Does Paired Kidney Exchange Reduce Demographic Disparities in Transplant Outcomes?

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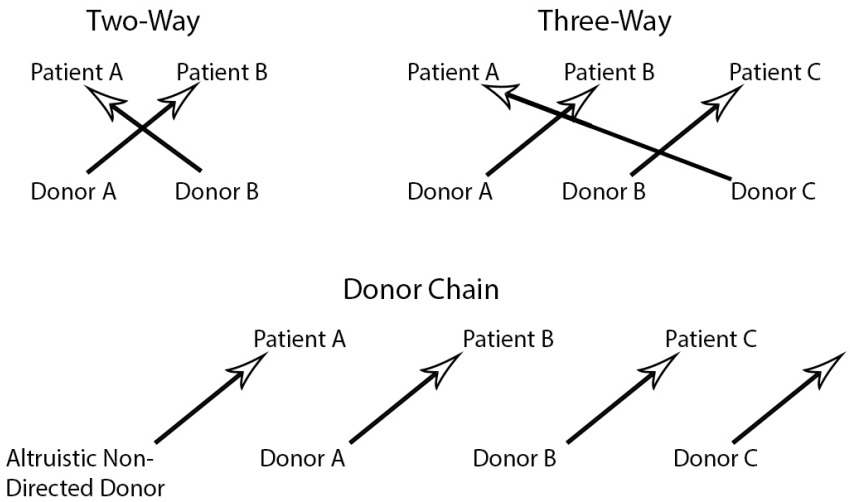
What is Paired Kidney Exchange?



- Incompatible or poorly-compatible donor-recipient pairs are added to a registry over which matches are determined
- Algorithms maximize some mix of match quantity & quality
  - Quality of match: blood type, presence or absence of certain antibodies, age, travel distance, wait time

Motivation

- Kidney exchanges improve TX outcomes (Teltser, 2019)
  - 64% of exchange transplants represent new living donor TXs
  - Exposure to exchange increases survival, reduces waiting time
- Do these gains accrue evenly across groups? Do they reduce or exacerbate existing disparities in transplant outcomes?
  - No formal prices or market mechanism; equity in organ allocation is a clearly-stated priority
  - Paired exchange solves *living donor* compatibility issues

Existing Racial Disparities in Transplant Access

- In 2019, only 11% of living donor kidney TXs went to black patients; 25% of people diagnosed with ESRD were black
- Lower rates of survival after 1, 3, 5 years (Gordon et al., 2010)
- Among black recipients, 25% receive living donation. In contrast, 46% among white recipients (Gore et al., 2009)
- Disparity is growing over time (Purnell et al., 2018)
- Potential explanations (from Gore et al., 2009):
  - Willingness to ask relatives and friends
  - Distrust of medical system, institutional racism
  - Donor suitability — higher rates of diabetes, hypertension

Simple Conceptual Framework

- If gap is primarily attributable to relative lack of *compatible* willing donors, exchange could reduce the disparity
- However, if attributable to having fewer willing/suitable donors, then exchange could exacerbate the disparity

Data

- Universe of registration-level waiting list and TX data from the Scientific Registry of Transplant Recipients (SRTR)
  - Exclude if age$<$18 at time of registration/transplant
- Includes zip codes of residence for TX candidates/recipients and donors, zip codes of TX centers
- Calculate zip-month TX counts from January 2000 (data quality improved) through December 2018 (end of sample)

Estimation of Quantity and Quality

$$Y_{(i)zt} = \lambda Activity_{zt} + \alpha_z + \gamma_t + \eta_z t + \zeta_{sy} + \epsilon_{(i)zt} \quad (1)$$

- Y includes TX outcomes (for zip z in month-year t) and quality outcomes (individual i in zip z and month-year t)
- α_z, γ_t, $\eta_z t$, and ζ_{sy} are zip code FEs, month-year FEs, zip-specific linear trends, and state-year FEs
- Activity: time-varying local exposure to exchange

Measuring Exposure to Exchange Activity

- Use variation in exchange activity across time and place to estimate impact of exposure on transplant outcomes
- $Activity_{\tilde{z}t}$ = number of exchanges within 50 miles of zip code in the month of observation (excluding own if relevant)
- Why 50 miles? Patients must be able to cost-effectively access a participating center
  - 71% of exchange TXs are performed within 50 miles
- No evidence of demand-driven exchange adoption, endogenous patient relocation (Teltser, 2019)

Quantity Results

		Exchange	Direct Living	Any Living
Nearby exchanges (Excluding Own)				
	White	0.00038***	-0.00011*	0.00028***
		(0.00003)	(0.00006)	(0.00007)
		[0.00084]	[0.01104]	[0.01213]
		45.5%	-1.0%	2.3%
	Black	0.00017***	-0.00009**	0.00010**
		(0.00002)	(0.00004)	(0.00004)
		[0.00020]	[0.00243]	[0.00269]
		86.7%	-3.7%	3.7%
	Other	0.00020***	-0.00011**	0.00009*
		(0.00002)	(0.00005)	(0.00005)
		[0.00026]	[0.00310]	[0.00342]
		77.6%	-3.5%	2.6%
P-values for tests of different coefficients:				
Black and White		**0.000**	0.765	**0.028**
Other and White		**0.000**	0.971	**0.032**
Black and Other		0.387	0.756	0.907

Quality Results

		Graft Survival			Registration	HLA
		>1 year	>3 years	>5 years	Duration (Days)	Mismatches
Nearby Exchanges (Excluding Own)						
	White	-0.0010	-0.0006	0.0010	-0.798	0.0124***
		(0.0008)	(0.0012)	(0.0018)	(1.879)	(0.0047)
		[0.93]	[0.85]	[0.77]	[493.87]	[3.49]
		-0.1%	-0.1%	0.1%	-0.2%	0.4%
	Black	0.0026***	0.0033**	0.0033	-2.476	-0.0034
		(0.0009)	(0.0015)	(0.0023)	(2.685)	(0.0045)
		[0.91]	[0.80]	[0.69]	[826.61]	[4.20]
		0.3%	0.4%	0.5%	-0.3%	-0.1%
	Other	0.0016*	-0.0020	-0.0025	-5.263*	-0.0078
		(0.0009)	(0.0015)	(0.0022)	(2.913)	(0.0053)
		[0.94]	[0.88]	[0.81]	[774.75]	[3.78]
		0.2%	-0.2%	-0.3%	0.7%	-0.2%
P-values for tests of different coefficients:						
White and Black		**0.002**	**0.048**	0.425	0.609	**0.015**
White and Other		**0.023**	0.466	0.214	0.196	**0.004**
Black and Other		0.398	**0.015**	**0.064**	0.481	0.524

Summary of Key Findings

- When exchange exposure increases, black patients experience
  - larger % increase in exchange TXs and slightly larger % increase in living donor TXs than white patients
  - larger increases in 1 and 3-year survival than white patients
  - no decrease in antibody mismatches, while white patients do
- However,
  - implied substitution between direct living and exchange is 53% for black patients, 29% for white patients
  - as with white patients, black patients do not experience a reduction in time to transplant

Concluding Remarks

- Exchange seems to have (marginally) reduced racial disparities in kidney transplant access
- Results can inform the design of kidney exchange matching algorithms and allocation policy moving forward
- How can we further reduce the gap?
  - Exchange programs could place greater emphasis on enrolling and matching disadvantaged patients
  - Another tool: expand list exchange, which can facilitate allocation of living donor kidneys from incompatible pairs to disadvantaged patients on the deceased donor waitlist