A Concentric-Neighborhoods Solution to Disparity in Liver Access that contains current UNOS Districts

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Abbreviations:

DSA- Donor Service Area

LSAM – Liver Simulated Allocation Model

MELD – Model for End-Stage Liver Disease

OPO – Organ Procurement Organization

OPTN - Organ Procurement and Transplant Network

UNOS - United Network for Organ Sharing

US – United States

Abstract

Background: Policymakers are deliberating reforms to reduce geographic disparity in liver allocation. Public comments and the UNOS Liver and Intestinal Committee have expressed interest in refining the neighborhoods approach. Share 35 and Share 15 policies affect geographic disparity.

Methods: We construct concentric neighborhoods superimposing the current 11 regions. Employing concepts from concentric circles, we construct neighborhoods for each DSA that consider all DSAs within 400, 500, or 600 miles as neighbors. We consider limiting each neighborhood to 10 DSAs and use no metrics for liver supplies and demands. We change MELD thresholds for the Share 15 policy to 18 or 20 and apply 3- and 5-point MELD proximity boosts to enhance local priority, control travel distances, and reduce disparity. We conduct simulations comparing current allocation with the neighborhoods and sharing policies.

Results: Concentric neighborhoods structures provide an array of solutions where simulation results indicate that they reduce geographic disparity, annual mortalities, and the airplane travel distances by varying degrees. Tuning of the parameters and policy combinations can lead to beneficial improvements with acceptable transplant volume loss and reductions in geographic disparity and travel distance. Particularly, the 10-DSA, 500-miles neighborhood solution with Share 35, Share 15, and 0-point MELD boost achieves such while limiting transplant volume losses to below 10%.

Conclusions: The current 11-districts can be adapted systematically by adding neighboring DSAs to improve geographic disparity, mortality, and airplane travel distance. Modifications to Share 35 and Share 15 policies result in further improvements. The solutions may be refined further for implementation.

Introduction

Addressing geographic disparities in access to liver transplantation has been a weighty predicament for policymakers in recent years[1]. Since liver transplant is the unique restorative therapy for irreversible and progressive liver failure[2,3], members of the transplantation community are understandably distressed that the current liver allocation system permits those with similar medical urgency in different parts of the US to experience varying transplant rates, waiting times, and mortality[4-6]. However, the provision of this therapy relies almost exclusively on scarce deceased-donor resources (about 95% of all liver transplants annually since 2014[7]), which are acquired through the generosity of organ donors and their families, the actions of donor hospitals and transplant centers, and the efforts of 58 organ procurement organizations (OPOs) across the country. Numerous publications describe the extent of disparity in access[4,5,8]. Notwithstanding an increase in the total number of organ donors, any liver redistribution policy must confront the dilemma between reducing geographic disparity in access through the reallocation of organs from regions of high supply relative to demand and mitigating reductions in local access to the resource for those sharing more, especially in rural and under-resourced parts of the country[9]. Moreover, since redistribution likely entails more non-local transportation of organs, the latter half of the dilemma includes controlling organ transport distances, availability of aircraft/crews, organ quality, and costs.

Responsible for the organ procurement and transplant network (OPTN) and for promoting organ donation, the United Network for Organ Sharing (UNOS) is keenly aware of these issues. The UNOS Liver and Intestinal Committee[10] has the unenviable task of resolving the aforementioned dilemma. In August 2016, they release as a public comment a proposal to redistrict the OPTN into 8 districts in order to promote a fairer distribution of transplanted organs[11-15]. The new proposal was polarizing[1] in the liver transplantation community with 8 of the 11 UNOS regions rejecting the proposal with nearly unanimous votes while 2 of 11 regions showed nearly unanimous voting in support of the proposal. Fervent denials arose from transplant centers, health-care professionals, and individuals from areas where transplant volumes were expected to decline and patient mortality to increase after redistricting[16]. Mehrotra et al.[17,18], numerous public comments[16], and recent meetings of the UNOS Liver and Intestinal Committee[1] held that additional modeling frameworks warranted consideration.

Besides the redistricting and concentric circles proposals, another framework considered for further development by the members of the committee[1] was optimized neighborhoods[19]. Possessing concepts from both

redistricting and concentric circles, the framework yielded an alternative design of the OPTN that would be more resilient to regional changes in demand and supply of deceased donor organs while also mitigating rising transport costs and reducing geographic disparity and annual mortalities. The work provided a demonstrative example of its conceptual promise but did not recommend a particular geographic structure or sharing policy for consideration. This article presents a specific, specialized neighborhoods construction, contributing to the systematic development towards a solution to a complex problem that has polarized the community. The presented design incorporates feedback from members of the transplantation community and many aspects of the public comments. However, further refinements will be needed with better quantification of the community's concerns, but they can be made within the framework of concentric neighborhoods presented here. Below, we summarize liver allocation; briefly recapitulate neighborhoods concepts; describe refinements of the neighborhood concept that define concentric neighborhoods; and review the performance of concentric neighborhoods under different sharing policies using simulation.

Summary of Liver Allocation

The current geographic structure for the OPTN divides the US into 58 Donor Service Areas (DSAs), which are grouped into 11 UNOS regions. Each DSA has a designated OPO that facilitates local procurement and allocation procedures. Allocation of deceased-donor livers is based upon a three-tier geographic system — local/regional/national (local refers to the DSA of the procuring OPO) [20]. Coupled with the geographic structure, the OPTN follows specific allocation rules or sharing policies that mainly prioritize which candidates are offered an organ for transplant. These sharing policies and their accompanying rationale are detailed in Elwir and Lake[21,22] and Trotter[22].

Patients are prioritized by their Model for End-stage Liver Disease (MELD) scores. MELD scores (ranging from 6-40 points) are predictors of 3-month mortality without liver transplantation and presumably indicate medical urgency[23-26] based on lab values (INR, bilirubin, creatinine, and sodium[27-29]). Within the allocation framework, more than one-third of candidates receive additional points called exception points because their original MELD scores may not accurately reflect their mortality risk. Exception points are given to patients diagnosed with hepatocellular carcinoma (HCC) or hepatopulmonary syndrome along with other uncommon indications[30,31]. Collectively, liver allocation to potential recipients proceeds roughly as follows: (1) Status 1 candidates regionally; (2) regional candidates with the highest MELD scores $\geq$ 35 with local priority if the top 2

candidates share the same MELD score but only one is in the allocating OPO [Share 35 policy]; (3) local candidates with MELD scores 15-34 in the same DSA as the procuring OPO; (4) regional candidates with MELD scores 15-34 in the same UNOS region as the procuring OPO; (5) national candidates with Status 1 and then MELD scores 15-40; (6) local candidates, followed by regional candidates, and lastly national candidates with MELD scores less than 15. The threshold MELD score of 15 used in these sharing policies is known as the Share 15 policy.

Explanation of an OPO's Concentric Neighborhood

A concentric neighborhood is a special type of neighborhood[19]. The center of a concentric neighborhood is the OPO where an organ is procured. A concentric neighborhood is constructed by adding OPOs/DSAs around the procuring OPO in a circular fashion until it meets the maximum distance, minimum population, or maximum number of neighboring DSAs. Geographic proximity is imposed to reduce travel distance and address concerns regarding local prioritization. The procuring OPO and the surrounding OPOs that define the concentric neighborhood acts as the region in the current local-regional-national allocation system — that is, allocation proceeds as before with the exception that the OPOs and DSAs involved in this "regional allocation" are defined by the procuring OPO. Different relational requirements among the OPOs in a neighborhood can be incorporated using a general framework that yields several alternative designs for the OPTN. However, concentric neighborhoods are of particular interest because they allow OPOs to maintain relationships with nearby OPOs and transplant centers and they might possess other benefits, such as communication efficiencies, that may not be easily quantifiable.

Materials and Methods

Development of the Concentric Neighborhoods Structure:

The UNOS Liver and Intestinal Committee requested the first author to provide neighborhoods satisfying the following constraints:

1. Each DSA's neighborhood has a minimum population of 12 million.
2. Each neighborhood should be contiguous and avoid holes (i.e. each neighborhood ought to be as convex as possible).
3. The average organ transport time for each neighborhood should be less than or equal to 3 hours. Observed average transport times may be less when sharing policies are applied.

Other public comments[16] and notes from the UNOS Liver and Intestinal Committee[1] were further incorporated. The public comments and notes reveal an apprehension for enacting sweeping structural changes to the OPTN. Unfortunately, redistricting[11] or the demonstrative example of optimized neighborhoods provided by Kilambi and Mehrotra[19] disrupt the existing regional relationships among OPOs and transplant centers.

After conversations with several members of the liver transplantation community, we imposed the additional requirement on the neighborhoods solution:

4. Every neighborhood of an OPO contains the OPO itself and the DSAs in its current UNOS Region. For example, the DSA for Oregon is currently in UNOS Region 6 with the DSA serving Washington, Idaho, Alaska, and Montana. This particular solution has the feature that the neighborhood for Oregon includes these DSAs in addition to other nearby DSAs (e.g. Northern California in region 5).

By ensuring that each neighborhood of an OPO contains its original UNOS region, all OPOs and transplant centers that work together in the current system for regional allocation may continue working together in the future albeit with some new relationships. This requirement is included more so for facilitating implementation of a solution and it should not be construed that honoring extant OPO boundaries is in itself optimal.

Since the public comments also raised concerns about organ supply and demand estimates used in the design of any “optimized” system, we combined the concept of neighborhoods with the concept of concentric circles. Concentric circles use constant radii that do not rely on estimates for organ supply and demand. Given the expressed concerns regarding organ transport times in the public comments[16] and the notes of the UNOS Liver and Intestinal Committee[1], we introduced the following two versions of the proposed concentric neighborhoods structure:

5a. An OPO is allowed to have as many neighbors as possible. If an OPO’s physical address is within r (r = 400, 500, or 600) miles of a procuring OPO, then the former will be in the latter’s neighborhood and vice versa.

5b. An OPO is allowed to have at most n (n=10) neighbors, including itself and the OPOs of the same UNOS region. If an OPO’s physical address is within r (r = 400, 500, or 600) miles of a procuring OPO, then the former will be in the latter’s neighborhood as long as it does not exceed the limit.

We hereafter refer to 5a and 5b as unconstrained concentric neighborhoods and constrained concentric neighborhoods respectively.

Possible values for *r* that we selected are 400, 500, or 600 miles. These values represent the flight distances for a standard jet used in procurement with a flight time less than 2 hours. For example, the direct distance between the LifeNet Health OPO serving Virginia in Virginia Beach, VA, and the Gift of Life Donor OPO serving Eastern Pennsylvania in Philadelphia, PA, is approximately 250 miles. Thus, Eastern Pennsylvania will be a potential neighbor of Virginia and Virginia will be a potential neighbor of Eastern Pennsylvania.

We used $n = 10$ since it is the maximum number of DSAs across the current UNOS regions. When implementing the constrained concentric neighborhoods, if an OPO has more than 10 potential neighbor OPOs, the neighbors are added to the OPO's neighborhood in the following order until the limit is met: (1) the OPO itself, (2) OPOs of the same UNOS region, and (3) closest OPOs outside the UNOS region by OPO-OPO direct distances. Figure 1 provides an example of both the unconstrained and constrained concentric neighborhoods for the Eastern Pennsylvania OPO using a radius of 500 miles.

By including nearby OPOs in the neighborhood, the procuring OPO may allocate organs to nearer candidates with higher MELD scores than to farther candidates with lower MELD scores during regional allocation. OPOs usually have their geographically immediate neighbors in their neighborhood. This property helps produce contiguous neighborhoods (i.e. no holes).

The structural properties of the concentric neighborhoods solution are summarized in Table 1. It is important to note that unlike the earlier optimized neighborhoods[19], these particular concentric neighborhoods are fully described by the requirements that OPOs within a specified radii are connected as in concentric circles and that each OPO's neighborhood contains its original UNOS region. Therefore, there is no optimization employed nor does any particular solution herein allude to any metric for organ supply and demand. Moreover, for assessing geographic disparity, we follow the recent literature and consider equalizing average/median MELD at transplant across DSAs and reducing its standard deviation[13].

Two further changes are investigated within the concentric neighborhoods design obtained from the imposed requirements above. The first is to grant a 3- or 5-point proximity boost to MELD scores for patients listed in the OPO where the organ is procured. The reasons are as follows: (1) avoiding unnecessary travel; (2) providing a buffer for possible differences in increased mortality arising from lower access to transplant in less populated areas; and (3) maintaining the viability of low-volume transplant centers. The need to address these

issues were raised in the public comments[16]. The second change is to increase the threshold in the Share 15 policy to a higher value. Since patients with lower MELD scores are expected to have longer survival times, geographic equity may be better served by directing organs to non-local candidates with greater MELD scores. Simulation results show that the aforementioned conferral of proximity boosts to local candidates counterbalances the negative effects of changing the Share 15 threshold value, such as increased organ travel time by airplanes.

Sharing Policies:

We simulated the concentric neighborhoods with several variations of the sharing and boosting policies and the 8-district redistricting[11,13] policy with the same variations. We used the current system (i.e. 11-districts with Share 35/Share 15 policies and no proximity boosts) as a baseline to evaluate the performance of the concentric neighborhoods. Specifically, for the Share 35 policy, we consider the current value 35 and another value 29, which is being considered by UNOS at the time of writing[32]. For the Share 15 and boosting policies, we consider changing the threshold to 18 and 20 with 3- and 5-point boosts respectively to counterbalance increased travel with local priority. To assess the effects on geographic disparity of only changing the sharing policies for the current system, we conducted simulations of the current geographic structure (11 districts/regions) with different values of the thresholds for Share 35 and Share 15 and of the proximity boosts.

The different combinations of the sharing policies and proximity boosts are listed in Table 2a. Each combination is simulated on the 8-district map and the concentric neighborhoods maps (r = 400, 500, 600 miles) with and without the constraint of 10 DSAs per neighborhood. The policies are organized into policy sets (I-VII) based on the sharing policy thresholds and the magnitudes of the boosts. Table 2b lists the combinations of the policy sets and geographic structures tested.

Simulating Neighborhoods Solutions:

As previously described[19], the Liver Simulated Allocation Model (LSAM v Aug 2014) [33] cannot accommodate neighborhoods. We therefore tested the performance of the proposed concentric neighborhoods solution (relative to the current system) using an open-source discrete event simulator LivSim. More information about LivSim is discussed in our previous work and the LivSim User Guide[19,34]. The software source code and the manual are accessible from https://github.com/LivSim2017/LivSim-Codes.

The current version of LivSim uses the same acceptance model as LSAM along with inactive waitlist candidates, relists, and re-transplants. Our simulation experiment is similar to that of the previous publication[19]

and utilizes the same input data. Specifically, we used input data on patient listing, MELD progression, and organ donors from the LSAM Candidate Generator and the LSAM Donor Generator (v Aug 2014). The run-length was 5-years (Jan 2010 – Dec 2014) with 5 replications (25 replication-years). We incorporated MELD-Na (i.e. MELD with sodium) and HCC exceptions including the cap-and-delay policy[35]. We assumed no exceptions (i.e. used lab MELD scores with sodium) for non-HCC candidates. Therefore, the MELD scores used in the simulation are adjusted for sodium and roughly correspond to using lab MELD scores for everyone except HCC patients (whose allocation MELD follows a predictable schedule).

We focus our results on overall system performance rather than on specific patient groups. The simulation measures disparity by standard deviation of DSA mean transplant MELD across DSAs and other important statistics related to mortalities and organ transport. To compare the performance between a policy and the current system, we compute the difference for each statistic. Significance of the differences in waitlist removals, waitlist deaths, and mean and median MELD statistics were assessed using two-tailed t-tests with 24 degrees of freedom for the 25 replication-years. Differences in the average of standard deviations of mean and median DSA-MELD at transplant across replication-years were also evaluated by two-tailed t-tests with 24 degrees of freedom. Annualized total deaths were computed as the sum of the four average death statistics. Its difference cannot be assessed by two-tailed t-tests due to different number of observations between the death statistics, so p-values are not provided. We compute percentage changes in each DSA's transplant volume relative to its volume under the current system.

Results

The supplementary digital content includes sets of figures depicting the maps of the 58 DSAs and their corresponding unconstrained and constrained concentric neighborhoods with radii of 400, 500, and 600 miles for each OPO. Due to the numerous results, we focus on the specific summaries provided by Table 3 and Figure 2. Complete results for each policy set and geographic structure combination are shown in Tables 4-10 and Figures 3-8.

Table 3 presents results for the Share 29 and Share 35 policies for 8-district redistricting and the 500-miles concentric neighborhoods (unconstrained and constrained) relative to the current system without proximity boosts. Figure 2 depicts the distributions of average MELD at transplant and percentage changes in transplant volume across DSAs for each of these interventions.

Whether current sharing policies remain or the Share 35 threshold changes to 29, 8-district redistricting reduces annual mortalities, geographic disparity, and average transport time by airplane. It also yields a maximum loss in transplant volume for any DSA of approximately 25% relative to current transplant volume. Depending on the sharing policy, concentric neighborhoods may or may not further reduce geographic disparity, annual mortality, and average transport time relative to redistricting – but in all cases shown in Table 3, make significant improvements in these areas relative to the current system. Maximum loss of transplant volumes by DSAs is limited to approximately 9-22% of current volume. Constraints on the number of DSAs in the neighborhood deter some of these benefits, but lead to smaller losses of transplant volumes. Particularly, 500-mile constrained neighborhoods with current sharing policies limited the losses to less than 10%. Increasing the Share 15 threshold to 20 and including 5-point boost reduces geographic disparity even more, but as a result, maximum losses in transplant volumes also increase.

Table 4b also shows that maintaining Share 35 and the current 11 districts, but increasing the Share 15 threshold to either 18 or 20 leads to reductions in geographic disparity and also annual mortality if proximity boosts are not included. Transport times will increase as a result however.

Tables 4a-10a give the raw figures for the remaining combinations of policy sets and geographic structures listed in Table 2b. Tables 4b-10b present the differences of the corresponding totals relative to the current system. Figures 3-5 show the distribution of average MELD at transplant across DSAs for all of the interventions. Figures 6-8 depict the percentage changes in DSA transplant volume for each intervention.

Discussion

With the feature that each OPO continues to work with its current regional partners and some nearby OPOs, a concentric neighborhoods solution serves to transplant the sickest candidates quickly, reduces geographic disparity in access to liver transplant, and decreases annual mortalities regardless of the adjunct sharing policy tested. Allowing current transplant centers and OPOs to continue working with those with whom they have existing relationships is expected to facilitate actual implementation. The essence of concentric circles also appears in the solution –- as the neighborhoods' maps show that each OPO can share with several surrounding DSAs to extend supply. Despite the increased geographic size of a neighborhood for several DSAs, airplane travel distance decreases for many of the concentric neighborhoods solutions. For a given sharing policy, using larger radii for the concentric neighborhoods further reduced geographic disparity. It is important to

reemphasize that unlike the redistricting proposal[11], concentric neighborhoods were not obtained with reference to a mathematical model that optimized deviations in organ demand and supply rates. The advantage of this position is that it avoids addressing contentious issues such as how to measure the need for organs at each DSA.

The sharing policy choice reflects a balance between equity in access and resource utility. Raising the Share 15 threshold may significantly reduce total mortalities and geographic disparity regardless of the geographic structure employed – even if neither redistricting nor neighborhoods are implemented. Consequently, the policy change induces a larger percentage of organs traveling by airplane and possibly longer travel distances and times. The inclusion of proximity boosts aims to address these travel issues. Including the boost points when increasing the Share 15's threshold attenuates the negative impact of broader sharing upon disadvantaged parts of the country where the population is medically underserved and potentially faces increased mortality when the local supply of organs is diminished. We strove to find a solution whose observed performance reduced disparity and mortality without significantly increasing logistic burden. Moreover, the geographic structure obtained (i.e. the membership relations for each neighborhood) is itself agnostic to how MELD scores are used. The impact of MELD scores and sharing policies, and thereby the observed performance of the entire intervention (i.e. geographic structure + sharing policy changes), are reflected in the simulation results and subject to the limitations thereof.

Losses in transplant volumes were of interest and concern in public comments[16]. When a fixed resource is rationed, shifts in allocation result in net-gainers and net-losers. The unconstrained concentric neighborhoods with Share 35/Share 20 policy and 5-point proximity boost shows losses in transplant volumes for any DSA up to 20% of its current volume from among the DSAs who will become the net supplier. The validity of this prediction depends on current organ acceptance behaviors persisting. A significant loss in transplant volume may not be acceptable for transplant centers in certain DSA for several reasons, such as financial viability or access to transplants for the patients. However, the authors suggest that if an *a priori* cap on the losses is specified, refinements can be made to the concentric neighborhoods and the sharing policy presented here in order to reduce disparity while maintaining transplant volume losses within a specified range. Limiting the number of DSAs in the neighborhood may ameliorate this; in particular, the 500-mile constrained concentric neighborhoods limited maximum losses in transplant volume to less than 10% of current volume. Simulation results show that

as we increase the radius *r* (from 400 to 600 miles), the solutions can attain greater reduction in geographic disparity but at the cost of increased airplane travel distances.

Two additional contentious issues warrant additional comments. The first of these is how to *expressly* reward or penalize OPOs for their performances. A major assumption in the simulation is that the organ procurement and placement performance of high-performing OPOs will not deteriorate due to sharing with additional partners. The quantitative modeling of this issue is desirable. Since the concentric neighborhoods design presented herein only adds OPOs to the current 11-districts, it does not change any existing relationships among OPOs but only augments them. Additionally, with additional, proximal neighbors, a high-performing OPO may find it easier to disseminate its best practices for organ procurement. The second contentious issue is the use of allocation MELD at transplant as a metric for evaluating disparity. Alternative metrics are being developed by the liver transplant community, and the baseline solution presented here may be further refined with respect to these metrics.

We presented the specific combinations of Share 18/3-point boost and Share 20/5-point boost because they yield symmetric changes to the sharing policies and have reduced geographic disparity compared to the current system in the simulations. Different combinations of the boosts and thresholds may be tested. Specific "boosts" might be created for each DSA or for specific ranges of MELD scores when further considering this neighborhoods approach in the future. Ultimately, the choice of radius in the concentric neighborhoods, the appropriate value for the Share 15 threshold, and the magnitude of the proximity boosts all reflect a delicate balancing act.

The principal contributions of this article are that reducing the number of deaths, geographic disparity, and transport distance by airplanes with slight organ volume losses are possible without dismantling the current 11-UNOS regions but by augmenting them using the concept of concentric neighborhoods and/or by adjusting the Share 15 policy.

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Tables

Table 1: Structural Properties of Concentric Neighborhood Solutions[1]

• ***Maintains existing regional relationships:*** DSAs have their current UNOS region inside their neighborhood
• ***Nearby and Immediate Neighbors*****:** DSAs have all DSAs with OPO locations that are within *r* (*r*=400,500, or 600) miles in their neighborhood. DSAs usually have their geographically immediate neighbors in their neighborhood.
• ***Population:*** Each DSA's neighborhood has a minimum population of 12 million
• ***Contiguity:*** Each DSA's neighborhood is geographically contiguous
• ***Compactness:*** The average transport time for a DSA's neighborhood is within 3 hours
• ***Transplant Centers:*** Each DSA's neighborhood has at least 8 transplant centers[2]

[1] Hawaii and Puerto Rico were not included in the model. Their neighborhoods were defined as their current UNOS region. Neighborhoods do not refer directly to an optimization model.

[2] With exception for LifeCenter Northwest OPO (WALC) whose neighborhood contains 5 transplant centers.

Table 2a: List of Sharing Policy Combinations (Policy Sets) Simulated

Policy Sets			
Baseline	**Current System (Share 35/Share 15)**	(IV)	**Share 29/Share 20/5-Point Boost**
(I)	**11 Districts with Modified Sharing and Boost Policies**	(V)	**Share 35/Share 15/0-Point Boost**
(II)	**Share 29/Share15/0-Point Boost**	(VI)	**Share 35/Share 18/3-Point Boost**
(III)	**Share 29/Share 18/3-Point Boost**	(VII)	**Share 35/Share 20/5-Point Boost**

Table 2b: List of Policy Sets and Geographic Structure Combinations Simulated

Policy Sets and Geographic Structures Simulated					
	Current System (Share 35/Share 15)		(IV)	**Share 29/Share 20/5-Point Boost**	
	(i)	Share 35/Share 15 with 0 point boost and 11 districts		(xx)	Share 29/Share 20 with 5 point boost and 8 districts
				(xxi)	Share 29/Share 20 with 5 point boost and 400-mile Nbhd. (U)
				(xxii)	Share 29/Share 20 with 5 point boost and 400-mile Nbhd. (C)
				(xxiii)	Share 29/Share 20 with 5 point boost and 500-mile Nbhd. (U)
				(xxiv)	Share 29/Share 20 with 5 point boost and 500-mile Nbhd. (C)
				(xxv)	Share 29/Share 20 with 5 point boost and 600-mile Nbhd. (U)
				(xxvi)	Share 29/Share 20 with 5 point boost and 600-mile Nbhd. (C)
(I)	**11 Districts with Modified Sharing and Boost Policies**		(V)	**Share 35/Share 15/0-Point Boost**	
	(ii)	Share 35/Share 18 with 0 point boost and 11 districts		(xxvii)	Share 35/Share 15 with 0 point boost and 8 districts
	(iii)	Share 35/Share 20 with 0 point boost and 11 districts		(xxviii)	Share 35/Share 15 with 0 point boost and 400-mile Nbhd. (U)
	(iv)	Share 35/Share 18 with 3 point boost and 11 districts		(xxix)	Share 35/Share 15 with 0 point boost and 400-mile Nbhd. (C)
	(v)	Share 35/Share 20 with 5 point boost and 11 districts		(xxx)	Share 35/Share 15 with 0 point boost and 500-mile Nbhd. (U)
				(xxxi)	Share 35/Share 15 with 0 point boost and 500-mile Nbhd. (C)
				(xxxii)	Share 35/Share 15 with 0 point boost and 600-mile Nbhd. (U)
				(xxxiii)	Share 35/Share 15 with 0 point boost and 600-mile Nbhd. (C)
(II)	**Share 29/Share15/0-Point Boost**		(VI)	**Share 35/Share 18/3-Point Boost**	
	(vi)	Share 29/Share 15 with 0 point boost and 8 districts		(xxxiv)	Share 35/Share 18 with 3 point boost and 8 districts
	(vii)	Share 29/Share 15 with 0 point boost and 400-mile Nbhd. (U)		(xxxv)	Share 35/Share 18 with 3 point boost and 400-mile Nbhd. (U)
	(viii)	Share 29/Share 15 with 0 point boost and 400-mile Nbhd. (C)		(xxxvi)	Share 35/Share 18 with 3 point boost and 400-mile Nbhd. (C)
	(ix)	Share 29/Share 15 with 0 point boost and 500-mile Nbhd. (U)		(xxxvii)	Share 35/Share 18 with 3 point boost and 500-mile Nbhd. (U)
	(x)	Share 29/Share 15 with 0 point boost and 500-mile Nbhd. (C)		(xxxviii)	Share 35/Share 18 with 3 point boost and 500-mile Nbhd. (C)
	(xi)	Share 29/Share 15 with 0 point boost and 600-mile Nbhd. (U)		(xxxix)	Share 35/Share 18 with 3 point boost and 600-mile Nbhd. (U)
	(xii)	Share 29/Share 15 with 0 point boost and 600-mile Nbhd. (C)		(xl)	Share 35/Share 18 with 3 point boost and 600-mile Nbhd. (C)
(III)	**Share 29/Share 18/3-Point Boost**		(VII)	**Share 35/Share 20/5-Point Boost**	
	(xiii)	Share 29/Share 18 with 3 point boost and 8 districts		(xli)	Share 35/Share 20 with 5 point boost and 8 districts
	(xiv)	Share 29/Share 18 with 3 point boost and 400-mile Nbhd. (U)		(xlii)	Share 35/Share 20 with 5 point boost and 400-mile Nbhd. (U)
	(xv)	Share 29/Share 18 with 3 point boost and 400-mile Nbhd. (C)		(xliii)	Share 35/Share 20 with 5 point boost and 400-mile Nbhd. (C)
	(xvi)	Share 29/Share 18 with 3 point boost and 500-mile Nbhd. (U)		(xliv)	Share 35/Share 20 with 5 point boost and 500-mile Nbhd. (U)
	(xvii)	Share 29/Share 18 with 3 point boost and 500-mile Nbhd. (C)		(xlv)	Share 35/Share 20 with 5 point boost and 500-mile Nbhd. (C)
	(xviii)	Share 29/Share 18 with 3 point boost and 600-mile Nbhd. (U)		(xlvi)	Share 35/Share 20 with 5 point boost and 600-mile Nbhd. (U)
	(xix)	Share 29/Share 18 with 3 point boost and 600-mile Nbhd. (C)		(xlvii)	Share 35/Share 20 with 5 point boost and 600-mile Nbhd. (C)

[1]Unconstrained concentric neighborhood is abbreviated as Nbhd. (U).
[2]Constrained concentric neighborhood is abbreviated as Nbhd. (C).

Table 3: 5-Year Performances of Selected Policies Based on Organ Volume Loss, Relative to the Current System

Policies	Maximum Organ Volume Loss Relative to Current System	Annualized Total Deaths	DSA Median Transplant MELD	DSA Median Transplant MELD Std.	Avg. Airplane Transport Time (hr.)	Percentage of Organs Transported by Airplane
(vi) Share29/Share15 0-Point Boost 8 district	-25.53%	-27.04	+1.44 (p<0.001)	-0.51 (p<0.001)	-0.04 (p<0.001)	+7.63% (p<0.001)
(x) Share 29/Share 15 0-Point Boost 500-mi. Nbhd. (C)	-19.03%	-34.6	+1.13 (p<0.001)	-0.08 (0.071)	-0.11 (p<0.001)	+9.08% (p<0.001)
(ix) Share 29/Share 15 0-Point Boost 500-mi. Nbhd. (U)	-20.12%	-53.04	+1.79 (p<0.001)	-0.36 (p<0.001)	-0.15 (p<0.001)	+12.11% (p<0.001)
(xxiii) Share 29/Share 20 5-Point Boost 500-mi. Nbhd. (U)	-21.99%	-42.32	+2.02 (p<0.001)	-0.77 (p<0.001)	-0.06 (p<0.001)	+7.02% (p<0.001)
(xxvii) Share35/Share15 0-Point Boost 8 district	-27.39%	-5.28	+0.49 (p<0.001)	-0.30 (p<0.001)	-0.06 (p<0.001)	+0.24% (0.072)
(xxxi) Share 35/Share 15 0-Point Boost 500-mi. Nbhd. (C)	-9.88%	-18.08	+0.34 (p<0.001)	-0.11 (0.035)	-0.08 (p<0.001)	+1.82% (p<0.001)
(xxx) Share 35/Share 15 0-Point Boost 500-mi. Nbhd. (U)	-16.31%	-28.68	+0.66 (p<0.001)	-0.21 (p<0.001)	-0.14 (p<0.001)	+3.32% (p<0.001)
(xliv) Share 35/Share 20 5-Point Boost 500-mi. Nbhd. (U)	-18.24%	-27.84	+1.01 (p<0.001)	-0.37 (p<0.001)	-0.05 (p<0.001)	+1.81% (p<0.001)

Table 4a: 5-Year Performances of Current System and 11 Districts with Modified Sharing and Boost Policies (Table 2a: Policy Set I)

Category	Current System (Share 15, Share 35) (i)	Share35, Share18, 11 district, Local MELD Boost+0 (ii)	Share35, Share20, 11 district, Local MELD Boost+0 (iii)	Share35, Share18, 11 district, Local MELD Boost+3 (iv)	Share35, Share20, 11 district, Local MELD Boost+5 (v)
Annualized Waitlist Removals	3128.60	3078.16	3044.2	3114.68	3113.32
Annualized Total Deaths	2243.28	2218.36	2208.76	2249.52	2247.96
Annualized Waitlist Deaths	1173.68	1127.2	1093.56	1165.16	1159.4
Annualized Waitlist Relist Deaths	23.92	23.8	23.56	23.92	23.6
Annualized Post Tx Deaths	996.12	1016.4	1038.92	1009	1014.36
Annualized Post Re-Tx Deaths	49.56	50.96	52.72	51.44	50.6
DSA Mean Transplant MELD	23.09	24.03	24.66	23.34	23.41
DSA Mean Transplant MELD Std.	1.88	1.48	1.35	1.78	1.76
DSA Median Transplant MELD	24.48	25.67	26.53	24.83	25.09
DSA Median Transplant MELD Std.	2.84	2.06	1.55	2.65	2.59
Avg. Organ Transport Distance (mi.)					
Ground Vehicle	33.34	33.77	34.20	33.01	32.62
Helicopter	100.99	99.31	100.36	102.12	101.22
Airplane	525.87	612.02	693.51	563.24	589.92
Avg. Organ Transport Time (hr.)					
Ground Vehicle	0.78	0.79	0.80	0.78	0.77
Helicopter	1.22	1.21	1.22	1.23	1.22
Airplane	2.48	2.65	2.80	2.55	2.60
Percentage of Organs Transported					
Ground Vehicle	46.94%	40.04%	33.92%	47.81%	48.41%
Helicopter	0.68%	0.57%	0.41%	0.75%	0.75%
Airplane	52.23%	59.24%	65.53%	51.30%	50.70%

Table 4b: 5-Year Comparative Performance between Current System and 11 Districts with Modified Sharing and Boost Policies (Table 2a: Policy Set I)

Category	Current System (Share 15, Share 35) (i)	Share35, Share18, 11 district, Local MELD Boost+0 (ii)	Share35, Share20, 11 district, Local MELD Boost+0 (iii)	Share35, Share18, 11 district, Local MELD Boost+3 (iv)	Share35, Share20, 11 district, Local MELD Boost+5 (v)
Annualized Waitlist Removals	---	-50.44	-84.4	-13.92	-15.28
Annualized Total Deaths	---	-24.92	-34.52	6.24	4.68
Annualized Waitlist Deaths	---	-46.48	-80.12*	-8.52	-14.28
Annualized Waitlist Relist Deaths	---	-0.12	-0.36	0	-0.32
Annualized Post Tx Deaths	---	+20.28*	+42.8*	+12.88*	+18.24*
Annualized Post Re-Tx Deaths	---	+1.4	+3.16*	+1.88*	+1.04
DSA Mean Transplant MELD	---	+0.94*	+1.57*	+0.26*	+0.32*
DSA Mean Transplant MELD Std.	---	-0.40*	-0.53*	-0.11	-0.12*
DSA Median Transplant MELD	---	+1.19*	+2.04*	+0.35*	+0.61*
DSA Median Transplant MELD Std.	---	-0.78*	-1.29*	-0.19*	-0.26*
Avg. Organ Transport Distance (mi.)	---				
Ground Vehicle	---	+0.43*	+0.86*	-0.33	-0.72*
Helicopter	---	-1.67	-0.63	+1.14	+0.23
Airplane	---	+86.15*	+167.64*	+37.37*	+64.05*
Avg. Organ Transport Time (hr.)	---				
Ground Vehicle	---	+0.01*	+0.02*	-0.01	-0.01*
Helicopter	---	-0.01	0	+0.01	0
Airplane	---	+0.17*	+0.33*	+0.07*	+0.12*
Percentage of Organs Transported	---				
Ground Vehicle	---	-6.90%*	-13.02%*	+0.87%*	+1.46%*
Helicopter	---	-0.12%*	-0.27%*	+0.06%*	+0.07%*
Airplane	---	+7.02%*	+13.30%*	-0.93%*	-1.52%*

*This indicates that difference has p-value less than 0.05 ($p < 0.05$).

Table 5a: 5-Year Performances of Current System and Share 29/Share 15/0-Point Boost Policy (Table 2a: Policy Set II)

Category	Current System (Share 15, Share 35) (i)	Share29, Share15, 8 district, Boost+0 (vi)	Share29, Share15, 400 mi. Nbhd. (U) Boost+0 (vii)	Share29, Share15, 400 mi. Nbhd. (C) Boost+0 (viii)	Share29, Share15, 500 mi. Nbhd. (U) Boost+0 (ix)	Share29, Share15, 500 mi. Nbhd. (C) Boost+0 (x)	Share29, Share15, 600 mi. Nbhd. (U), Boost+0 (xi)	Share29, Share15, 600 mi. Nbhd. (C), Boost+0 (xii)
Annualized Waitlist Removals	3128.60	3086.52	3101.84	3100.76	3077.48	3093.48	3062.20	3091.84
Annualized Total Deaths	2243.28	2216.24	2220.32	2215.56	2190.24	2208.68	2173.76	2215.2
Annualized Waitlist Deaths	1173.68	1128.04	1150.28	1138.88	1111.64	1134.56	1097.84	1134.16
Annualized Waitlist Relist Deaths	23.92	23.52	24.04	22.76	22.88	23.40	22.20	23.24
Annualized Post Tx Deaths	996.12	1014.60	997.72	1003.68	1003.88	1003.64	1002.28	1009.44
Annualized Post Re-Tx Deaths	49.56	50.08	48.28	50.24	51.84	47.08	51.44	48.36
DSA Mean Transplant MELD	23.09	23.76	23.26	23.61	23.87	23.61	24.08	23.64
DSA Mean Transplant MELD Std.	1.88	1.59	1.80	1.77	1.70	1.83	1.64	1.83
DSA Median Transplant MELD	24.48	26.01	24.92	25.59	26.27	25.61	26.69	25.73
DSA Median Transplant MELD Std.	2.84	2.34	2.68	2.75	2.48	2.76	2.19	2.77
Avg. Organ Transport Distance (mi.)								
Ground Vehicle	33.34	34.21	33.04	34.71	34.32	34.63	33.77	34.70
Helicopter	100.99	103.96	103.89	105.54	104.66	104.40	103.77	105.47
Airplane	525.87	507.88	454.37	468.38	451.53	469.74	465.80	468.56
Avg. Organ Transport Time (hr.)								
Ground Vehicle	0.78	0.80	0.78	0.81	0.80	0.81	0.79	0.81
Helicopter	1.22	1.24	1.24	1.25	1.25	1.25	1.24	1.25
Airplane	2.48	2.44	2.33	2.37	2.33	2.37	2.36	2.37
Percentage of Organs Transported								
Ground Vehicle	46.94%	39.39%	44.33%	38.22%	35.03%	37.90%	33.75%	37.63%
Helicopter	0.68%	0.63%	0.71%	0.69%	0.52%	0.67%	0.50%	0.71%
Airplane	52.23%	59.86%	54.81%	60.97%	64.34%	61.31%	65.65%	61.55%

Table 5b: 5-Year Comparative Performance between Current System and Share 29/Share 15/0-Point Boost Policy (Table 2a: Policy Set II)

Category	Current System (Share 15, Share 35) (i)	Share29, Share15, 8 district, Boost+0 (vi)	Share29, Share15, 400 mi. Nbhd. (U) Boost+0 (vii)	Share29, Share15, 400 mi. Nbhd. (C) Boost+0 (viii)	Share29, Share15, 500 mi. Nbhd. (U) Boost+0 (ix)	Share29, Share15, 500 mi. Nbhd. (C) Boost+0 (x)	Share29, Share15, 600 mi. Nbhd. (U), Boost+0 (xi)	Share29, Share15, 600 mi. Nbhd. (C), Boost+0 (xii)
Annualized Waitlist Removals	---	-42.08	-41	-27.84	-51.12	-35.12	-66.4	-36.76
Annualized Total Deaths	---	-27.04	-22.96	-27.72	-53.04	-34.6	-69.52	-28.08
Annualized Waitlist Deaths	---	-45.64	-49.84	-34.8	-62.04	-39.12	-75.84*	-39.52
Annualized Waitlist Relist Deaths	---	-0.4	-0.8	-1.16	-1.04	-0.52	-1.72	-0.68
Annualized Post Tx Deaths	---	+18.48*	+12.28	+7.56	+7.76	+7.52	+6.16	+13.32
Annualized Post Re-Tx Deaths	---	+0.52	+0.52	+0.68	+2.28	-2.48*	+1.88	-1.2
DSA Mean Transplant MELD	---	+0.68*	+0.62*	+0.52*	+0.78*	+0.52*	+0.99*	+0.56*
DSA Mean Transplant MELD Std.	---	-0.29*	-0.13*	-0.11	-0.18*	-0.06	-0.25*	-0.05
DSA Median Transplant MELD	---	+1.52*	+1.44*	+1.10*	+1.79*	+1.13*	+2.21*	+1.24*
DSA Median Transplant MELD Std.	---	-0.51*	-0.21*	-0.09*	-0.36*	-0.08	-0.65*	-0.08
Avg. Organ Transport Distance (mi.)	---							
Ground Vehicle	---	+0.88*	+0.78*	+1.37*	+0.98*	+1.29*	+0.43*	+1.36*
Helicopter	---	+2.98*	+4.01*	+4.55*	+3.67*	+3.41*	+2.79*	+4.49*
Airplane	---	-17.99*	-80.26*	-57.50*	-74.34*	-56.14*	-60.07*	-57.31*
Avg. Organ Transport Time (hr.)	---							
Ground Vehicle	---	+0.02*	+0.02*	+0.03*	+0.02*	+0.02*	+0.01*	+0.03*
Helicopter	---	+0.02*	+0.03*	+0.03*	+0.03*	+0.02*	+0.02*	+0.03*
Airplane	---	-0.04*	-0.16*	-0.11*	-0.15*	-0.11*	-0.12*	-0.11*
Percentage of Organs Transported	---							
Ground Vehicle	---	-7.55%*	-10.46%*	-8.72%*	-11.92%*	-9.04%*	-13.19%*	-9.32%*
Helicopter	---	-0.05%	-0.12%*	+0.01%	-0.17%*	0%	-0.19%*	+0.03%
Airplane	---	+7.63%*	+10.61%*	+8.74%*	+12.11%*	+9.08%*	+13.42%*	+9.32%*

*This indicates that difference has p-value less than 0.05 ($p < 0.05$).

Table 6a: 5-Year Performances of Current System and Share 29/Share 18/3-Point Boost Policy (Table 2a: Policy Set III)

Category	Current System (Share 15, Share 35) (i)	Share29, Share18, 8 district, Boost+3 (xiii)	Share29, Share18, 400 mi. Nbhd. (U), Boost+3 (xiv)	Share29, Share18, 400 mi. Nbhd. (C), Boost+3 (xv)	Share29, Share18, 500 mi. Nbhd. (U), Boost+3 (xvi)	Share29, Share18, 500 mi. Nbhd. (C), Boost+3 (xvii)	Share29, Share18, 600 mi. Nbhd. (U), Boost+3 (xviii)	Share29, Share18, 600 mi. Nbhd. (C), Boost+3 (xix)
Annualized Waitlist Removals	3128.60	3077.56	3083.56	3091.48	3072.92	3090.60	3053.76	3092.36
Annualized Total Deaths	2243.28	2224.12	2207.72	2235.6	2193.92	2220.8	2179.56	2214.6
Annualized Waitlist Deaths	1173.68	1130.04	1120.60	1141.28	1112.80	1132.72	1100.12	1135.72
Annualized Waitlist Relist Deaths	23.92	23.12	23.40	22.40	23.04	22.88	22.40	23.32
Annualized Post Tx Deaths	996.12	1020.12	1012.04	1019.48	1009.60	1015.00	1007.48	1004.96
Annualized Post Re-Tx Deaths	49.56	50.84	51.68	52.44	48.48	50.20	49.56	50.60
DSA Mean Transplant MELD	23.09	23.89	23.89	23.72	24.00	23.78	24.13	23.78
DSA Mean Transplant MELD Std.	1.88	1.54	1.64	1.70	1.66	1.75	1.57	1.72
DSA Median Transplant MELD	24.48	26.18	26.14	25.80	26.39	25.84	26.74	25.90
DSA Median Transplant MELD Std.	2.84	2.18	2.38	2.53	2.25	2.54	2.02	2.51
Avg. Organ Transport Distance (mi.)								
Ground Vehicle	33.34	33.61	33.49	33.92	33.44	33.84	33.20	33.84
Helicopter	100.99	103.79	104.27	104.11	104.08	103.87	103.16	105.31
Airplane	525.87	532.09	472.57	503.91	474.91	502.44	482.86	501.79
Avg. Organ Transport Time (hr.)								
Ground Vehicle	0.78	0.79	0.79	0.80	0.79	0.79	0.78	0.79
Helicopter	1.22	1.24	1.24	1.24	1.24	1.24	1.24	1.25
Airplane	2.48	2.48	2.37	2.43	2.37	2.43	2.39	2.43
Percentage of Organs Transported								
Ground Vehicle	46.94%	42.15%	39.69%	41.40%	38.16%	41.15%	36.96%	40.78%
Helicopter	0.68%	0.69%	0.58%	0.71%	0.54%	0.72%	0.56%	0.72%
Airplane	52.23%	57.04%	59.62%	57.78%	61.19%	58.00%	62.37%	58.37%

Table 6b: 5-Year Comparative Performances between Current System and Share 29/Share 18/3-Point Boost Policy (Table 2a: Policy Set III)

Category	Current System (Share 15, Share 35) (i)	Share29, Share18, 8 district, Boost+3 (xiii)	Share29, Share18, 400 mi. Nbhd. (U), Boost+3 (xiv)	Share29, Share18, 400 mi. Nbhd. (C), Boost+3 (xv)	Share29, Share18, 500 mi. Nbhd. (U), Boost+3 (xvi)	Share29, Share18, 500 mi. Nbhd. (C), Boost+3 (xvii)	Share29, Share18, 600 mi. Nbhd. (U), Boost+3 (xviii)	Share29, Share18, 600 mi. Nbhd. (C), Boost+3 (xix)
Annualized Waitlist Removals	---	-51.04	-45.04	-37.12	-55.68	-38	-74.84	-36.24
Annualized Total Deaths	---	-19.16	-35.56	-7.68	-49.36	-22.48	-63.72	-28.68
Annualized Waitlist Deaths	---	-43.64	-53.08	-32.4	-60.88	-40.96	-73.56*	-37.96
Annualized Waitlist Relist Deaths	---	-0.8	-0.52	-1.52	-0.88	-1.04	-1.52	-0.6
Annualized Post Tx Deaths	---	+24*	+15.92*	+23.36*	+13.48	+18.88*	+11.36	+8.84
Annualized Post Re-Tx Deaths	---	+1.28	+2.12	+2.88*	-1.08	+0.64	0	+1.04
DSA Mean Transplant MELD	---	+0.81*	+0.80*	+0.63*	+0.91*	+0.69*	+1.05*	+0.70*
DSA Mean Transplant MELD Std.	---	-0.34*	-0.24*	-0.18*	-0.22*	-0.13*	-0.31*	-0.16*
DSA Median Transplant MELD	---	+1.69*	+1.65*	+1.31*	+1.90*	+1.36*	+2.25*	+1.42*
DSA Median Transplant MELD Std.	---	-0.67*	-0.46*	-0.31*	-0.60*	-0.31*	-0.82*	-0.33*
Avg. Organ Transport Distance (mi.)	---							
Ground Vehicle	---	+0.27	+0.15	+0.58*	+0.10	+0.50*	-0.14	+0.50*
Helicopter	---	+2.81*	+3.29*	+3.12*	+3.09*	+2.88*	+2.17	+4.32*
Airplane	---	+6.22*	-53.30*	-21.96*	-50.97*	-23.43*	-43.01*	-24.08*
Avg. Organ Transport Time (hr.)	---							
Ground Vehicle	---	0	0	+0.01*	0	+0.01*	0	+0.01*
Helicopter	---	+0.02*	+0.02*	+0.02*	+0.02*	+0.02*	+0.02	+0.03*
Airplane	---	+0.01	-0.10*	-0.04*	-0.10*	-0.04*	-0.08*	-0.04*
Percentage of Organs Transported	---							
Ground Vehicle	---	-4.80%*	-7.26%*	-5.55%*	-8.78%*	-5.80%*	-9.98%*	-6.16%*
Helicopter	---	+0.01%	-0.11%*	+0.02%	-0.14%*	+0.04%	-0.12%*	+0.04%
Airplane	---	+4.81%*	+7.40%*	+5.55%*	+8.96%*	+5.78%*	+10.14%*	+6.15%*

*This indicates that difference has p-value less than 0.05 ($p < 0.05$).

Table 7a: 5-Year Performances of Current System and Share 29/Share 20/5-Point Boost Policy (Table 2a: Policy Set IV)

Category	Current System (Share 15, Share 35) (i)	Share29, Share20, 8 district, Boost+5 (xx)	Share29, Share20, 400 mi. Nhbd. (U), Boost+5 (xxi)	Share29, Share20, 400 mi. Nhbd. (C), Boost+5 (xxii)	Share29, Share20, 500 mi. Nbhd. (U), Boost+5 (xxiii)	Share29, Share20, 500 mi. Nbhd. (C), Boost+5 (xxiv)	Share29, Share20, 600 mi. Nbhd. (U), Boost+5 (xxv)	Share29, Share20, 600 mi. Nbhd. (C), Boost+5 (xxvi)
Annualized Waitlist Removals	3128.60	3078.24	3079.52	3092.44	3066.56	3090.60	3066.28	3087.16
Annualized Total Deaths	2243.28	2220	2215.56	2227.64	2200.96	2220.8	2182.16	2227.6
Annualized Waitlist Deaths	1173.68	1130.56	1125.12	1138.96	1116.80	1132.72	1098.20	1136.76
Annualized Waitlist Relist Deaths	23.92	23.12	22.88	23.12	22.36	22.88	22.36	23.00
Annualized Post Tx Deaths	996.12	1014.16	1016.20	1013.60	1011.12	1015.00	1012.32	1015.96
Annualized Post Re-Tx Deaths	49.56	52.16	51.36	51.96	50.68	50.20	49.28	51.88
DSA Mean Transplant MELD	23.09	23.90	23.93	23.81	24.03	23.78	24.18	23.86
DSA Mean Transplant MELD Std.	1.88	1.55	1.66	1.69	1.66	1.75	1.54	1.67
DSA Median Transplant MELD	24.48	26.26	26.22	25.94	26.50	25.84	26.77	26.03
DSA Median Transplant MELD Std.	2.84	2.09	2.19	2.36	2.07	2.54	1.86	2.35
Avg. Organ Transport Distance (mi.)								
Ground Vehicle	33.34	33.33	33.07	33.42	33.23	33.84	32.79	33.48
Helicopter	100.99	104.00	104.56	104.29	103.51	103.87	103.32	103.96
Airplane	525.87	556.97	498.81	532.22	495.42	502.44	501.03	530.13
Avg. Organ Transport Time (hr.)								
Ground Vehicle	0.78	0.78	0.78	0.79	0.78	0.79	0.78	0.79
Helicopter	1.22	1.24	1.25	1.24	1.24	1.24	1.24	1.24
Airplane	2.48	2.53	2.42	2.49	2.41	2.43	2.42	2.48
Percentage of Organs Transported								
Ground Vehicle	46.94%	43.70%	41.46%	43.19%	40.04%	41.15%	38.89%	42.69%
Helicopter	0.68%	0.70%	0.60%	0.76%	0.60%	0.72%	0.56%	0.74%
Airplane	52.23%	55.47%	57.82%	55.94%	59.25%	58.00%	60.44%	56.44%

Table 7b: 5-Year Comparative Performances between Current System and Share 29/Share 20/5-Point Boost Policy (Table 2a: Policy Set IV)

Category	Current System (Share 15, Share 35) (i)	Share29, Share20, 8 district, Boost+5 (xx)	Share29, Share20, 400 mi. Nhbd. (U), Boost+5 (xxi)	Share29, Share20, 400 mi. Nhbd. (C), Boost+5 (xxii)	Share29, Share20, 500 mi. Nbhd. (U), Boost+5 (xxiii)	Share29, Share20, 500 mi. Nbhd. (C), Boost+5 (xxiv)	Share29, Share20, 600 mi. Nbhd. (U), Boost+5 (xxv)	Share29, Share20, 600 mi. Nbhd. (C), Boost+5 (xxvi)
Annualized Waitlist Removals	---	-50.36	-49.08	-36.16	-62.04	-40.08	-62.32	-41.44
Annualized Total Deaths	---	-23.28	-27.72	-15.64	-42.32	-22.48	-61.12	-15.68
Annualized Waitlist Deaths	---	-43.12	-48.56	-34.72	-56.88	-39.52	-75.48*	-36.92
Annualized Waitlist Relist Deaths	---	-0.8	-1.04	-0.8	-1.56	-0.32	-1.56	-0.92
Annualized Post Tx Deaths	---	+18.04*	+20.08*	+17.48*	+15	+25.12*	+16.2*	+19.84*
Annualized Post Re-Tx Deaths	---	+2.6*	+1.8*	+2.4	+1.12	+1	-0.28	+2.32
DSA Mean Transplant MELD	---	+0.82*	+0.85*	+0.73*	+0.95*	+0.75*	+1.09*	+0.77*
DSA Mean Transplant MELD Std.	---	-0.34*	-0.22*	-0.19*	-0.22*	-0.22*	-0.34*	-0.21*
DSA Median Transplant MELD	---	+1.78*	+1.74*	+1.46*	+2.02*	+1.50*	+2.29*	+1.54*
DSA Median Transplant MELD Std.	---	-0.75*	-0.66*	-0.49*	-0.77*	-0.50*	-0.98*	-0.49*
Avg. Organ Transport Distance (mi.)	---							
Ground Vehicle	---	-0.01	-0.27	+0.08	-0.11	+0.04	-0.55*	+0.14
Helicopter	---	+3.02*	+3.58*	+3.31*	+2.53*	+4.17*	+2.34	+2.98*
Airplane	---	+31.10*	-27.06*	+6.35*	-30.45*	+3.33	-24.84*	+4.26*
Avg. Organ Transport Time (hr.)	---							
Ground Vehicle	---	0	0	0	0	0	-0.01*	0
Helicopter	---	+0.02*	+0.03*	+0.02*	+0.02*	+0.03*	+0.02	+0.02*
Airplane	---	+0.06*	-0.05*	+0.01*	-0.06*	+0.01*	-0.05*	+0.01*
Percentage of Organs Transported	---							
Ground Vehicle	---	-3.25%*	-5.48%*	-3.76%*	-6.90%*	-4.12%*	-8.06%*	-4.25%*
Helicopter	---	+0.02%	-0.09%*	+0.07%*	-0.09%*	-0.06%*	-0.12%*	+0.06%*
Airplane	---	+3.25%*	+5.60%*	+3.72%*	+7.02%*	+4.09%*	+8.21%*	+4.22%*

*This indicates that difference has p-value less than 0.05 ($p < 0.05$).

Table 8a: 5-Year Performances of Current System and Share 35/Share 15/0-Point Boost Policy (Table 2a: Policy Set V)

Category	Current System (Share 15, Share 35) (i)	Share35, Share15, 8 district, Boost+0 (xxvii)	Share35, Share15, 400 mi. Nbhd. (U), Boost+0 (xxviii)	Share35, Share15, 400 mi. Nbhd. (C), Boost+0 (xxix)	Share35, Share15, 500 mi. Nbhd. (U), Boost+0 (xxx)	Share35, Share15, 500 mi. Nbhd. (C), Boost+0 (xxxi)	Share35, Share15, 600 mi. Nbhd. (U), Boost+0 (xxxii)	Share35, Share15, 600 mi. Nbhd. (C), Boost+0 (xxxiii)
Annualized Waitlist Removals	3128.60	3106.92	3101.84	3113.40	3094.64	3107.64	3086.56	3108.72
Annualized Total Deaths	2243.28	2238	2220.32	2224.6	2214.6	2225.2	2209.68	2224.36
Annualized Waitlist Deaths	1173.68	1153.68	1150.28	1157.16	1139.56	1159.00	1135.32	1160.64
Annualized Waitlist Relist Deaths	23.92	23.92	24.04	24.08	23.92	23.72	23.60	23.88
Annualized Post Tx Deaths	996.12	1010.40	997.72	992.68	1002.16	992.52	1002.44	991.08
Annualized Post Re-Tx Deaths	49.56	50.00	48.28	50.68	48.96	49.96	48.32	48.76
DSA Mean Transplant MELD	23.09	23.31	23.26	23.23	23.39	23.26	23.53	23.27
DSA Mean Transplant MELD Std.	1.88	1.64	1.80	1.84	1.80	1.84	1.73	1.83
DSA Median Transplant MELD	24.48	24.98	24.92	24.74	25.14	24.83	25.40	24.81
DSA Median Transplant MELD Std.	2.84	2.54	2.68	2.75	2.63	2.74	2.53	2.73
Avg. Organ Transport Distance (mi.)								
Ground Vehicle	33.34	33.18	33.04	33.28	32.90	33.22	32.68	33.29
Helicopter	100.99	103.40	103.89	102.97	103.51	104.22	102.60	104.89
Airplane	525.87	499.26	454.37	483.38	457.60	484.42	464.96	478.58
Avg. Organ Transport Time (hr.)								
Ground Vehicle	0.78	0.78	0.78	0.78	0.78	0.78	0.77	0.78
Helicopter	1.22	1.24	1.24	1.24	1.24	1.24	1.23	1.25
Airplane	2.48	2.42	2.33	2.39	2.34	2.40	2.35	2.38
Percentage of Organs Transported								
Ground Vehicle	46.94%	46.60%	44.33%	45.05%	43.62%	45.03%	43.34%	44.95%
Helicopter	0.68%	0.80%	0.71%	0.80%	0.70%	0.78%	0.69%	0.77%
Airplane	52.23%	52.47%	54.81%	54.02%	55.55%	54.05%	55.85%	54.14%

Table 8b: 5-Year Comparative Performances between Current System and Share 35/Share 15/0-Point Boost Policy (Table 2a: Policy Set V)

Category	Current System (Share 15, Share 35) (i)	Share35, Share15, 8 district, Boost+0 (xxvii)	Share35, Share15, 400 mi. Nbhd. (U), Boost+0 (xxviii)	Share35, Share15, 400 mi. Nbhd. (C), Boost+0 (xxix)	Share35, Share15, 500 mi. Nbhd. (U), Boost+0 (xxx)	Share35, Share15, 500 mi. Nbhd. (C), Boost+0 (xxxi)	Share35, Share15, 600 mi. Nbhd. (U), Boost+0 (xxxii)	Share35, Share15, 600 mi. Nbhd. (C), Boost+0 (xxxiii)
Annualized Waitlist Removals	---	-21.68	-26.76	-15.2	-33.96	-20.96	-42.04	-19.88
Annualized Total Deaths	---	-5.28	-22.96	-18.68	-28.68	-18.08	-33.6	-18.92
Annualized Waitlist Deaths	---	-20	-23.4	-16.52	-34.12	-14.68	-38.36	-13.04
Annualized Waitlist Relist Deaths	---	0	+0.12	+0.16	0	-0.2	-0.32	-0.04
Annualized Post Tx Deaths	---	+14.28	+1.6	-3.44	+6.04	-3.6	+6.32	-5.04
Annualized Post Re-Tx Deaths	---	+0.44	-1.28	+1.12	-0.6	+0.4	-1.24	-0.8
DSA Mean Transplant MELD	---	+0.22*	+0.18*	+0.14*	+0.31*	+0.18*	+0.44*	+0.18*
DSA Mean Transplant MELD Std.	---	-0.24*	-0.08	-0.04	-0.08	-0.04	-0.15*	-0.05
DSA Median Transplant MELD	---	+0.49*	+0.44*	+0.26*	+0.66*	+0.34*	+0.91*	+0.33*
DSA Median Transplant MELD Std.	---	-0.30*	-0.16*	-0.09*	-0.21*	-0.11*	-0.31*	-0.12*
Avg. Organ Transport Distance (mi.)	---							
Ground Vehicle	---	-0.16	-0.30*	-0.06	-0.44*	-0.12	-0.66*	-0.05
Helicopter	---	+2.41*	+2.91*	+1.99*	+2.52*	+3.23*	+1.61	+3.91*
Airplane	---	-26.61*	-71.50*	-42.49*	-68.27*	-41.45*	-60.91*	-47.29*
Avg. Organ Transport Time (hr.)	---							
Ground Vehicle	---	0	-0.01*	0	-0.01*	0	-0.01*	0
Helicopter	---	+0.02*	+0.02*	+0.01*	+0.02*	+0.02*	+0.01	+0.03*
Airplane	---	-0.06*	-0.14*	-0.08*	-0.14*	-0.08*	-0.12*	-0.09*
Percentage of Organs Transported	---							
Ground Vehicle	---	-0.35%*	-2.61%*	-1.90%*	-3.33%*	-1.91%*	-3.61%*	-2.00%*
Helicopter	---	+0.12%*	+0.03%	+0.12%*	+0.01%	+0.10%*	+0.01%	+0.09%*
Airplane	---	+0.24%	+2.58%*	+1.79%*	+3.32%*	+1.82%*	+3.62%*	+1.92%*

*This indicates that difference has p-value less than 0.05 ($p < 0.05$).

Table 9a: 5-Year Performances of Current System and Share 35/Share 18/3-Point Boost Policy (Table 2a: Policy Set VI)

Category	Current System (Share 15, Share 35) (i)	Share35, Share18, 8 district, Boost+3 (xxxiv)	Share35, Share18, 400 mi. Nbhd. (U), Boost+3 (xxxv)	Share35, Share18, 400 mi. Nbhd. (C), Boost+3 (xxxvi)	Share35, Share18, 500 mi. Nbhd. (U), Boost+3 (xxxvii)	Share35, Share18, 500 mi. Nbhd. (C), Boost+3 (xxxviii)	Share35, Share18, 600 mi. Nbhd. (U), Boost+3 (xxxix)	Share35, Share18, 600 mi. Nbhd. (C), Boost+3 (xl)
Annualized Waitlist Removals	3128.60	3094.64	3100.40	3103.68	3088.36	3108.72	3091.04	3101.92
Annualized Total Deaths	2243.28	2239.68	2223.12	2232.44	2214.68	2226.36	2215.08	2238.6
Annualized Waitlist Deaths	1173.68	1153.68	1149.32	1154.52	1139.48	1148.56	1134.56	1153.68
Annualized Waitlist Relist Deaths	23.92	23.60	23.88	23.72	23.64	23.08	23.08	24.24
Annualized Post Tx Deaths	996.12	1012.36	1000.92	1003.92	1002.16	1005.72	1008.76	1009.28
Annualized Post Re-Tx Deaths	49.56	50.04	49.00	50.28	49.40	49.00	48.68	51.40
DSA Mean Transplant MELD	23.09	23.49	23.45	23.39	23.49	23.41	23.55	23.41
DSA Mean Transplant MELD Std.	1.88	1.64	1.74	1.76	1.74	1.78	1.72	1.73
DSA Median Transplant MELD	24.48	25.20	25.21	25.05	25.33	25.05	25.48	25.08
DSA Median Transplant MELD Std.	2.84	2.47	2.54	2.62	2.54	2.60	2.52	2.59
Avg. Organ Transport Distance (mi.)								
Ground Vehicle	33.34	32.93	32.82	32.94	32.82	32.93	32.62	32.99
Helicopter	100.99	102.30	103.26	103.45	102.46	103.81	102.41	104.06
Airplane	525.87	529.59	488.15	516.15	480.73	515.56	482.89	512.27
Avg. Organ Transport Time (hr.)								
Ground Vehicle	0.78	0.78	0.77	0.78	0.77	0.78	0.77	0.78
Helicopter	1.22	1.23	1.24	1.24	1.23	1.24	1.23	1.24
Airplane	2.48	2.48	2.40	2.46	2.38	2.46	2.39	2.45
Percentage of Organs Transported								
Ground Vehicle	46.94%	47.19%	45.10%	46.16%	44.50%	46.09%	43.95%	45.95%
Helicopter	0.68%	0.78%	0.74%	0.79%	0.71%	0.83%	0.71%	0.82%
Airplane	52.23%	51.90%	54.01%	52.91%	54.66%	52.94%	55.19%	53.10%

Table 9b: 5-Year Comparative Performances between Current System and Share 35/Share 18/3-Point Boost Policy (Table 2a: Policy Set VI)

Category	Current System (Share 15, Share 35) (i)	Share35, Share18, 8 district, Boost+3 (xxxiv)	Share35, Share18, 400 mi. Nbhd. (U), Boost+3 (xxxv)	Share35, Share18, 400 mi. Nbhd. (C), Boost+3 (xxxvi)	Share35, Share18, 500 mi. Nbhd. (U), Boost+3 (xxxvii)	Share35, Share18, 500 mi. Nbhd. (C), Boost+3 (xxxviii)	Share35, Share18, 600 mi. Nbhd. (U), Boost+3 (xxxix)	Share35, Share18, 600 mi. Nbhd. (C), Boost+3 (xl)
Annualized Waitlist Removals	---	-33.96	-28.2	-24.92	-40.24	-19.88	-37.56	-26.68
Annualized Total Deaths	---	-3.6	-20.16	-10.84	-28.6	-16.92	-28.2	-4.68
Annualized Waitlist Deaths	---	-20	-24.36	-19.16	-34.2	-25.12	-39.12	-20
Annualized Waitlist Relist Deaths	---	-0.32	-0.04	-0.2	-0.28	-0.84	-0.84	+0.32
Annualized Post Tx Deaths	---	+16.24*	+4.8	+7.8	+6.04	+9.6	+12.64	+13.16
Annualized Post Re-Tx Deaths	---	+0.48	-0.56	+0.72	-0.16	-0.56	-0.88	+1.84
DSA Mean Transplant MELD	---	+0.40*	+0.36*	+0.30*	+0.41*	+0.32*	+0.46*	+0.32*
DSA Mean Transplant MELD Std.	---	-0.24*	-0.14*	-0.12	-0.14*	-0.10	-0.17*	-0.15*
DSA Median Transplant MELD	---	+0.71*	+0.73*	+0.56*	+0.85*	+0.57*	+0.99*	+0.60*
DSA Median Transplant MELD Std.	---	-0.38*	-0.30*	-0.23*	-0.31*	-0.24*	-0.33*	-0.26*
Avg. Organ Transport Distance (mi.)	---							
Ground Vehicle	---	-0.41*	-0.52*	-0.40*	-0.52*	-0.41*	-0.72*	-0.35
Helicopter	---	+1.31	+2.27	+2.47	+1.47	+2.82*	+1.42	+3.08*
Airplane	---	+3.72	-37.72*	-9.72*	-45.14*	-10.31*	-42.98*	-13.60*
Avg. Organ Transport Time (hr.)	---							
Ground Vehicle	---	-0.01*	-0.01*	-0.01*	-0.01*	-0.01*	-0.01*	-0.01
Helicopter	---	+0.01	+0.02	+0.02	+0.01	+0.02*	+0.01	+0.02*
Airplane	---	0	-0.08*	-0.02*	-0.09*	-0.02*	-0.09*	-0.03*
Percentage of Organs Transported	---							
Ground Vehicle	---	+0.25%	-1.84%*	-0.79%*	-2.44%*	-0.85%*	-2.99%*	-1.00%*
Helicopter	---	+0.09%*	+0.06%*	+0.11%*	+0.02%	+0.14%*	+0.03%	+0.13%*
Airplane	---	-0.33%*	+1.78%*	+0.69%*	+2.43%*	+0.71%*	+2.97%*	+0.87%*

*This indicates that difference has p-value less than 0.05 ($p < 0.05$).

Table 10a: 5-Year Performances of Current System and Share 35/Share 20/5-Point Boost Policy (Table 2a: Policy Set VII)

Category	Current System (Share 15, Share 35) (i)	Share35, Share20, 8 district, Boost+5 (xli)	Share35, Share20, 400 mi. Nbhd. (U), Boost+5 (xlii)	Share35, Share20, 400 mi. Nbhd. (C), Boost+5 (xliii)	Share35, Share20, 500 mi. Nbhd. (U), Boost+5 (xliv)	Share35, Share20, 500 mi. Nbhd. (C), Boost+5 (xlv)	Share35, Share20, 600 mi. Nbhd. (U), Boost+5 (xlvi)	Share35, Share20, 600 mi. Nbhd. (C), Boost+5 (xlvii)
Annualized Waitlist Removals	3128.60	3092.20	3100.96	3104.60	3083.76	3100.00	3086.36	3105.52
Annualized Total Deaths	2243.28	2246.24	2224.08	2238.44	2215.44	2238.68	2204.76	2239.6
Annualized Waitlist Deaths	1173.68	1151.88	1141.56	1151.72	1138.12	1153.88	1129.28	1153.12
Annualized Waitlist Relist Deaths	23.92	23.84	23.92	24.12	23.52	23.40	23.88	23.88
Annualized Post Tx Deaths	996.12	1020.20	1009.44	1012.36	1004.72	1010.40	1001.44	1011.96
Annualized Post Re-Tx Deaths	49.56	50.32	49.16	50.24	49.08	51.00	50.16	50.64
DSA Mean Transplant MELD	23.09	23.50	23.49	23.47	23.59	23.47	23.64	23.46
DSA Mean Transplant MELD Std.	1.88	1.70	1.69	1.75	1.75	1.74	1.72	1.75
DSA Median Transplant MELD	24.48	25.34	25.38	25.24	25.50	25.24	25.60	25.23
DSA Median Transplant MELD Std.	2.84	2.38	2.48	2.54	2.47	2.56	2.45	2.59
Avg. Organ Transport Distance (mi.)								
Ground Vehicle	33.34	32.72	32.53	32.89	32.59	32.92	32.47	33.06
Helicopter	100.99	102.05	102.33	102.65	103.20	103.88	103.04	103.50
Airplane	525.87	552.29	509.62	542.32	501.84	538.57	501.21	534.51
Avg. Organ Transport Time (hr.)								
Ground Vehicle	0.78	0.77	0.77	0.78	0.77	0.78	0.77	0.78
Helicopter	1.22	1.23	1.23	1.23	1.24	1.24	1.24	1.24
Airplane	2.48	2.52	2.44	2.51	2.42	2.50	2.42	2.49
Percentage of Organs Transported								
Ground Vehicle	46.94%	47.64%	45.82%	46.75%	45.09%	46.74%	44.45%	46.72%
Helicopter	0.68%	0.80%	0.76%	0.85%	0.73%	0.80%	0.72%	0.79%
Airplane	52.23%	51.43%	53.28%	52.26%	54.04%	52.32%	54.71%	52.34%

Table 10b: 5-Year Comparative Performances between Current System and Share 35/Share 20/5-Point Boost Policy (Table 2a: Policy Set VII)

Category	Current System (Share 15, Share 35) (i)	Share35, Share20, 8 district, Boost+5 (xli)	Share35, Share20, 400 mi. Nbhd. (U), Boost+5 (xlii)	Share35, Share20, 400 mi. Nbhd. (C), Boost+5 (xliii)	Share35, Share20, 500 mi. Nbhd. (U), Boost+5 (xliv)	Share35, Share20, 500 mi. Nbhd. (C), Boost+5 (xlv)	Share35, Share20, 600 mi. Nbhd. (U), Boost+5 (xlvi)	Share35, Share20, 600 mi. Nbhd. (C), Boost+5 (xlvii)
Annualized Waitlist Removals	---	-36.4	-27.64	-24	-44.84	-28.6	-42.24	-23.08
Annualized Total Deaths	---	2.96	-19.2	-4.84	-27.84	-4.6	-38.52	-3.68
Annualized Waitlist Deaths	---	-21.8	-32.12	-21.96	-35.56	-19.8	-44.4	-20.56
Annualized Waitlist Relist Deaths	---	-0.08	0	+0.2	-0.4	-0.52	-0.04	-0.04
Annualized Post Tx Deaths	---	+24.08*	+13.32	+16.24	+8.6	+14.28*	+5.32	+15.84
Annualized Post Re-Tx Deaths	---	+0.76	-0.4	+0.68	-0.48	+1.44	+0.6	+1.08
DSA Mean Transplant MELD	---	+0.41*	+0.40*	+0.39*	+0.50*	+0.39*	+0.55*	+0.38*
DSA Mean Transplant MELD Std.	---	-0.18*	-0.19*	-0.13*	-0.13*	-0.14*	-0.17*	-0.13*
DSA Median Transplant MELD	---	+0.86*	+0.90*	+0.76*	+1.01*	+0.76*	+1.11*	+0.75*
DSA Median Transplant MELD Std.	---	-0.46*	-0.37*	-0.30*	-0.37*	-0.29*	-0.39*	-0.25*
Avg. Organ Transport Distance (mi.)	---							
Ground Vehicle	---	-0.62*	-0.82*	-0.45*	-0.75*	-0.42*	-0.87*	-0.27
Helicopter	---	+1.07	+1.35	+1.67	+2.21*	+2.90*	+2.06	+2.52
Airplane	---	+26.41*	-16.25*	+16.45*	-24.03*	+12.70*	-24.67*	+8.64*
Avg. Organ Transport Time (hr.)	---							
Ground Vehicle	---	-0.01*	-0.02*	-0.01*	-0.01*	-0.01*	-0.02*	0
Helicopter	---	+0.01	+0.01	+0.01	+0.02*	+0.02*	+0.01	+0.02
Airplane	---	+0.05*	-0.03*	+0.03*	-0.05*	+0.02*	-0.05*	+0.02*
Percentage of Organs Transported	---							
Ground Vehicle	---	+0.69%*	-1.13%*	-0.19%*	-1.85%*	-0.21%	-2.50%*	-0.23%*
Helicopter	---	+0.12%*	+0.08%*	+0.17%*	+0.05%*	+0.12%*	+0.04%	+0.11%*
Airplane	---	-0.80%*	+1.05%*	+0.03%	+1.81%*	+0.09%	+2.48%*	+0.12%

*This indicates that difference has p-value less than 0.05 ($p < 0.05$).

Figures

Figure 1: Concentric Neighborhood for OPO serving Eastern Pennsylvania (PADV)

Figure 1 shows two versions of concentric neighborhood of 500-mile radius for the OPO serving Eastern Pennsylvania. Figure 1(a) shows the unconstrained concentric neighborhoods solution. This neighborhood contains the current UNOS region for the OPO (UNOS Region 2) and all OPOs whose physical addresses are within 500 miles of the OPO's main address in Philadelphia. Figure 1(b) shows the constrained concentric neighborhoods solution. This neighborhood contains only 10 OPOs, where the first 5 are the current UNOS region for the OPO (UNOS Region 2) and the last 5 are the closest OPOs outside the UNOS region whose physical addresses are within 500 miles of the OPO's main address in Philadelphia.

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