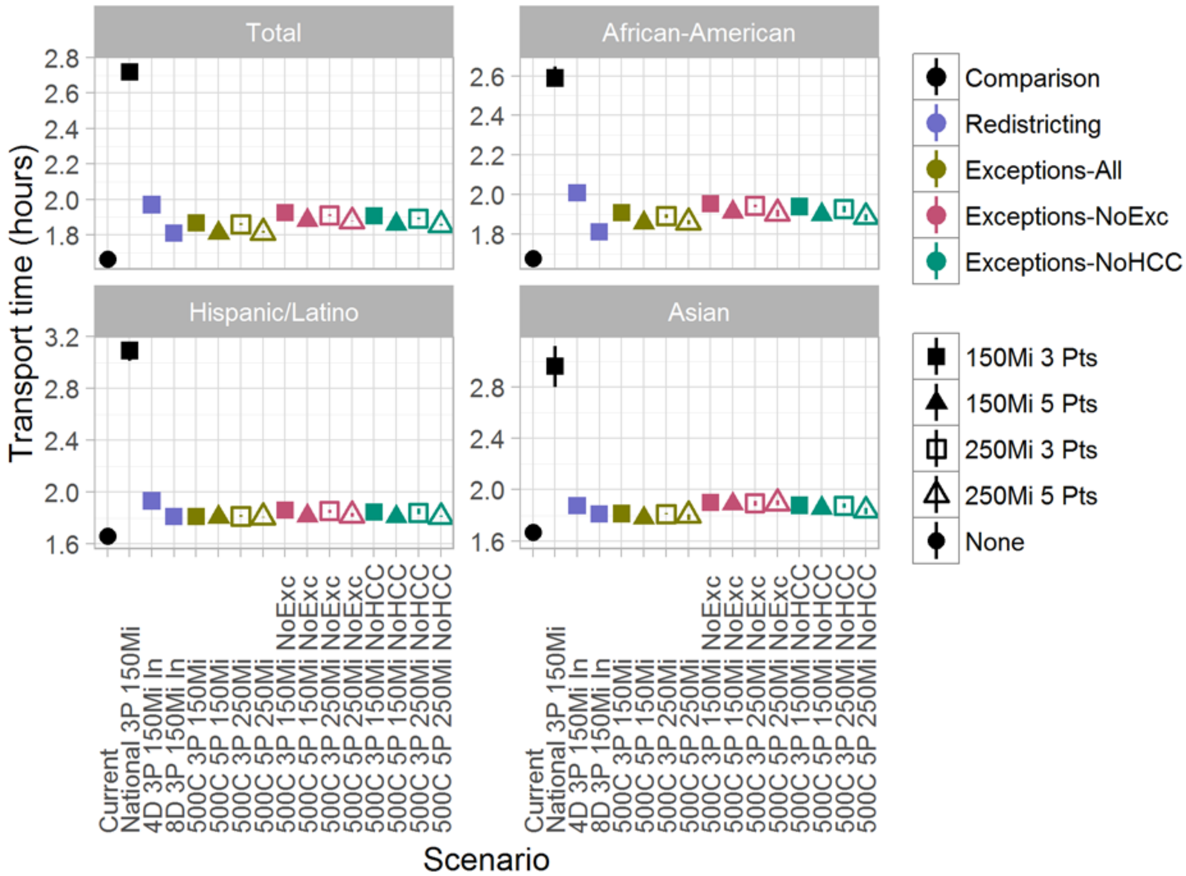


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Figure 47. Median transport distance (all transplants by pediatric status)

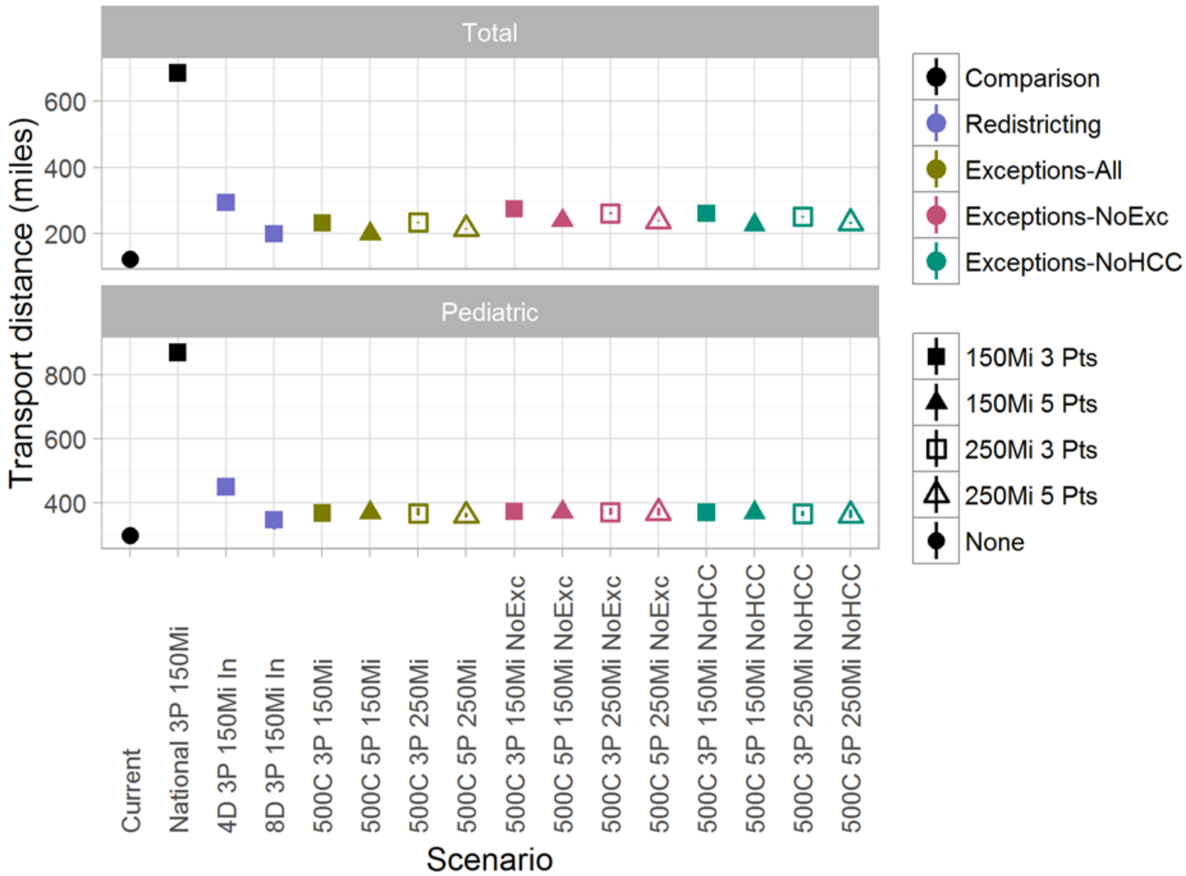

Figure 48. Median transport distance (all transplants by sex)

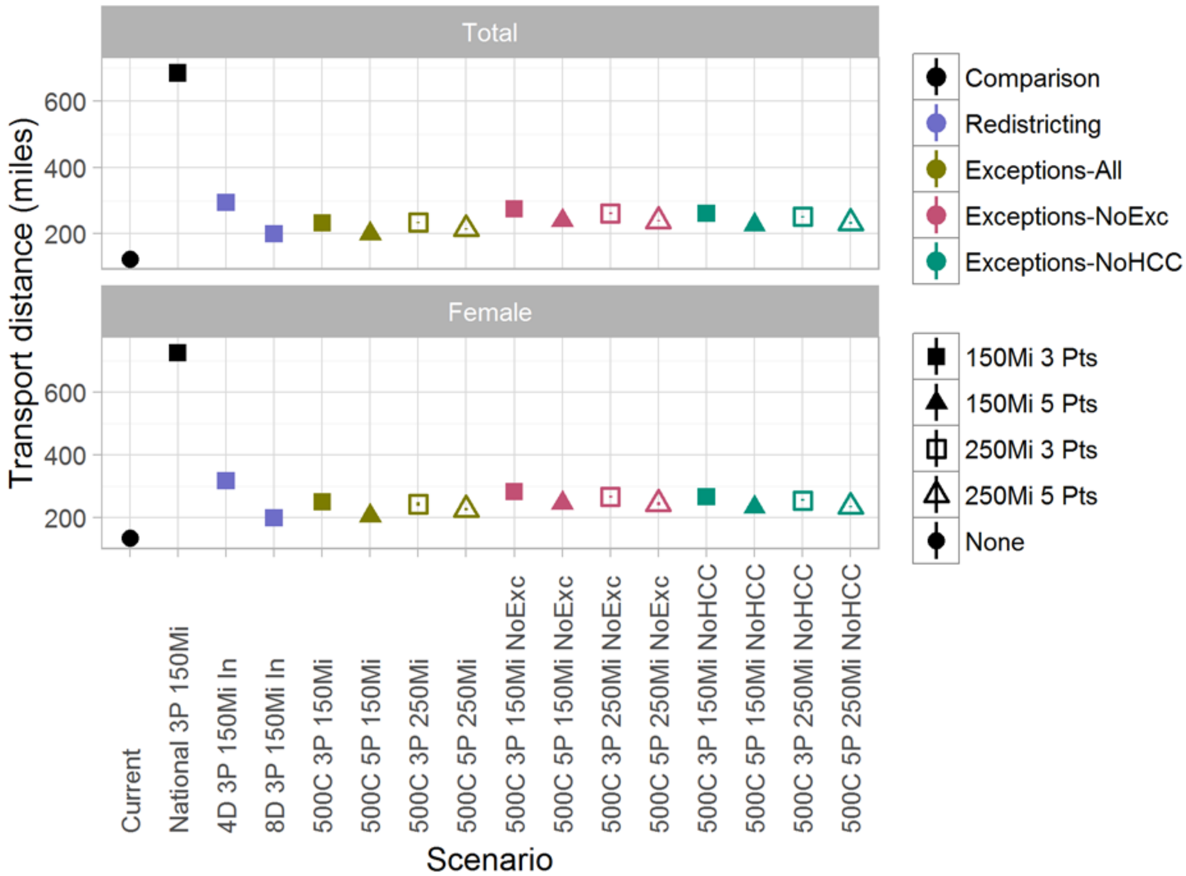

Figure 49. Median transport distance (all transplants by race/ethnicity)

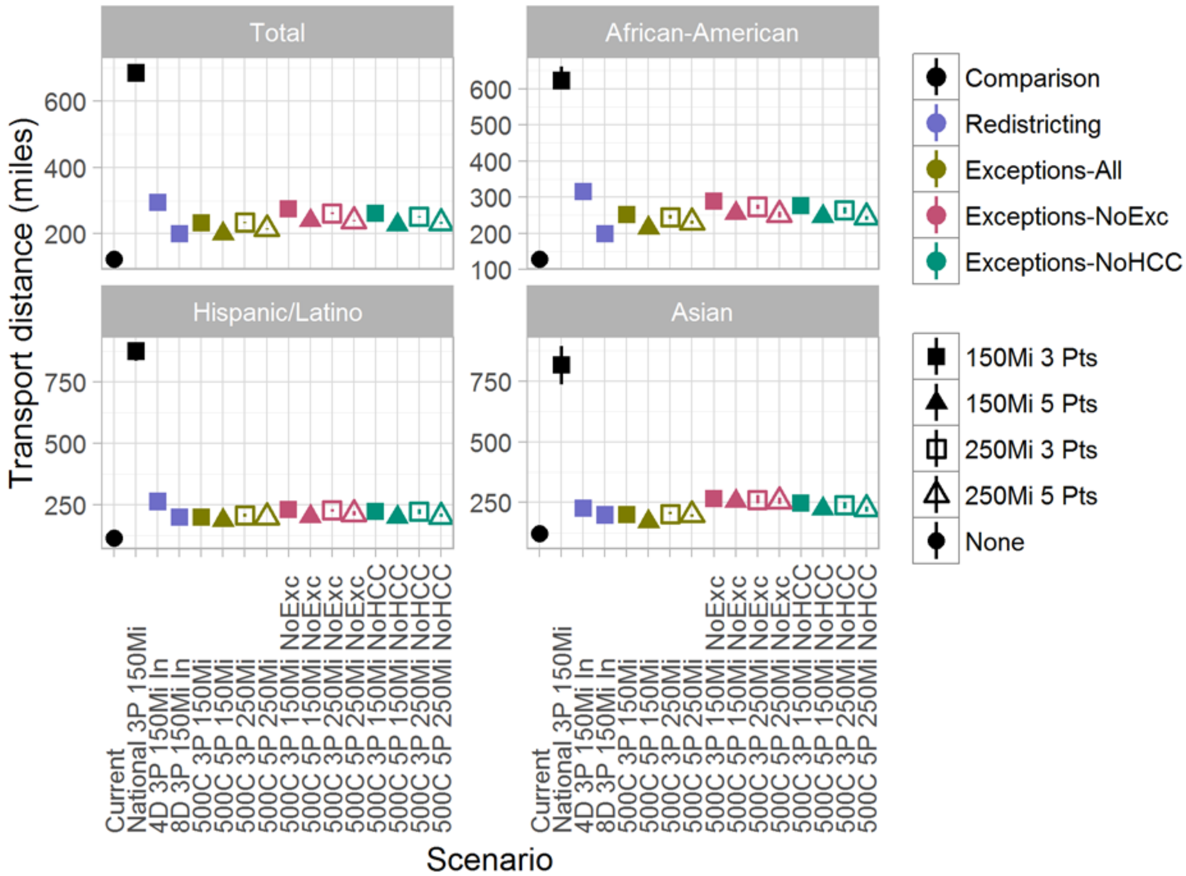

Figure 50. Percentage of organs flown (all transplants by pediatric status)

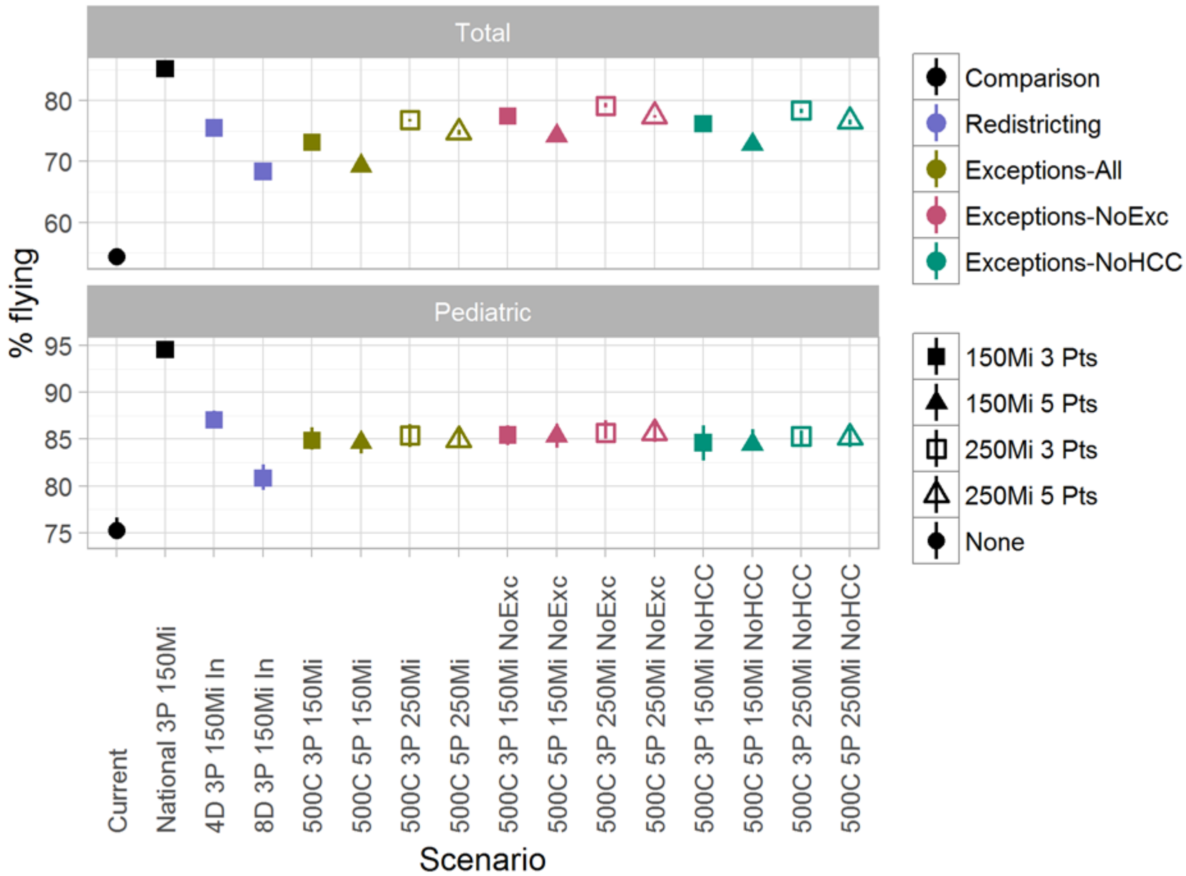

Figure 51. Percentage of organs flown (all transplants by sex)

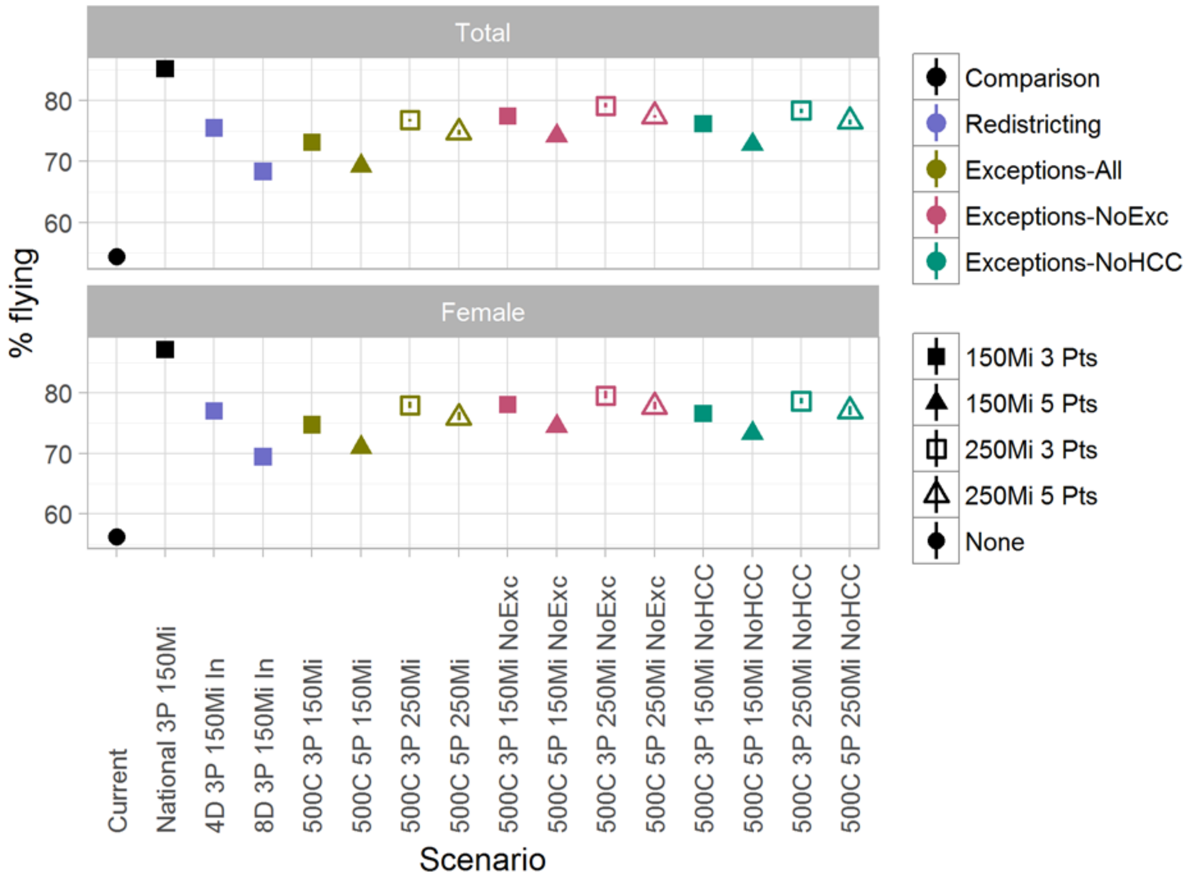

Figure 52. Percentage of organs flown (all transplants by race/ethnicity)