

Robust Models Support Redistricting Liver Allocation to Reduce Geographic Disparity

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We read with interest the Commentary of Mehrotra et al¹ on modeling the organ allocation system 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 and Health Resources and Services Administration 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. Although 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 boundaries do not respect state borders, statewide sharing would disrupt organ procurement organization/donor service area relationships. Of the approaches that the committee examined, optimized redistricting would yield the best improvement in geographic equity.

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 Although 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 rates⁵ 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

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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. Although 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.

The Authors' Reply

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The authors appreciate the response of Gentry et al to the recent editorial regarding the restructuring of the liver allocation system and share their concerns for the outcomes of future transplant candidates.^{1,2} We neither wish to appear dismissive of the redistricting idea nor hinder any progress toward a better and more equitable system of liver allocation. However, the hesitation to endorse a static redistricting plan as in Gentry et al³ at this time stems from a greater concern for the experiences of future transplant candidates as well as the administrative and financial burdens imposed by a system change that might require repeated revisions.

First, an important clarification in response to the statement that the authors suggest statewide sharing as a solution—the authors of this editorial never advocated that or the reordering of the waiting list. However, in a previous article, some of the same authors suggested that partnerships among donor service areas (not limited to the same state) appear viable and can be implemented in a stepwise fashion without causing a disruptive change to the existing system.^{4,5} The authors only suggest such broader sharing as 1 alternative among those to be considered.

Any criticism of the methodology cited by Gentry et al^{1,3} and the Liver Simulated Allocation Model was given to help the transplant community better understand their limitations.

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Mehrotra et al² described the principles for designing a more robust liver allocation system with the aim of fostering dialogue on the potential opportunities and limitations. The authors share the common objective to improve the system. The collective concern is that the current proposal does not provide a design that is flexible with respect to future uncertainty. In any change to allocation, the transplant community overseeing the utility of a scarce donor resource must have a robust model for change as future changes to the system come slowly and at considerable cost. The transplant community also has an economic responsibility, and the costs of a system change must be justified in any proposal, which in case of Gentry et al³ is estimated to save the life of approximately 2% transplant candidates (1329 vs 1307).¹ It is unclear that this benefit will be realized if behaviors shift after implementing the new system or if the assumptions made were incorrect.³

It is therefore critical that before a substantive change is made to the allocation system, that multiple groups of experts in the community independently validate any proposed model for different future behavioral scenarios and, furthermore, that fair attempts are made to use the best methodologies and data available. The authors acknowledge that any critique of the present methodology is limited to what is known publicly. There are numerous examples where modeling has fallen short of the predictions, such as the significant increase in model for end-stage liver disease exceptions, the dramatic increases in transplant rates for hepatocellular carcinoma since the institution of model for end-stage liver disease, and most recently the new kidney allocation system.^{6–9} All these failed predictions are due to behavioral changes that were not anticipated in the model.

Hence, the enemy of good has never been the pursuit of the better, but rather the enemy of the good is haste and the lack of an open dialogue. Before taking on the burden of allocation restructuring at the transplant center and organ procurement level, we must develop a system that meets the principles of robust system design² that is adaptive to unforeseen changes and be in accordance with all elements of the Final Rule.⁷ It was our hope that this editorial would spur

more rigorous scientific dialogue that resolves geographic disparity in liver transplantation, and your letter¹ is a great step in this direction.

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