October 14, 2016

ASTS Comments on OPTN Redesigning Liver Allocation Proposal

ASTS appreciates the opportunity to comment on the Redesigning Liver Allocation proposal. Because ASTS members have a variety of opinions on this proposal, the Society will not take a position for or against it. However, ASTS will make several points along the spectrum of member perspectives.

ASTS strongly supports the well-established policy process of the OPTN and opposes efforts to circumvent it or to involve legislators, the media, or public opinion. Though some of our members have advocated for their patients and centers to these audiences, the Society as a whole believes that the issue is best addressed by those with a firm grasp of the nuances and complexity of organ allocation. The optimum solution will come through civil and constructive discourse among those in the transplant community. Everyone in the transplant community shares the same goal: the best care for patients with the most access to lifesaving treatments.

ASTS believes the transplant community must remain mindful of our aspiration to inspire hope in those with end stage organ failure and to maintain the public trust that we will make the best use of donated organs. Public discord may cause lasting damage to our image as an inspiration for hope and, in the worst case, have a negative impact on donation and injury to those we wish to help. We must not lose sight of the larger picture in this debate.

With that in mind, ASTS submits two viewpoints containing different perspectives on this proposal. They can be found below in no particular order.

Comments on the OPTN Redesigning Liver Allocation (in favor)

Over 16 years ago, in March of 2000, The Department of Health and Human Services (HHS) published 'the Final Rule' which outlined the principles that should guide organ allocation policy. The Final Rule stated that organ allocation policies must be based on sound medical judgment, seek to achieve the best use of donated organs, and ***shall not be based on the candidate's place of residence of place of listing***.

The allocation policy changes that have been implemented have, in large part, addressed several mandates, including the implementation of MELD and modifications of the MELD score, among others. However, there has been no movement regarding geographic disparity in organ distribution.

The UNOS Liver and Intestinal Transplant Committee was tasked by the Secretary of HHS, and subsequently the UNOS Board, to develop a strategy to reduce this disparity without increasing waitlist mortality. The proposal presented was the result of over 4 years of work and modifications by the committee based upon significant public input and thousands of hours of modeling, committee and subcommittee meetings, and three public forums. The current proposal was approved by a large

majority of the committee as the best compromise that would significantly reduce disparity in access to livers for transplant, and to a small degree, even reduces waitlist deaths.

Mathematic modelling to redesign “districts” from the current 11 UNOS regions and respecting the 58 donation service areas (DSAs) was proposed. The eight district model with 150-mile proximity circles around the donor hospital to assign an additional 3 MELD points to patients within the circle was proposed. The committee had evaluated an alternative model using concentric circles as well as others that are currently being evaluated. All models are predicted to significantly reduce the disparity of access to these organs compared to the current system and created a better mechanism to get the livers to those recipients with the most urgent need based upon MELD scores. The current proposal that has been released for public comment was chosen as it reduced disparity, was predicted to incur fewer numbers of flights, reduced travel distances, and complied with the desire of incremental change with a sharing threshold of MELD 29.

The much criticized and maligned Liver Simulation Allocation Model (LSAM), which has been successfully used to guide all other proposal changes, was used to evaluate at least 30 different scenarios of organ allocation and several outcome metrics. What critics often fail to acknowledge is that the data set used for modelling needs to be of a certain vintage to analyze meaningful 3- and 5- year post transplant survival. The SRTR acknowledges the strengths and weaknesses of LSAM modelling, and more modelling regarding different sharing thresholds is forthcoming. Some, after criticizing the accuracy of the modelling, then focus on one particular outcome of the modelling, which is predicted to be potentially inaccurate by the modellers themselves: the decrease in the total number of transplants. It should be noted that after Share 35, an INCREASE, not a DECREASE in transplants was observed. The prediction of fewer transplants should be interpreted with caution as the LSAM does not take into account behavioral changes. One behavior which is left intact is the likelihood of transplant centers to decline a liver offer if it originates outside their CURRENT DSA or Region. This almost certainly will not remain the case in the scenario that creates new distribution areas, but this was not included in the predictive model.

The current proposal is predicted to decrease the variance of MELD at transplant, decrease the variance of transplant rates, and decrease the variance of pre-transplant mortality. The prime tenets of the need for liver redistribution rest with the high rate of transplant at lower MELD scores in some areas of the country, compared to lower rates of transplant at higher MELD scores in others. The allocation MELD score at transplant is the relevant metric as this is indeed how organs are allocated. Critics have argued that only lab MELD scores of ALL candidates should have been considered and analyzed as the only validated measure of waitlist mortality. This of course makes little sense to include in the analysis as the patients who have exception scores often have low MELD scores. The exception system was of course initially incorporated with ***consensus in the liver transplant community*** to maintain access to liver transplantation for patients whose need for transplant is not manifest in their lab MELD scores. The most obvious and important condition in which this applies is that of hepatocellular carcinoma. Those who argue we should only have lab MELD scores drive the data analysis and allocation policy are arguing that we should either ***eliminate the exception system altogether***, or perform a completely flawed data analysis by including patients whose need for transplants that we have all agreed is NOT reflected in their lab MELD score (hence the need for an exception system). It is acknowledged that some members

of the community feel that the magnitude of exception points given to patients with certain diagnosis may currently be 'excessive.' It also has certainly been recognized that some patients with hepatocellular carcinoma have likely enjoyed a disproportionate access to liver transplantation, and therefore, there have been several changes to the initial system of exception, and the UNOS Liver Committee continues to modify incrementally the system of exception point approval, including the separate proposals in development of a National Liver Review Board, potential modification in which points are awarded, and a proposal to modify HCC criteria. However, the analysis shows that the patients who are listed under their lab MELDs are indeed suffering the brunt of the geographic disparity in access to transplant.

The other outcomes studied and examined in the modelling include transport times, transport distances, and costs related to pre- and post-transplant costs.

LSAM is not perfect. This has been acknowledged. LSAM is strongest at predicting large scale shifts, the direction of change, but not necessarily the magnitude of that change, nor changes at the level of individual DSA's or transplant centers. So the Liver Committee went on further to examine data, without any need for modelling, regarding actual supply and demand data. The supply/demand ratios were mapped by the 58 DSA's, and the current 11 Regions and were compared to 8- and 4- district maps. This analysis was performed on more contemporary data and requires NO modelling. The disparity in supply and demand was best improved with a 4-district map, but was also significantly improved with an 8-district map.

The community has learned much with experience with previous allocation changes. When we expose a subpopulation to wider access to organ offers, their transplant rates increase, and their waitlist times and waitlist mortality decrease. This was observed both with Regional Sharing for status 1 candidates and after Share 35.

Alternative proposals are still being evaluated during the public comment period.

In selecting a proposal, the committee wanted to integrate such a major change in allocation/distribution which could have significant repercussions by instituting a stepwise system. Debates about whether this should include exceptions or calculated MELD and whether there should be a MELD threshold and what that would be were held. A decision was made in favor of using MELD at allocation with a threshold of 29 or higher as the starting point for district-wide sharing before going back to DSA. Although this would be an intermediate step regarding redistribution, this was thought to be a reasonable initial step to assess potential unintended consequences and make adjustments. It was thought to represent a large enough group of patients to actually demonstrate gains in disparity metrics post implementation. To deal with the inconsistent practices regarding exception candidates at the regional level, the UNOS Liver Committee has put forth a proposal to establish a National Liver Review Board to level the playing field and make more consistent the MELD exception practices throughout the country.

The discussions surrounding this topic have very importantly stressed the need for a parallel but separate effort on increasing organ donation, which is paramount, but unfortunately only a small factor

in the differences seen in donations geographically with the major driver being the number of medically eligible/potential deaths. No matter how much we can increase donation, the disparity will continue to exist between the numbers of donor livers and the density of recipients with end stage liver disease on transplant center waitlists if we continue to use the current distribution system. Further, the importance of utilizing every possible recovered organ with more efficient methods of information sharing and communication will generate pathways for greater liver utilization. There is evidence that increased competition will likely result in increased utilization of marginal liver grafts and potentially increase living donor liver transplantation. Both of these issues continue to have resources allocated by OPOs, AOPO, Donate Life America, and the OPTN.

It remains unfair for patients to face such a difference in access to liver transplant because of where they are listed. This unfairness also results in inequities between patients with resources and patients without them as the former are able to overcome the disparities to travel to an area with better access, where the latter are left to be subject to the local high demand and low supply environment.

Ultimately, organ distribution should be performed in an efficient and equitable fashion. Until the time comes when we can utilize technologies to significantly increase the donor pool or even produce donor organs in the lab, we must continue our collective efforts to increase donation, utilize every organ, and allocate and distribute these life-saving gifts as efficiently and equitably as possible. It has been acknowledged that logistical challenges arise when OPOs have a wider range of centers to offer organs, and there are several groups proposing changes in policy and sharing best practices to overcome these logistical challenges that accompany broader sharing. Some of these lessons learned, as a result of other policy changes such as Share 35, inform the discussion and planning for implementation.

The stepwise integration with MELD threshold of 29 allows the opportunity to assess and correct for any unintended consequences and potentially expand to a larger segment of the list. Reducing the existing geographic disparity is an important issue and should be addressed, whether by this proposal or another.

Comments on the OPTN Proposal for Redesigning Liver Distribution – Not in favor

The Liver and Intestinal Organ Transplantation Committee (LI Committee) of the OPTN/UNOS has proposed a redesign of liver distribution in order to mitigate the role geographic variation plays in a patient's chance of receiving a liver transplant within the United States. This proposal is an attempt to harmonize with the March 2000 "Final Rule" implemented by the U.S. Department of HHS which required that OPTN/UNOS policies be based upon sound medical judgment, achieve the best use of donated organs, and should not be based on geographic location of residence or location of listing institution. The OPTN has recognized the inadequate number of deceased donors relative to the size of the wait list and is committed to increasing donation, decreasing discards, and improving OPO performance as other methods to achieve the goals of the "Final Rule" and to provide access to transplantation.

Among current OPTN/UNOS regions in 2015, the difference in median allocation MELD (which includes exception points) at transplant was as great as 12 points (35 vs. 23). The LI Committee believes that a

smaller number of mathematically optimized districts would reduce geographic variability in disease severity at the time of transplant. The current proposal creates 8 new districts with additional priority of 3 MELD or PELD points for those candidates that are within the district and a 150-mile radius of the donor hospital (proximity points). The proposal includes district wide sharing of adult deceased donor livers for all candidates with a MELD or PELD of at least 29 before local DSA priority. The proposal is projected to avert 50 deaths per year on the wait list and to decrease the current variance in median MELD or PELD at transplant in half (2.9 vs. 6.2) and projected to decrease the variance in transplant rates. Variance is defined as the square of the MELD score at transplant, so a decrease variance of 3.3 will only result in a decrease difference in MELD sore of less than 2. An important caveat is that at the time the proposal was sent out for public comment, there had been no release of projections based on the most current proposal, specifically the 29 point sharing threshold. All data that have been publicly released to date are based on the original proposal, and not the proposal released to the broader community and which is the subject of this response. The projections based upon modeling also indicate 200-300 fewer transplants per year.

This proposal is the latest among several recent policy changes adopted by the OPTN/UNOS to overcome the regional variation in transplant MELD. These include 1) regional sharing for status 1A and 1B candidates which was approved by the OPTN/UNOS Board of Directors in 2009 2) in June 2012 the Board implemented "Share 35" allowing regional sharing for those candidates with the highest MELD scores. Additional recent changes to liver allocation include a 6-month time delay for HCC exception points as well as a cap on HCC exception points. Upcoming changes include replacement of Regional Review Boards with a National Liver Review Board.

While we applaud the efforts devoted to decrease geographic inequity, this proposal has several serious flaws and is unlikely to achieve the expected objectives of the "Final Rule" and will result in numerous unanticipated downstream effects which are unlikely to be predicted. Our concerns align along the following categories.

1. Proposal development and accuracy of projections
2. Lack of consideration of alternative methods to achieve similar goals that are less costly and would increase the number of transplants
3. Inattention to the logistical implications to wider organ sharing

Proposal Development and Accuracy of Projections:

A. LSAM projections are based upon currently irrelevant data.
   We are concerned that the estimates arrived through LSAM are based upon transplant candidates listed on the liver waiting lists as of Dec 31, 2006 and candidates added to those waiting lists and organs donated between Jan 1 2007 and Dec 31, 2011. The waiting list, number of transplants, MELD at transplant, and number of transplant programs has changed subsequent to the population utilized to develop the LSAM estimates. Furthermore, several policy changes have altered liver allocation and distribution; Share 35 and changes to waiting time and exception points for HCC are not fully realized and are not accounted for in the dataset used to

derive the current projections. Additional changes to liver allocation are expected with the adoption of a National Liver Review Board. As such the estimates provided by LSAM are based upon historical data which do not reflect the current realities of allocation and distribution. We question the reliability of estimates which are based upon historical data and allocation algorithms. The data utilized for LSAM modeling should be current and reflect current practice.

We are also concerned about the continued series of planned changes to liver allocation without a full accounting for or complete understanding of the implications of previous changes. The consequences of these changes may take years to become recognized within the OPTN. The system of organ allocation and distribution is complex, and even small changes can have unforeseen implications for OPOs, transplant centers, transplant center behavior, transplant candidates, and transplant recipients. Although rather gross changes may be predictable through LSAM, the changes which cannot be anticipated are nonetheless important and have consequences.

B. Absence of LSAM estimates based upon current proposal.

The current projection for lives saved and median changes to MELD score at the time of transplant do not include a limit on district wide sharing. The public has not had a chance to view LSAM estimates based upon the proposed sharing at 29 points. This is expected to be released on 10/14/16, one day before the public comment period ends. It is inconceivable that the public is being asked to assess a proposal if the estimates based upon that proposal are not available for review. The timing of the end of the public comment period relative to the availability of LSAM estimates of the proposed policy leave the impression that the LI Committee has little regard for the feedback provided by the community.

C. Modeling is an inexact science.

LSAM is viewed to have capability to assess large trends and not smaller ones. LSAM also is constrained by assumptions that are incorrect: uniform organ acceptance behavior across all centers and no behavioral changes in response to a proposal. LSAM predicts slightly less than a 2% decrease in the number of transplants performed each year under the 8 district model. The current proposal will save perhaps 50 lives, yet is predicted to decrease the number of transplants by 200-300 per year. It is incumbent on the LI committee to have a fair degree of certainty with regard to the output from the LSAM modeling. This becomes vitally important given the miniscule projected increase in projected lives saved and the marked potential for a decrease in transplants. Although viewed by the LI Committee as a potential “statistical anomaly,” the decrease in transplants is alarming and contradicts one of the goals of the OPTN.

The implications and unintended consequences of Share 35 – a proposal with a much smaller footprint than the current proposed reorganization of liver distribution - are only just being

recognized. As such the lessons learned from this experience should be taken into account as the community considers methods to decrease regional inequity in access to transplantation. Pre-adoption prediction of Share-35 policy estimated 80 fewer deaths on the wait list, however wait list deaths have actually increased from 2999 to 3111 between 2013 and 2014. Many of these deaths are likely to have occurred in patients who would have had priority for a liver transplant in the pre-share 35 era; of 1219 candidates who would have had priority prior to share 35 but were passed over for a transplant after share 35, 21% died while waiting for a transplant. (Chow EKH, Am J Trans 2016, in press).

Furthermore, the Share-35 experience demonstrates just how difficult, and perhaps impossible, it is to predict center behavior after changes to policy. An analysis by Goldberg et al. (AASLD 2016 abstract) demonstrates a statistically significant decrease in organ acceptance by centers since the initiation of Share-35 (Figure 1). The Share-35 experience was also associated with other unintended consequences such as a detriment in allograft survival in Regions 4 and 10 (Halazun et al. Am J Trans 2016) (Figure 2).

D. Optimization science

Concern exists that redistricting may not be the most efficient method to achieve geographic parity with respect to MELD at transplant. Smaller, less disruptive changes to the OPTN may achieve the same results at substantially less cost and disorder to the current allocation and distribution system. More robust techniques may exist that come from the field of system design that could offer better methods of optimization. In a recent commentary by Mehrotra et al. (Transplantation 2015;99: 278–281), a systems engineer from Northwestern University, the authors stated that redistricting "currently lacks evidence that it would perform effectively under realistic departures from its underlying data and assumptions. Moreover, we caution against prematurely focusing on redistricting as the only method to mitigate disparity." Importantly the current proposal does not provide a design that is flexible with respect to future uncertainty. The ability to be malleable is crucial given that assumptions utilized to develop redistricting are based upon older (currently inaccurate) data and that predicting behavior after policy change is difficult. We believe that it is important that the current proposal is vetted by experts from the field of optimization. In addition, optimization experts should be provided an opportunity to construct alternative allocation and distribution systems that would achieve all goals set forth by the "Final Rule."

E. Allocation MELD does not equal transplant MELD

The design of the proposal put forth by the LI Committee is based upon allocation MELD. Allocation MELD receives contributions from transplant candidates with true calculated MELD scores as well as candidates whose MELD score is based upon exception points. It is well documented that candidates with exception scores usually have lower risks of wait list removal and mortality. The underlying goal of the current proposal put forth by the LI Committee is to decrease the disparity in allocation MELD score in geographic regions of the U.S. However, the

utilization of exception MELD score varies by region, so the contribution to allocation MELD is disproportionately influenced by exception MELD scores. This disproportionate contribution of exception MELD scores inaccurately raises the appearance of an increased risk of wait list mortality between regions; however, the true risk of wait list removal is much less in regions where there is greater utilization of exception scores among wait list candidates. (Figure 3, provided by D Goldberg). Ultimately this raises the question whether the LI Committee is focusing on the wrong metric to rectify geographic disparity. Is the appropriate metric allocation MELD, which may not reflect the true risk of wait list death and removal, or should the LI Committee be concerned about adjudicating regional disparity in wait list death and removal among regions? We encourage the LI Committee to consider the true risk of wait list death and removal, which is not reflected by the greater utilization of exception MELD score in some regions of the country. Furthermore, these differences may become irrelevant with a National Liver Review Board which will provide uniform exception point practices across the country.

F. Metrics of disparity

A growing literature indicates that wait list metrics of regional performance as measured by wait list mortality and transplant rates are not correlated with corresponding population-based measures of access. There exist substantial differences among regions in the proportion of patients with end stage liver disease who are listed for liver transplantation. Policies based solely upon wait list metrics may underserve the larger population who could benefit from liver transplantation but face challenges to accessing high quality hepatology care. Without adequate deliberation of these issues, redistricting has the potential to exacerbate existing geographic disparities in access, particularly in rural areas.

Lack of consideration of alternative methods to achieve similar goals that are less costly and may increase the number of transplants

Aside from the previously discussed need to consider alternative methods to optimize organ distribution, there exist other potential opportunities among transplant centers and OPOs to mitigate much of the geographic disparity.

A. We encourage the LI Committee to consider the disparity in liver acceptance practices among transplant centers and the impact that this practice has on wait list mortality. This is particularly true among UNOS regions where there are a large number of transplant centers. (Goldberg et al, J Hep 2016). Patients listed at centers that have higher rates of organ declines are exposed to greater risks of wait list mortality and removal (Figure 4). It is unclear if the LI Committee has considered the implications of center behavior in their deliberations and model building. Changes to center behavior may have a greater impact on access to transplantation and wait list mortality than modifying the boundaries of liver distribution. The changes in organ acceptance rates with Share-35 that have been discussed previously in this document offer some insight into how centers may react in the context of broader geographic organ sharing.

B. A discussion of geographic disparity cannot take place without including a discussion of organ donation. The problem of regional variability in MELD is in part related to underperforming OPOs (Figure 5). We recognize that measuring OPO performance is a controversial topic and that the metrics currently utilized have flaws. We are also aware of activities underway to develop new OPO metrics and improve OPO performance. The current proposal fails to address the supply side of organ transplantation. The efforts and expense utilized to develop and potentially enact the LI Committee's current proposal for increased geographic organ sharing (which is projected to decrease the number of transplants) would be better utilized for improving organ donation and OPO performance. Increasing the supply of organs would help more patients and address organ inequity to a greater extent than the current efforts of the LI Committee.

   We are in disagreement with the LI Committee and subsequent reports (Gentry et al. Liver transplantation, 2015) that the proposal would not reallocate organs from high-performing OPOs to low-performing OPOs. The methods to study the potential impact of shifting organs raise some concerns (organ movement defined as net positive, unchanged, or net negative, without considering the magnitude of gains for a given donor service area, especially related to its donation rates) and in addition are based upon measures of OPO performance that have been criticized.

Inattention to the logistical implications to wider organ sharing

The creation of 8 new districts for liver distribution fails to consider the logistical and practical implications to wider organ sharing, particularly in the context of an estimated proposal to save at most 50 additional lives. There is potential for substantial increased costs, inefficiencies, and problems with late allocation which will result in organ loss and a decreased number of transplants which is underappreciated by the LI committee.

A. While many of the new proposed geographic districts are in continuity, there are some which defy logic. For example, the east coast of the U.S. would be one entire district including Puerto Rico, but bypasses Florida.
B. The number of OPOs, organ donors, and liver transplant programs varies quite widely among the proposed districts. (Figure 6) The level of logistical complexity and costs for the OPOs and centers and how they will solve these issues will vary by District and will likely increase for those with more OPOs and transplant centers. District 1, the Eastern U.S., would comprise approximately one-third of all liver transplant centers in a single district.
C. The financial implications for additional travel and perhaps the need for additional staffing by transplant centers and OPOs is unclear. The LI Committee presently estimates a 13% increase in the need for flights.
D. The number of potential organ offers that centers may receive could require new systems for screening and evaluation. This may be problematic in Districts with a large number of OPOs and potential donors. It is possible that centers may receive several

simultaneous offers for the same patient, potentially complicating donor acceptance by programs and potentially resulting in last minute organ declines. There is potential to incur substantial inefficiency in organ distribution.

E. With wider organ distribution, OPOs could also incur substantial logistical issues and inefficiency. Last minute organ declines and reallocation could result in organ discard, or organs undergoing expedited placement to lower ranked patients on the match run at select centers, and may open opportunities to game the distribution system. The decreased utilization of kidney allografts with a KDPI greater than 85 after policy changes allocated these organs on a regional a basis may offer some insight as to the utilization of livers with less favorable characteristics under the 8 District plan.

F. The relationship between an OPO and the local transplant centers may be disrupted through wider geographic sharing. There are subtle yet important attributes of these relationships built over many years which cannot be quantified or modeled. These relationships allow for effective and efficient organ allocation and distribution, and in some instances have resulted in very high performing OPOs with novel strategies for substantial cost savings. Such novel innovations will be very difficult to encourage under a system of large districts with disconnection of OPOs and local centers. This includes such efforts as normothermic perfusion for marginal organs, a technology that could increase transplantable organs substantially greater than the net effects in the current proposal.

Conclusions

ASTS members are in agreement that efforts are needed to mitigate geographic disparity in liver transplantation. However as outlined in this document, we have significant concerns with the development and adoption of the current 8 district plan. There is the appearance of haste to arrive at this plan without adequate public disclosure of the final projections and lack of representation from experts from the field of optimization who could suggest alternative models and who could independently validate this or alternative proposals.

Recommendations related to the current proposal:

1. Request input from neutral optimization experts regarding optimal potential plans for allocation.
2. Prior to planning for changes in liver distribution, establish metrics of outcomes goals, such as disease burden, life years saved, etc., that can be agreed upon by all parties.
3. Include measures of logistics and cost as part of the consideration of allocation changes.
4. Establish metrics of DSA performance that can be tracked and made accountable. Models of change cannot support movement of organs from high-performing DSAs to low-performing areas.
5. Prioritize “local” in the proposal wherever possible, to avoid unnecessary movement of organs and personnel and to minimize unnecessary costs.
6. Measure the impact of any proposed changes on rural and minority (underserved) populations.

7. Consider pilot allocation demonstration projects (as has been done in the past) prior to institution of major national policy changes.

Figure 1. The odds of a liver being accepted for patients in the first 5 positions of a match run have decreased significantly for patients with a MELD ≥ 35 since the initiation of Share 35 policy. Provided by D. Goldberg, AASLD 2016)

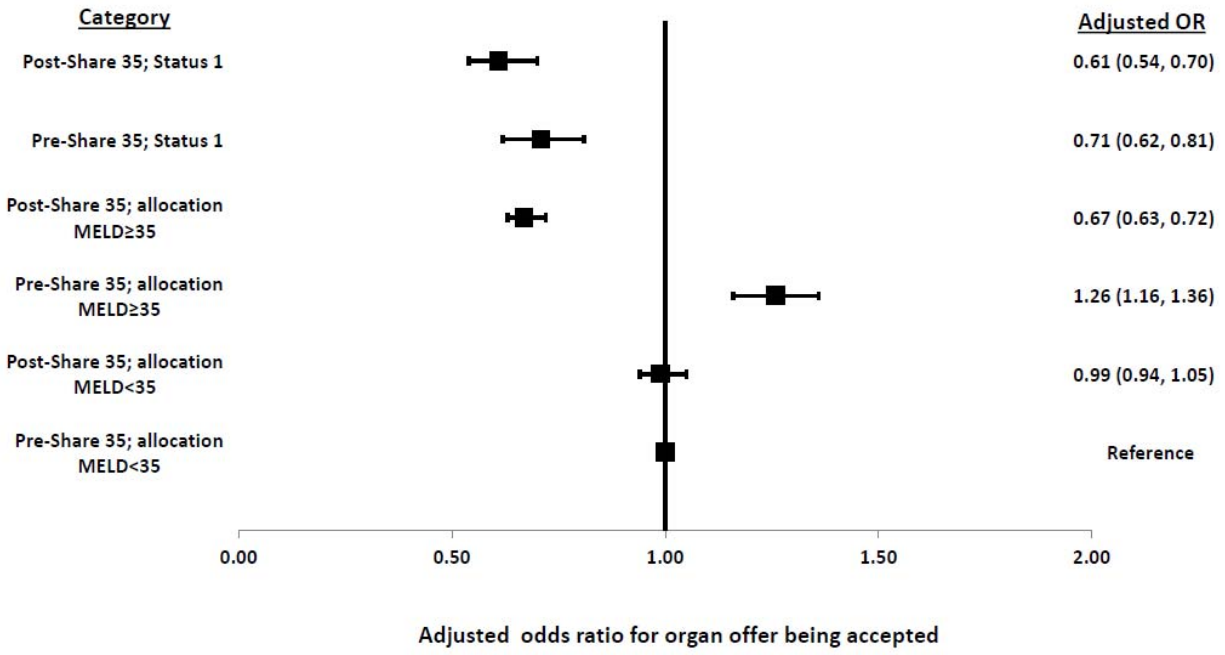
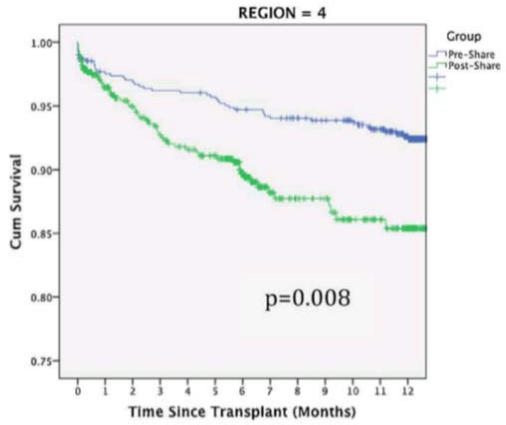
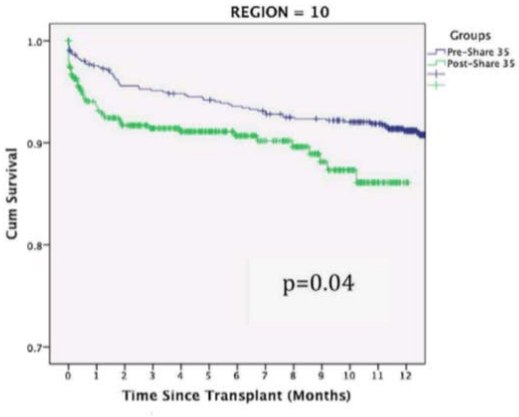


Figure 2. Decreased graft survival following initiation of Share-35 policy. (Halazun et al. Am J Trans 2016)

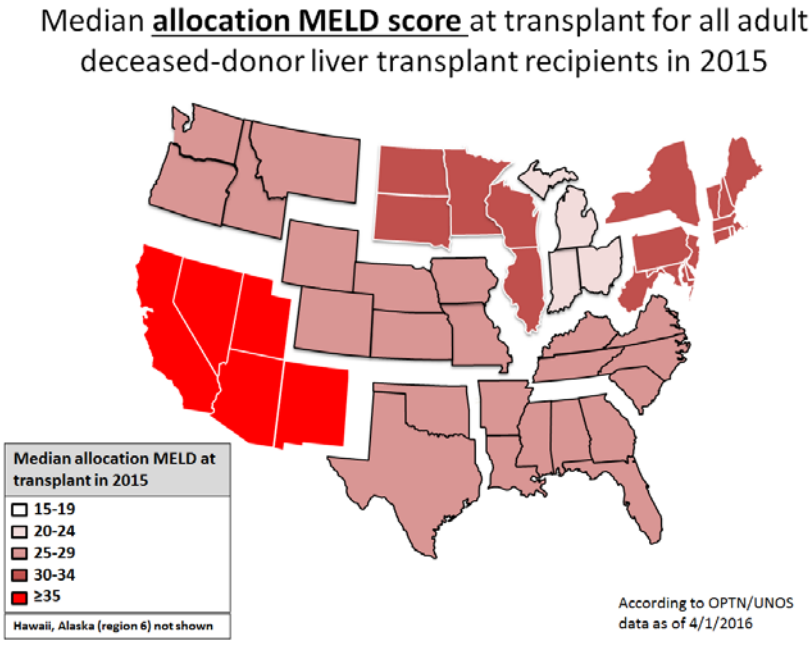


		Time (Months)				
		0 mths	3 mths	6 mths	9 mths	12 mths
No. At Risk	Pre-Share	462	438	427	413	327
	Post-Share	506	347	206	122	3



		Time (Months)				
		0 mths	3 mths	6 mths	9 mths	12 mths
No. At Risk	Pre-Share	473	443	434	418	331
	Post-Share	470	310	203	107	0

Figure 3. Median allocation and calculated MELD score among UNOS regions.



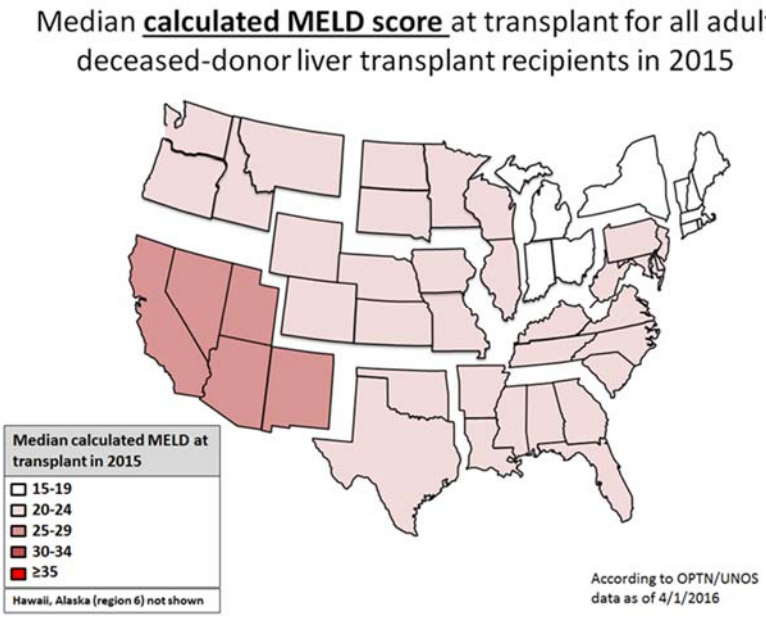


Figure 4. Correlation between a center's adjusted organ offer acceptance rate and waitlist mortality rate of patients ranked first on a match run. Each dot represents an individual transplant center. The dashed line represents the best-fit quadratic line of waitlist mortality regressed on the acceptance rate due to the non-linear relationship between center acceptance rate and center waitlist mortality rate. The area shaded in gray represents the 95% confidence interval of the standard error of the predicted waitlist mortality regressed on the acceptance rate, rather than the standard error of the mean. Correlation coefficient = -0.7, $p<0.001$.

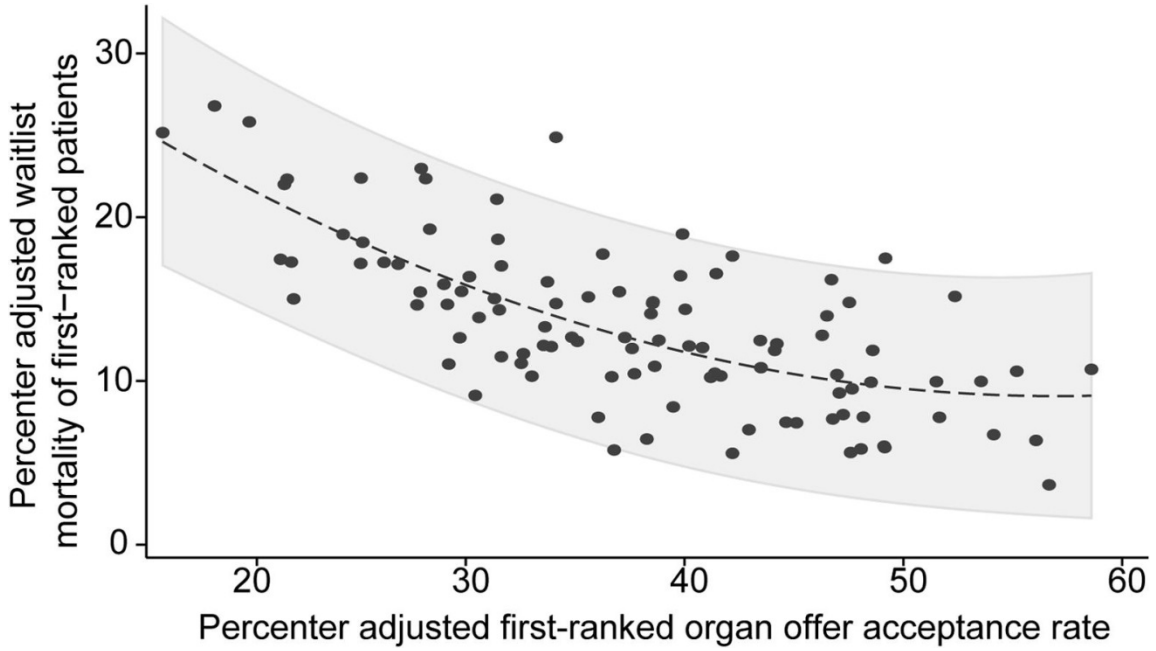
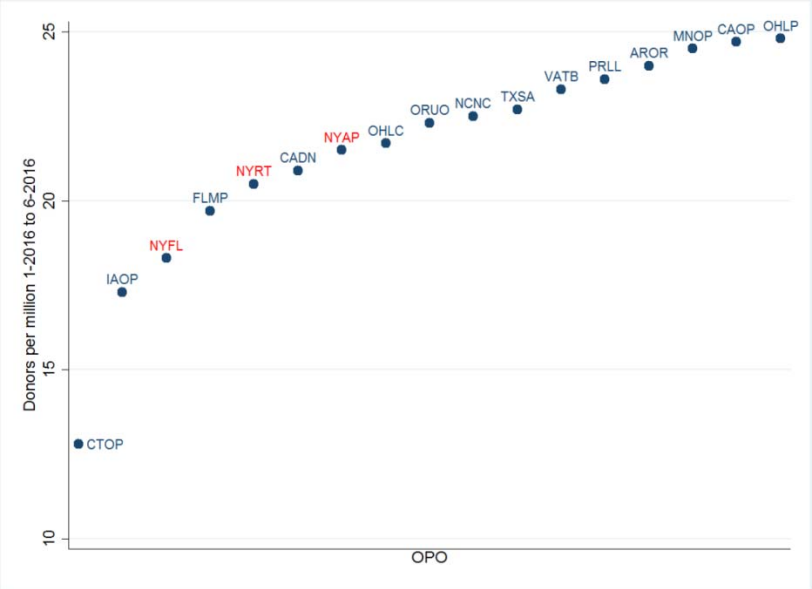


Figure 5. A. OPOs in the bottom quartile donors per million 1-2016 to 6-2016 **B**. OPOs in the top quartile donors per million 1-2016 to 6-2016



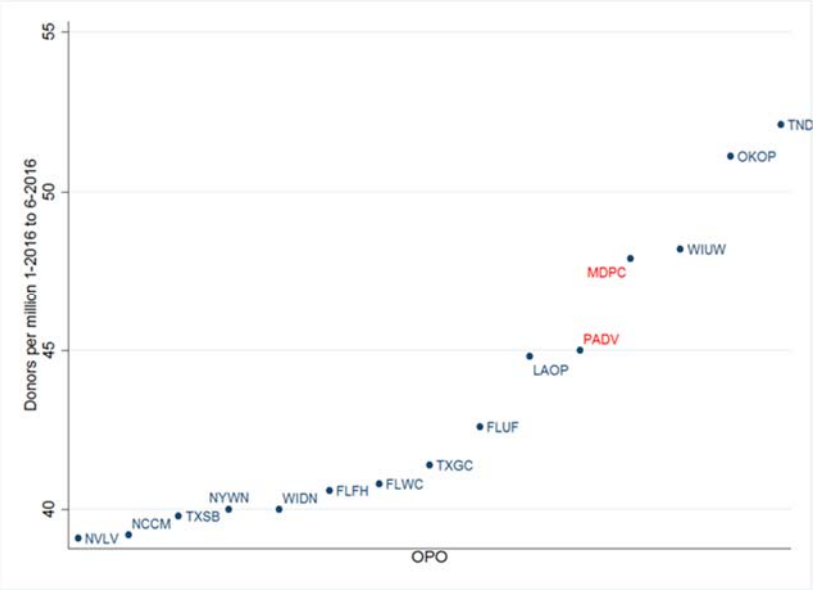
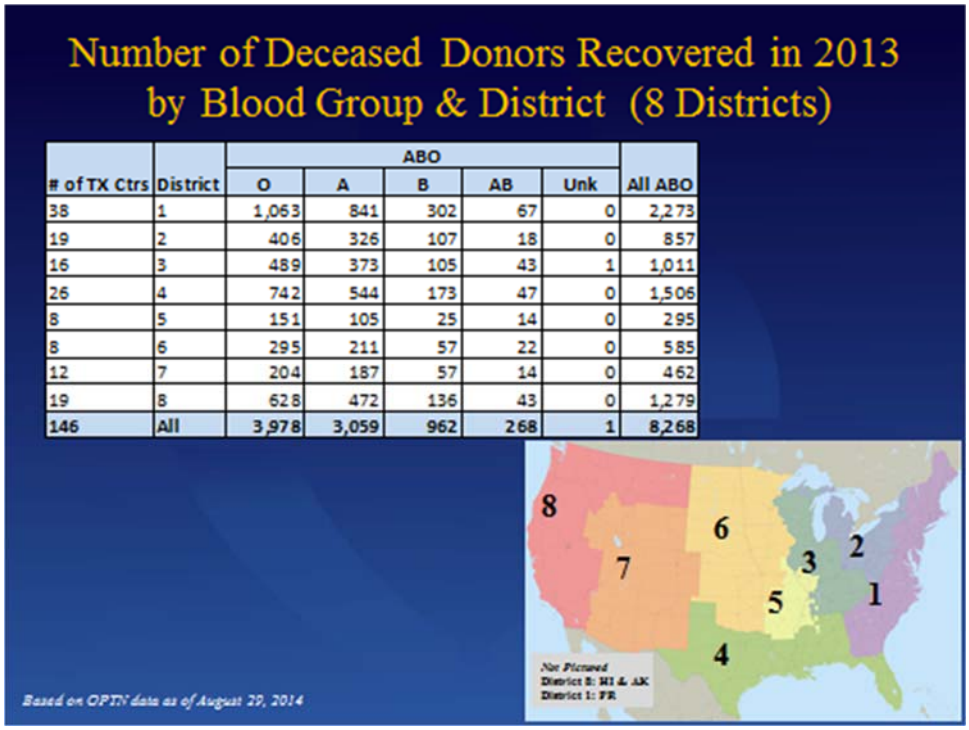


Figure 6. Number of deceased donors and liver transplant centers by district under the proposed redistricting plan (based upon 2013 data).



# of TX Ctrs	District	ABO					All ABO
		O	A	B	AB	Unk	
38	1	1,063	841	302	67	0	2,273
19	2	406	326	107	18	0	857
16	3	489	373	105	43	1	1,011
26	4	742	544	173	47	0	1,506
8	5	151	105	25	14	0	295
8	6	295	211	57	22	0	585
12	7	204	187	57	14	0	462
19	8	628	472	136	43	0	1,279
146	All	3,978	3,059	962	268	1	8,268