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Math optimizes kidney matches

Elizabeth Thomson
News Office

Many more people could get kidney transplants thanks to new mathematical techniques designed to optimize a novel matching program at the national level, according to MIT graduate student Sommer Gentry and her husband, a transplant surgeon at Johns Hopkins.

More than 60,000 patients are awaiting kidney transplants in the United States. About one-third of patients with willing live donors will be excluded from the surgery because of blood type and other incompatibilities.

Gentry, who will receive the Ph.D. from MIT this month in electrical engineering and computer science, her husband, Dr. Dorry Segev, and Johns Hopkins colleagues have demonstrated that a national matching program for kidney paired donation, or KPD, would ensure the best possible kidney for the greatest number of recipients who have incompatible donors. Currently KPD is practiced only on a local or regional level.

Key to the work is a new algorithm they developed to optimize the selection process. The work was reported in the *Journal of the American Medical Association*.

KPD provides organs to patients who have a willing, designated donor who is not compatible. A kidney from such a donor is matched to—and transplanted into—the recipient of a second incompatible donor-patient pair and vice versa. The transplants are performed simultaneously.

“Our findings demonstrate that a national pool of kidney donors and recipients, combined with new mathematical techniques for sorting through them to find the best possible organ matches, will not only allow more people to get the transplants they need, but will dramatically cut health-care costs, reduce disruptive and unnecessary travel for patients, and ensure that transplanted kidneys have the best possible chance of survival,” said Segev, lead author of the paper.

“Even if only 7 percent of patients awaiting kidney transplantation participated in an optimized



PHOTO / DORRY SEGEV

MIT doctoral student Sommer Gentry and her husband, surgeon Dorry Segev, are working to improve the system of matching kidney donors with recipients.

national KPD program, the health-care system could save as much as \$750 million,” he said.

The team’s new algorithm for making the most—and best—KPD matches is based on a technology called optimization. Optimization, a part of Gentry’s thesis work, has already proved successful in facilitating such tasks as airline scheduling and online driving directions.

“Dorry came to me with just a description of the problem and a notion that there must be an optimization procedure in it somewhere,” Gentry said.

The team then tested the new algorithm against the algorithm currently used to match KPD patients. After applying each to simulated pools of incompatible donor/recipient pairs, they found that a national KPD program using the new algorithm would indeed result in more transplants, better matches and more transplanted kidneys surviving at five years.

The researchers have developed an interactive web site, www.OptimizedMatch.com, that provides more details and interactive demonstrations of the algorithm and its use in transplantation.

The research was funded by the American Society of Transplant Surgeons and a Computational Science Graduate Fellowship to Gentry from the U.S. Department of Energy.