Robust models support redistricting liver allocation to reduce geographic disparity

Sommer E Gentry[1,2], **Dorry L Segev**[1,3], **Bertram L Kasiske**[4,5], **David C Mulligan**[6], and **Ryutaro Hirose**[7]

[1]Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, MD

[2]Department of Mathematics, United States Naval Academy, Annapolis, MD

[3]Department of Epidemiology, Johns Hopkins School of Public Health, Baltimore, MD

[4]Scientific Registry of Transplant Recipients, Minneapolis Medical Research Foundation, Minneapolis, MN

[5]Department of Medicine, Hennepin County Medical Center, University of Minnesota, Minneapolis, MN

[6]Department of Surgery, Yale University School of Medicine

[7]Department of Surgery, University of California San Francisco

We read with interest the Commentary of Mehrotra, et al., on modeling the organ allocation system (1), and wish to reply to critiques of the process and the methods used by the Organ Procurement and Transplantation Network (OPTN) to establish more equitable liver allocation.

The Department of Health and Human Services (DHHS) and Health Resources and Services Administration (HRSA) have long since given a mandate, in the published Final Rule, to minimize the effect of geography on access to transplantation for all candidates. The OPTN Board has instructed the Liver Committee to investigate redistricting (2, 3) and other approaches for reducing an unacceptable level of geographic disparity. While the liver committee's concept document primarily focused on redistricting, other publicly presented approaches have included broader sharing within the existing regions, and circular proximity distribution. Mehrotra et al. suggest statewide sharing as another alternative. The Liver Simulated Allocation Model (LSAM) certainly can be used to test sharing within any boundaries, optimized or not, but statewide sharing cannot reduce geographic disparity because there are enormous differences between states' listing and eligible death rates. Furthermore, because donor service area (DSA) boundaries do not respect state borders, statewide sharing would disrupt organ procurement organization / DSA relationships. Of the approaches that the committee examined, optimized redistricting would yield the best improvement in geographic equity.

Corresponding author: Sommer Gentry, 572-C Holloway Road, Mailstop 9E, Math Department, United States Naval Academy, Annapolis MD 21402, gentry@usna.edu, (410) 293-6724.

Deceased donor livers have been allocated according to model for end stage liver disease (MELD) score since 2002. Variation in transplant MELD across the country is not a desirable feature of allocation, but rather a measure of the extent to which ad hoc geographic boundaries have prevented organs from reaching the candidates who would derive the greatest benefit. Despite intimations to the contrary, prioritizing candidates by MELD score also prioritizes the candidates with highest survival benefit from transplantation (4). While ethical arguments about how candidates should be prioritized are important, changing the ordering of the waiting list within each geographic unit would not alter the calculus of geographic disparity. Maintaining geographic divisions in which supply and demand are profoundly imbalanced by disparate listing and eligible death rates (5) will prevent organs from reaching the most appropriate recipients, no matter which prioritization order is chosen.

We agree that redistricting should be dynamic, updating the districts whenever geographic disparities become so large as to be visibly unfair. Clearly, current disparities merit changes to the allocation map. Reassuringly, the sizable benefits of redistricting plans are stable from year to year; for example, districts optimized for 2006 data were still dramatically more equitable than the existing regions in a simulation using 2010 data (3).

Mehrotra et al. cite technical concerns about LSAM. Transplant policymakers have used the SAMs for many years to predict outcomes of allocation changes, and the SRTR has made major improvements in LSAM to support current liver committee efforts. For example, outcomes after the recent Share-35 change were similar to LSAM's projections (6). Still, we agree that LSAM does not and likely cannot predict behavior changes. However, in evaluating redistricting, this biases the simulation against accepting long-distance offers, and therefore the projected reductions in disparity from redistricting are very likely underestimates. Moreover, LSAM plays no role in designing the redistricted maps; it only evaluates the impact of these optimized maps in a granular simulation. The optimal districts are solutions to integer programs, independent of LSAM, that harmonize supply (deceased donors) and demand (waiting candidates whose MELD exceeds a threshold) in each area.

Mehrotra et al. argue for many additional sensitivity analyses and robust optimization techniques. While such studies would surely be welcomed from any contributor, they would also surely take time and have small marginal benefit. In the nearly 5 years since the OPTN effort for geographic equity began, hundreds of liver transplant candidates have died waiting for an organ that would have arrived in time under any of the redistricting plans proposed (2). Those candidates could not wait for perfect answers, and more candidates will meet needless deaths as long as the perfect remains the mortal enemy of the good.

Acknowledgments

References

1. Mehrotra S, Kilambi V, Gilroy R, Ladner DP, Klintmalm GB, Kaplan B. Modeling the allocation system: principles for robust design before restructuring. Transplantation. 2015; 99(2):278–281. [PubMed: 25651120]

2. Gentry SE, Chow E, Massie AB, Segev DL. Gerrymandering for justice: redistricting U.S. liver allocation (to appear). Interfaces. 2015

3. Gentry SE, Massie AB, Cheek SW, Lentine KL, Chow EH, Wickliffe CE, et al. Addressing geographic disparities in liver transplantation through redistricting. Am J Transplant. 2013

4. Merion RM, Schaubel DE, Dykstra DM, Freeman RB, Port FK, Wolfe RA. The survival benefit of liver transplantation. Am J Transplant. 2005; 5(2):307–313. [PubMed: 15643990]

5. Gentry SE, Chow EK, Massie A, Luo X, Zaun D, Snyder JJ, et al. Liver sharing and organ procurement organization performance. Liver transplantation. 2015; 21(3):293–299. [PubMed: 25556648]

6. Massie AB, Chow EK, Wickliffe CE, Luo X, Gentry SE, Mulligan DC, et al. Early changes in liver distribution following implementation of share 35. Am J Transplant. 2015; 15(3):659–667. [PubMed: 25693474]