Redesign of US donor-liver network could boost transplants by several hundred per year

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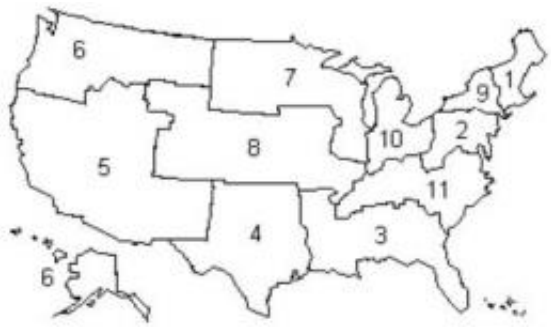


This is the current region map. Credit: Nan Kong

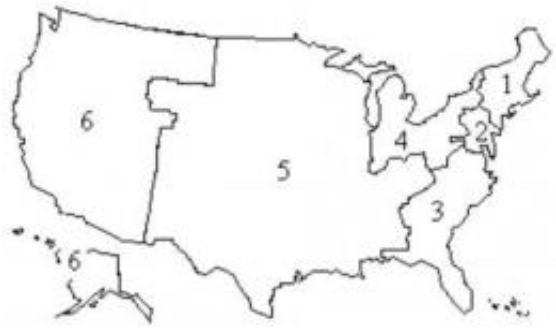
A redesign of the nation's donor-liver distribution network developed by University of Pittsburgh researchers could result in several hundred more people each year receiving the transplants they need.

The team reports in the journal INFORMS Management Science that donor livers currently are doled out to 11 national regions that evolved with little regard for geography and demographics, an arrangement that prevents many livers from getting to prospective recipients in time. The Pitt researchers instead trimmed the network down to six regions that better account for urban and rural population differences, geographic distance, and the anticipated supply of and demand for donor livers. They calculated that their rearrangement could result in up to 14 percent more transplants each year, a sizable increase considering that more than 6,000 transplants were performed in 2009 alone.

Andrew Schaefer, an associate professor of industrial engineering in Pitt's Swanson School of Engineering, said that the team's proposed regions do not change how livers are allocated—the most critical patients still receive an organ first—but rather put more potential donors and recipients within range of one another. Schaefer worked with his former doctoral student and lead author Nan Kong, a Pitt alumnus now at Purdue University; Brady Hunsaker, a former Pitt professor of industrial engineering now at Google Pittsburgh; and Mark S. Roberts, professor and chair of health policy and management in Pitt's Graduate School of Public Health. The project was supported by grants from the National Science Foundation and the Air Force Office of Scientific Research.

"We're simply redesigning the hierarchy by geographic and demographic information to increase the likelihood that recipients will be found closer to the liver's point of origin," Schaefer said. "Under the current system, a liver harvested in New Jersey is more likely to go to a patient in Beckley, West Virginia, than one in New York City. Plus, it is well known that there are big geographic disparities in procurement and that there are some places where it is better to be on an organ waiting list than others."

Roberts, whose research includes developing mathematical models for efficient treatment, explained that regions are used by local organ-procurement organizations (OPOs) to provide livers to recipients in other parts of the country if recipients are not available at the local level. But the national regions were not developed scientifically or with efficiency in mind. In the end, livers are wasted, he said.



This is one of the Pitt rearrangements. Credit: Nan Kong

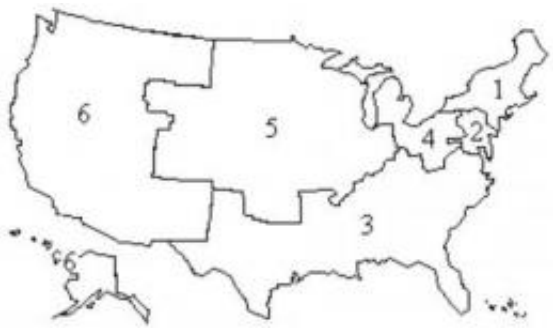
In some cases, dense populations supply and draw from rural areas that have neither the requisite need for nor stock of donor livers. For instance, Seattle is the largest city in the region covering the entire Pacific Northwest, plus Hawaii and Alaska. Oklahoma is paired only with Texas, which has more than six times the population. At the same time, large population centers such as New York City and New Jersey that could easily support each other are in separate regions, while a swath of countryside in the Great Plains states has no large city handy.

To determine the most efficient regional arrangements, the Pitt researchers plugged procurement data from OPOs nationwide into an optimization model they developed called an integer program that considered more than a trillion configurations before finally deciding on the two most efficient, Schaefer said.

Illustrations of the current regional breakdown and both Pitt rearrangements are available on Pitt's Web site at www.news.pitt.edu/news/Schaefer-donor-liver-redesign.

Both Pitt models basically break the Eastern United States into four proportioned population clusters—New England, New York City-New Jersey, the Southeast, and the Rust Belt—while the Western states form

two expansive regions anchored by dense areas. The entire West Coast—including population giant California—combined with the Mountain states, the Wouthwest, and Alaska and Hawaii. The northern Midwest joins the Chicago area in one model and, in the other, is part of an area that sweeps from North Carolina to Arizona, and from Texas to North Dakota.



This is the Pitt researchers' second possible redesign. Credit: Nan Kong

Although the Western regions are huge, Schaefer said, the data the team used showed that grueling journeys from, say, Houston to Minnesota are not common and that giving sparsely populated areas access to a larger supply of potential donors makes such long distances worthwhile.

The team's next step is to maximize fairness within the regions so that even more people have access to donor livers, Roberts said. The team demonstrates a method for ensuring equality in a paper to be published at a future date in the INFORMS Journal of Computing.

"If we can find a structure that benefits everyone, that's the best chance of pushing these kinds of changes through," Roberts said. "Still, it's important that through this rearrangement we waste fewer organs and get more people transplanted by what is a significant number when you

consider that that number represents real people."

Provided by University of Pittsburgh