

Strategies to Expand Kidney Exchange, and an Update of the US System

1st part

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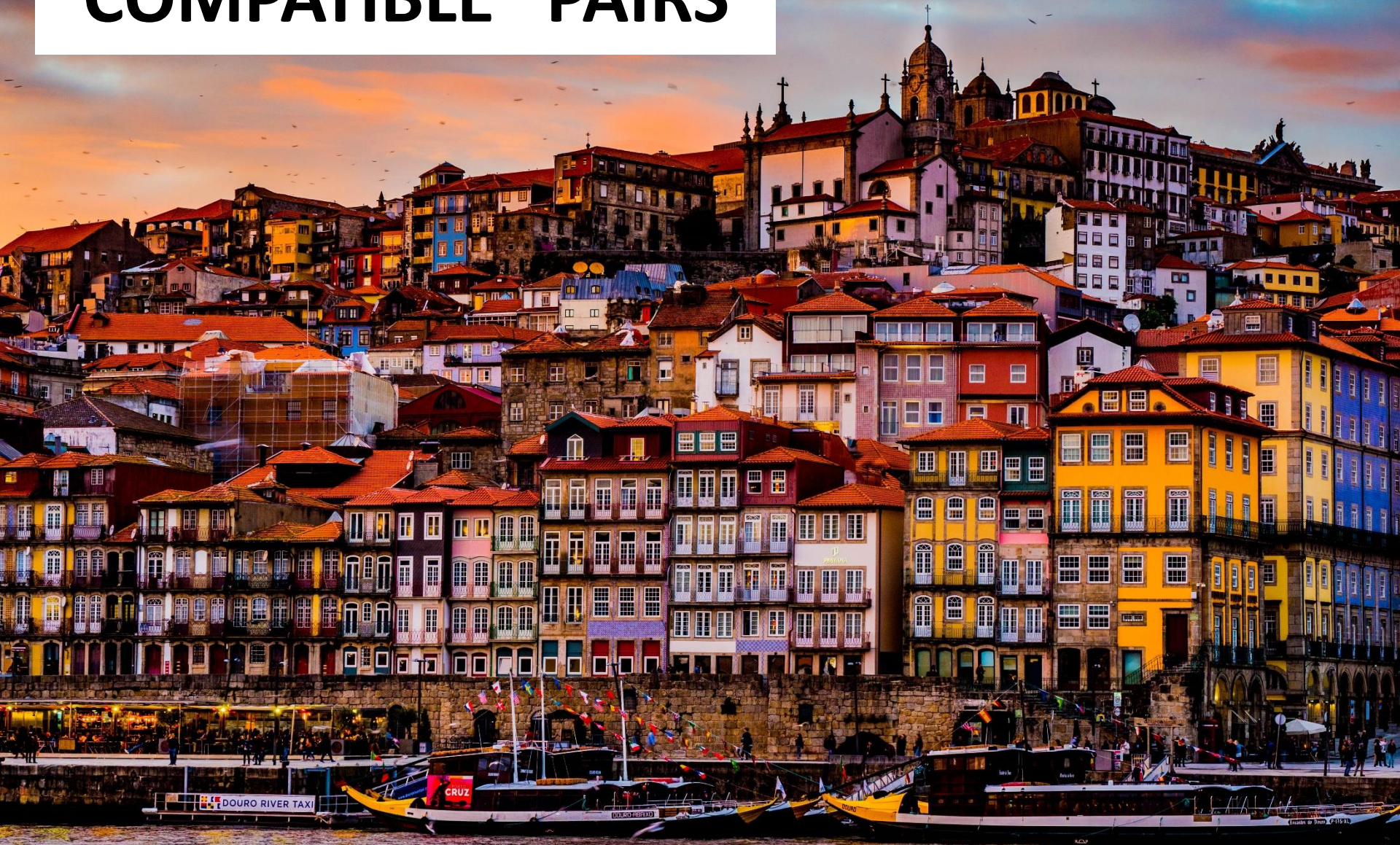
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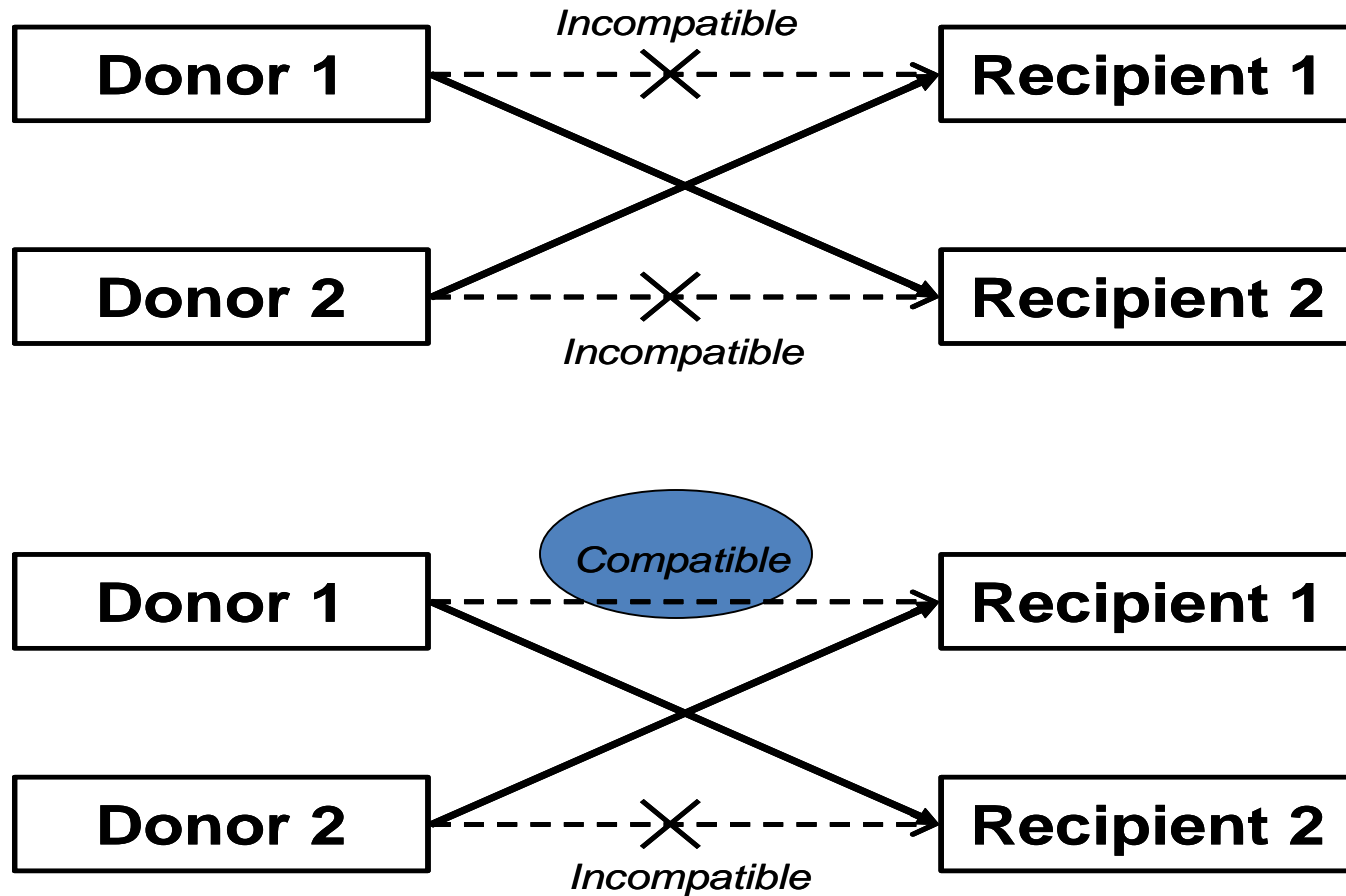
Overview

- "Compatible" pairs
- Shipping kidneys
- National Kidney Registry update
- Role of Kidney Exchange in the context of new allocation priorities and desensitization
- New calculators

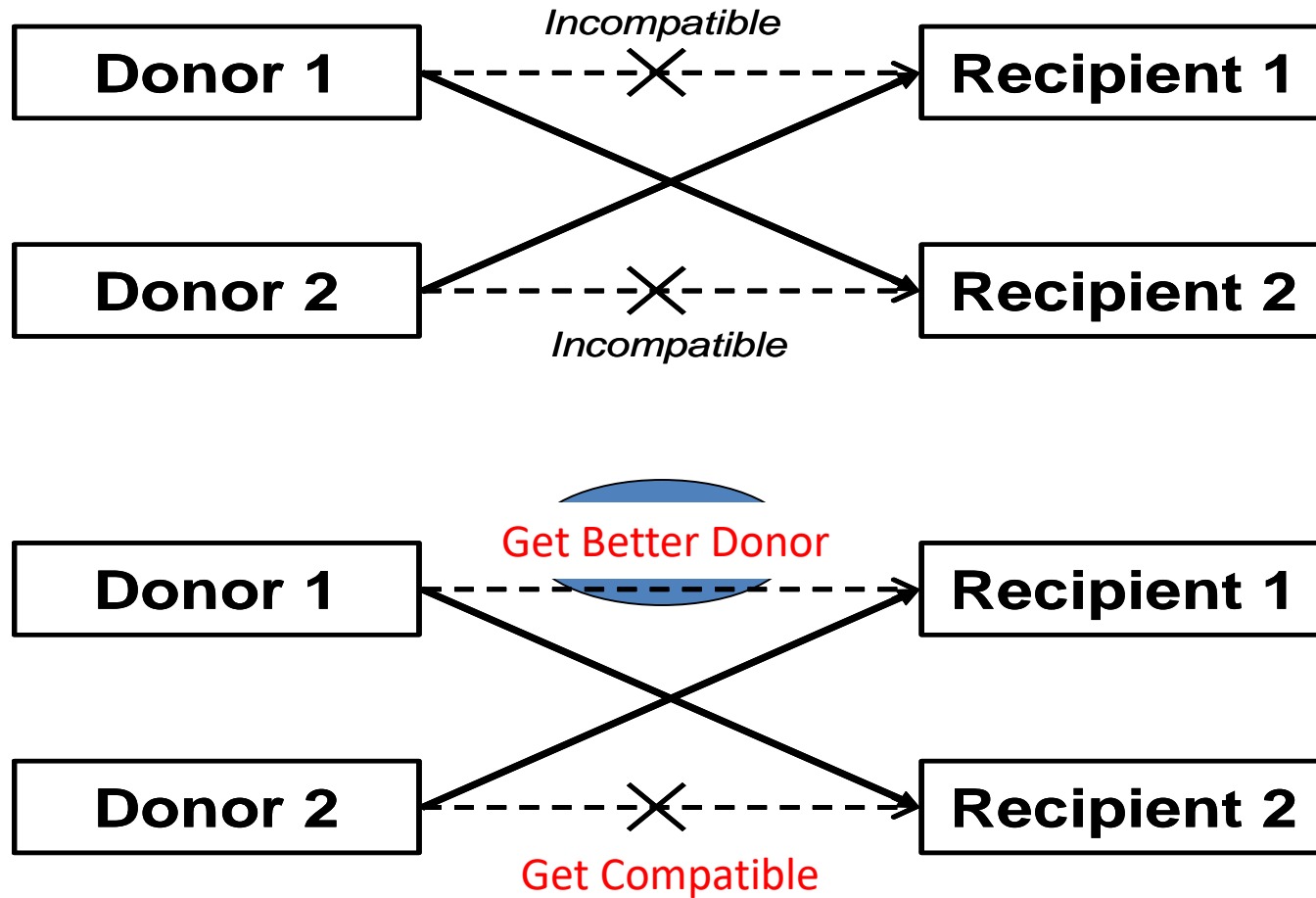
"COMPATIBLE" PAIRS



Compatible Donors in KPD



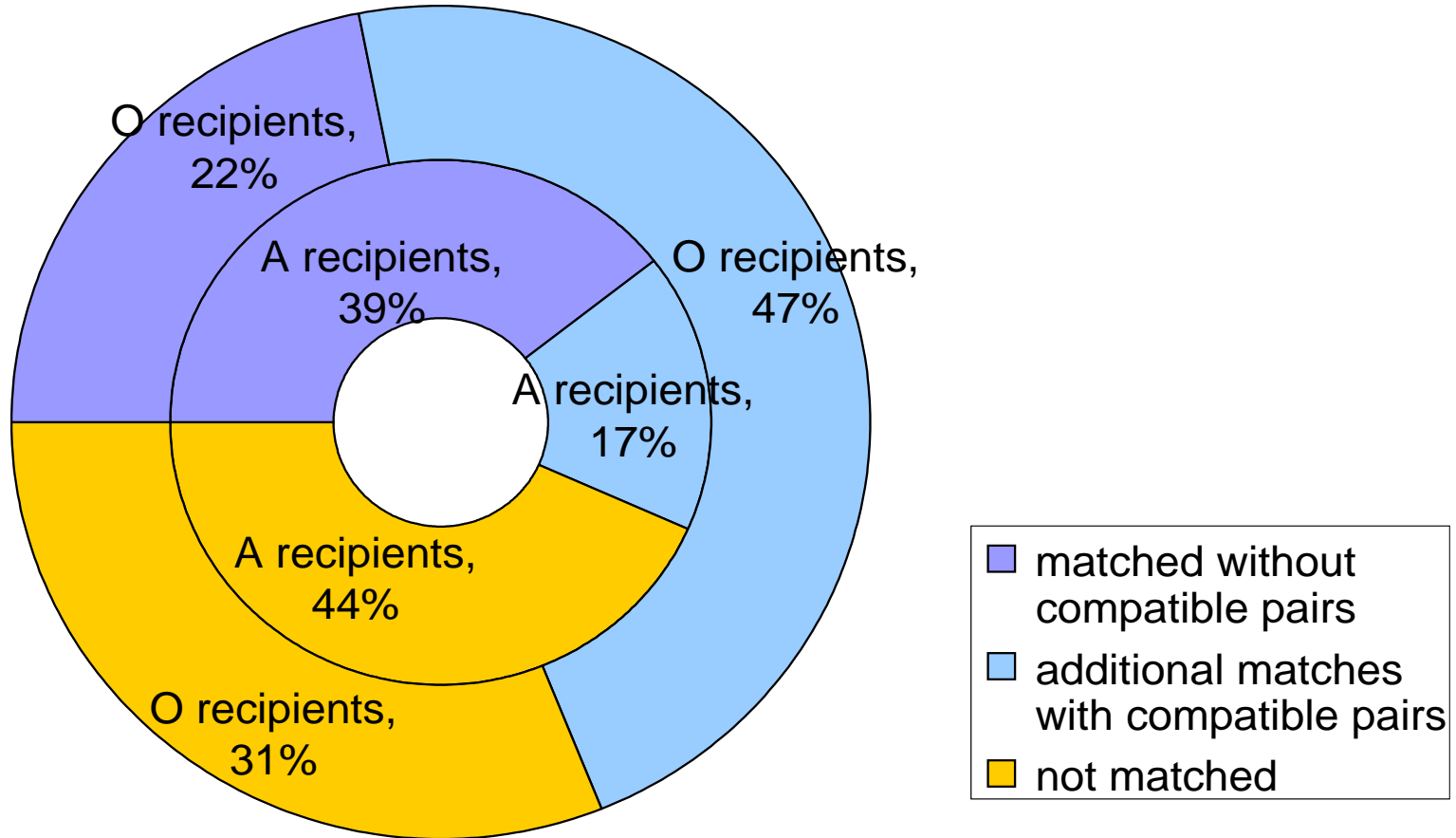
Compatible Donors in KPD



Compatible Donors in KPD

- What a compatible pair might gain:
 - Younger donor
 - Better size match (nephron mass)
 - O-mismatch
 - Altruistic decision
 - Financial feasibility
- What the incompatible pool gains if compatible pairs participate:
 - Higher match rates
 - More O recipients match

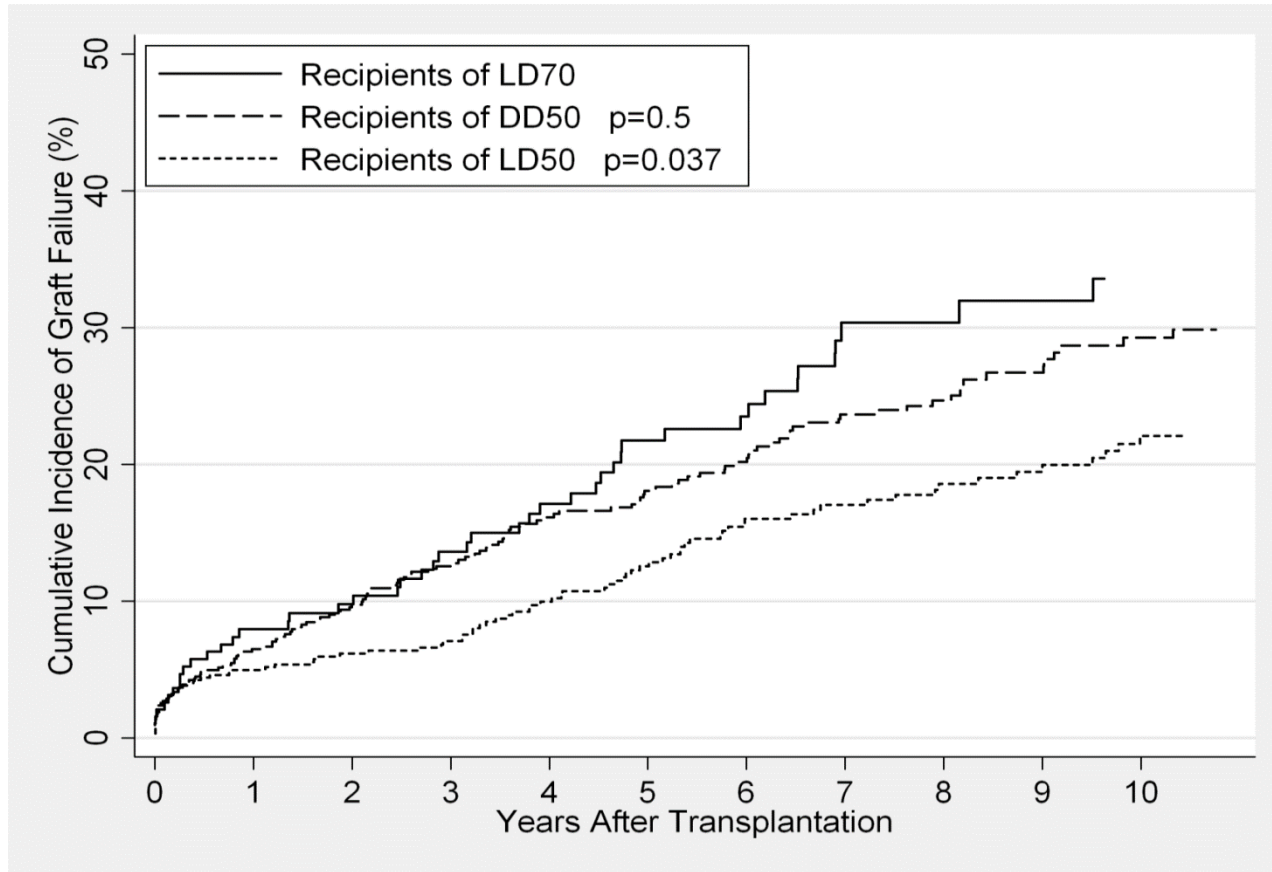
Compatible Donors in KPD



Compatible Donors in KPD

- 67 year old ex-president of Notre Dame University -> 42 year old nephew
- 38 year old male -> 63 year old mother
Sensitized, ABO incompatible
- 42 year old recipient gets a younger donor
- 63 year old recipient gets a compatible donor

Younger Donors = Better Outcomes



Berger/Segev, CJASN 2011

The Old Compatibility Paradigm

- First check blood type and HLA
- If incompatible → exclusion, find new donor, KPD, desensitization, etc
- If compatible → move forward with live donor transplantation

A New Compatibility Paradigm

- Check donor for eligibility
- Identify the various incompatibilities – age, nephron mass, ABO, HLA (donor-specific antibodies and HLA mismatch), etc.
- Use KPD to improve donor, regardless of the source of incompatibility

Live Donor KDPI

Donor characteristic	aHR		
LD: Age per year (over age 50)	1.02	1.02	1.03
LD: eGFR (per 10 units)	0.58	0.70	0.83
LD: BMI (per 10 units)	1.01	1.09	1.16
LD: Male donor to male recipient	0.75	0.81	0.87
LD: Black race	1.15	1.25	1.37
LD: ABO incompatible	1.03	1.27	1.58
LD: History of cigarette use	1.09	1.16	1.23
LD: Unrelated to recipient	0.84	0.90	0.97
LD: # HLA-B mismatches	1.03	1.08	1.14
LD: # HLA-DR mismatches	1.04	1.09	1.15

Massie/Segev, AJT, 2016

LKDPI equation

$$\begin{aligned} & 5.23 \\ + & 2.24 & * (\text{age}-50) \text{ if age} > 50 \\ - & 0.37 & * \text{eGFR} \\ + & 0.89 & * \text{BMI} \\ - & 22.20 & \text{if don/ recip both male} \\ + & 23.47 & \text{if African-American} \\ + & 25.04 & \text{if ABO incompatible} \\ + & 15.03 & \text{if donor history of cigarette use} \\ - & 10.51 & \text{if unrelated} \\ + & 8.34 & * (\# \text{ HLA-B mismatches}) \\ + & 8.77 & * (\# \text{ HLA-DR mismatches}) \end{aligned}$$

Massie/Segev, AJT, 2016

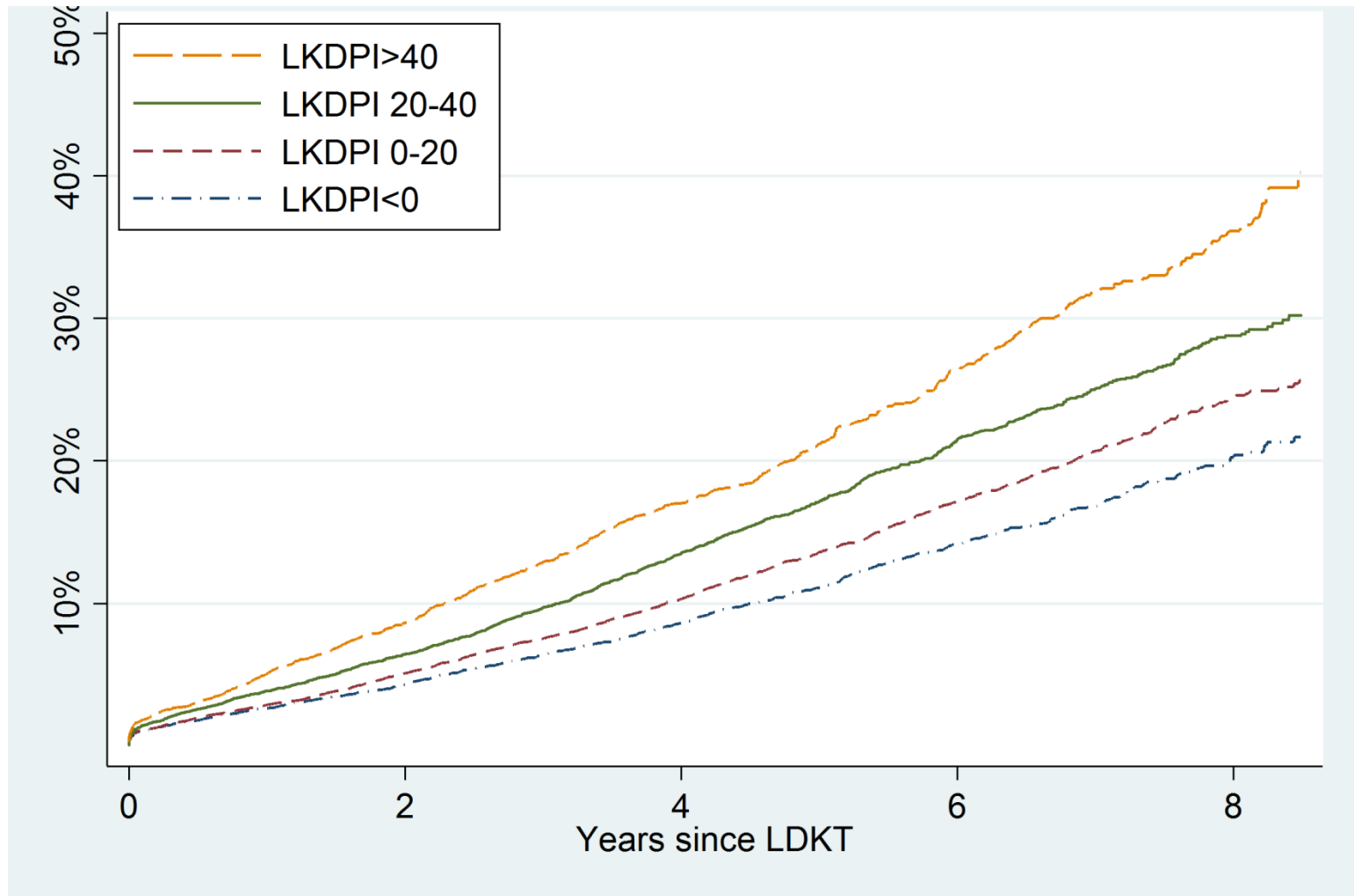
LKDPI equation

Example: 43-year-old nonsmoking non-AA F, eGFR 95, BMI 24

5.23		5.23	
+ 2.24	* (age-50) if age>50	+ 2.24	* 0
- 0.37	* eGFR	- 0.37	* 95
+ 0.89	* BMI	+ 0.89	* 24
- 22.20	if don/recip both male	- 0	
+ 23.47	if African-American	+ 0	
+ 25.04	if ABO incompatible	+ 0	
+ 15.03	if donor history of cigarette use	+ 0	
- 10.51	if unrelated	- 0	
+ 8.34	* (# HLA-B mismatches)	+ 8.30	* 1
+ 8.77	* (# HLA-DR mismatches)	+ 8.77	* 1

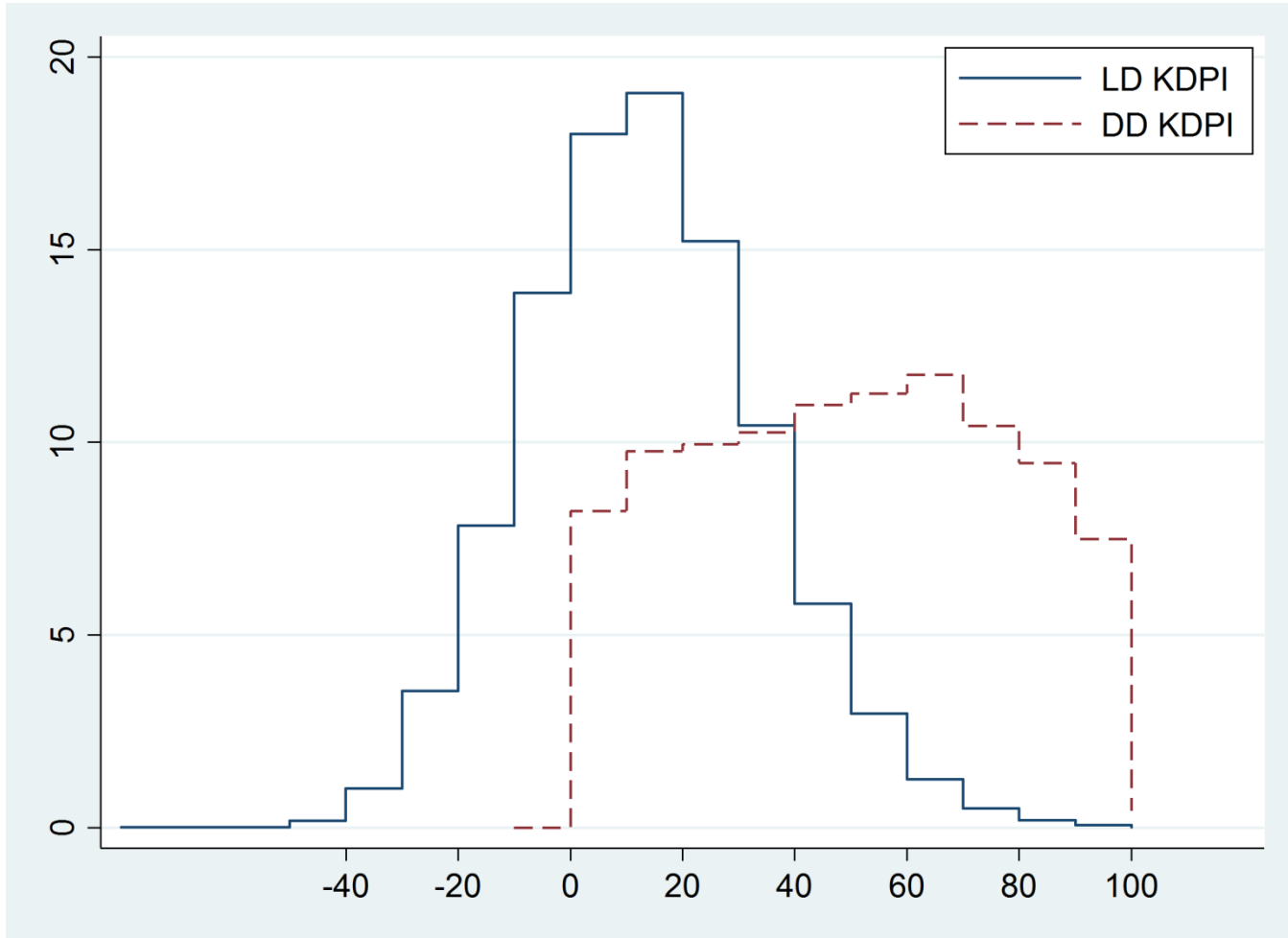
LKDPI = 8.4

Cumulative graft loss by LKDPI



Massie/Segev, AJT, 2016

Distribution of LKDPI



Massie/Segev, AJT, 2016

Brief Communication

Kidney Exchange to Overcome Financial Barriers to Kidney Transplantation

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C. L. Marsh⁵, J. Rogers⁶, S. E. Rees^{1,2}, A. Cicero⁷,
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the logistical obstacles in this approach, although considerable, are surmountable.

Abbreviations: ABOi, blood type incompatible; APD, Alliance for Paired Donation; AVF, arteriovenous fistula; BT, blood type; CMS, Centers for Medicare & Medicaid Services; DSA, donor-specific antibody; ESRD, end-stage renal disease; GKE, global kidney exchange; HLA, human leukocyte antigen; HRSA, Health Resources and Services Administration; KE, kidney exchange; NEAD, nonsimultaneous extended altruistic donor; NOTA, National Organ Transplantation Act; PRA, panel reactive antibody; RRT, renal replacement therapy; TB, tuberculosis; WNV, West Nile virus

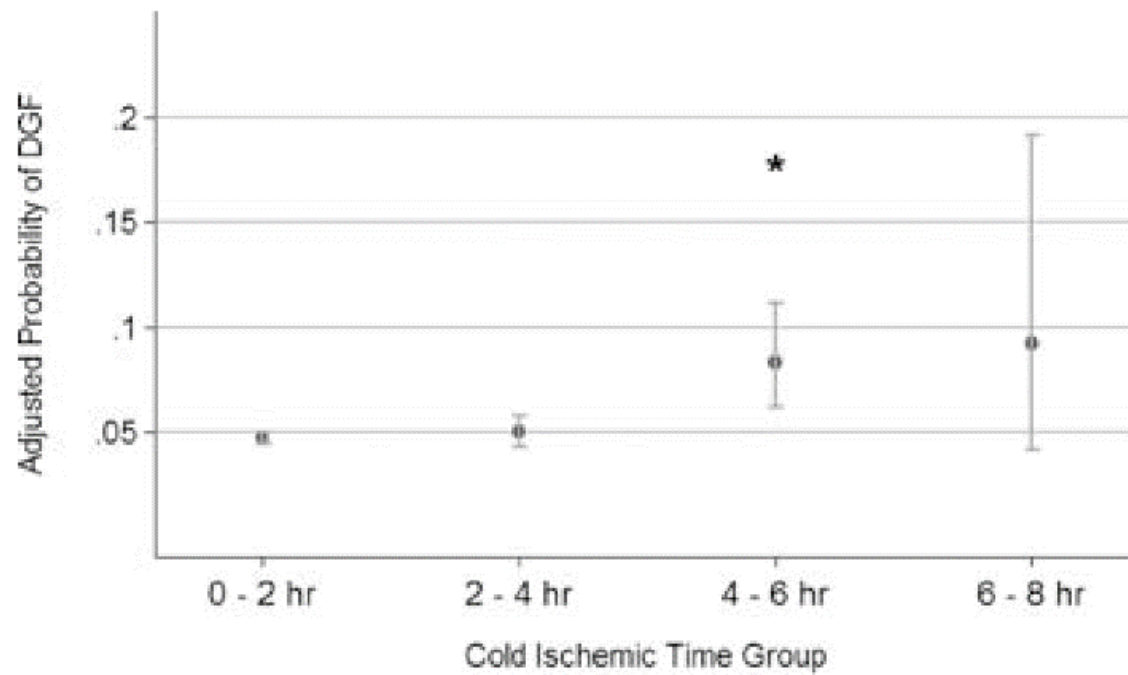
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SHIPPING KIDNEYS



Cold Ischemia Time and Allograft Outcomes in Live Donor Renal Transplantation: Is Live Donor Organ Transport Feasible?

- OPTN data
- 38,467 LD transplants with various CIT (why?)
 - 0-2h: N=32,719
 - 2-4h: N=4,663
 - 4-6h: N=692
 - 6-8h: N=393
- 15-year cohort (long f/u)



• Mean — 95% CI

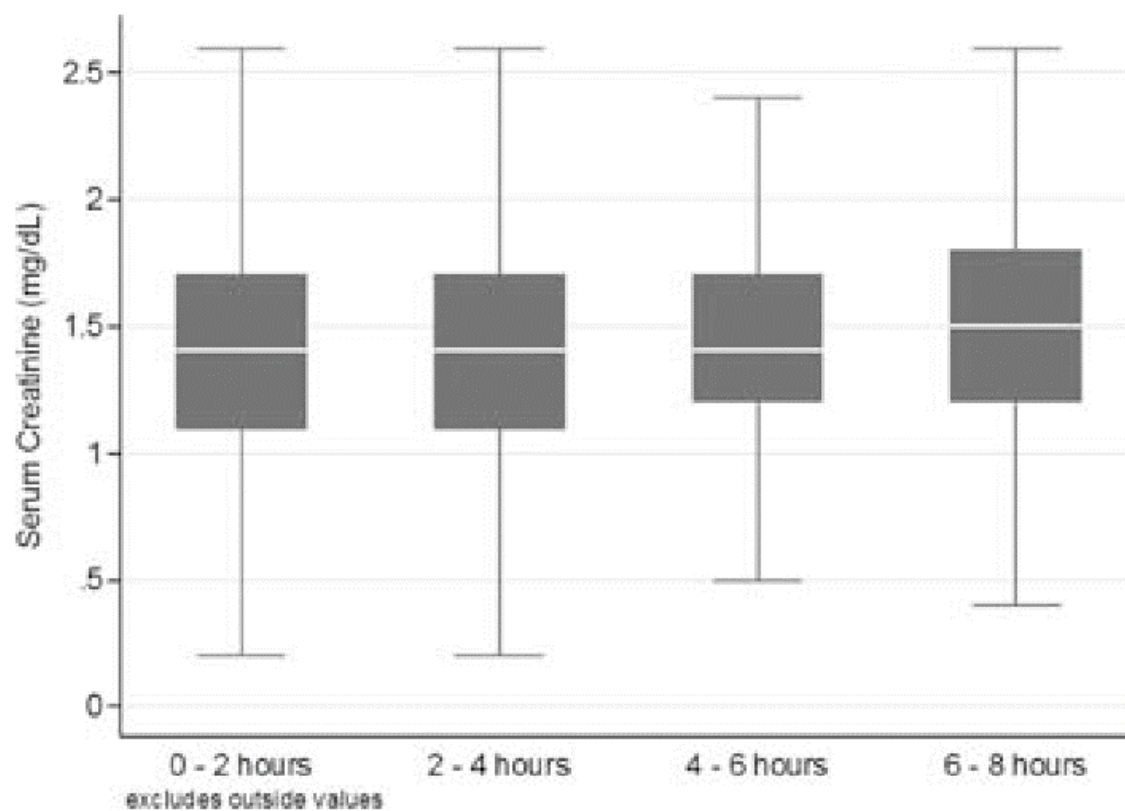
* $p < 0.05$ compared with 0 - 2 hr group

Adjusted Probability of DGF

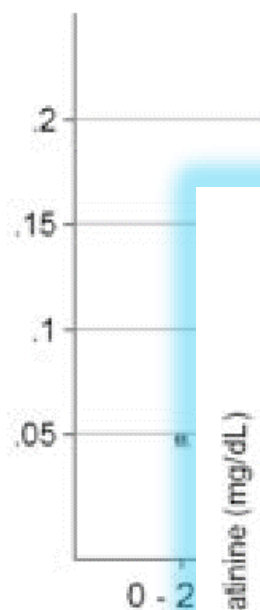
.2
.15
.1
.05

0 - 2

* $p < 0.05$

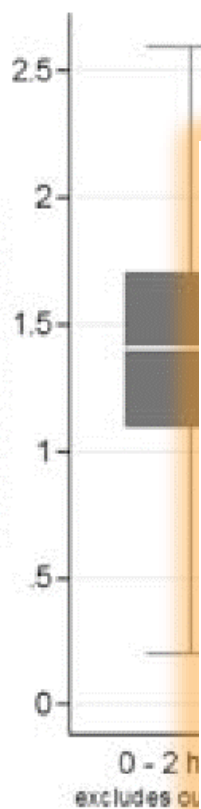


Adjusted Probability of DGF



* $p < 0.05$

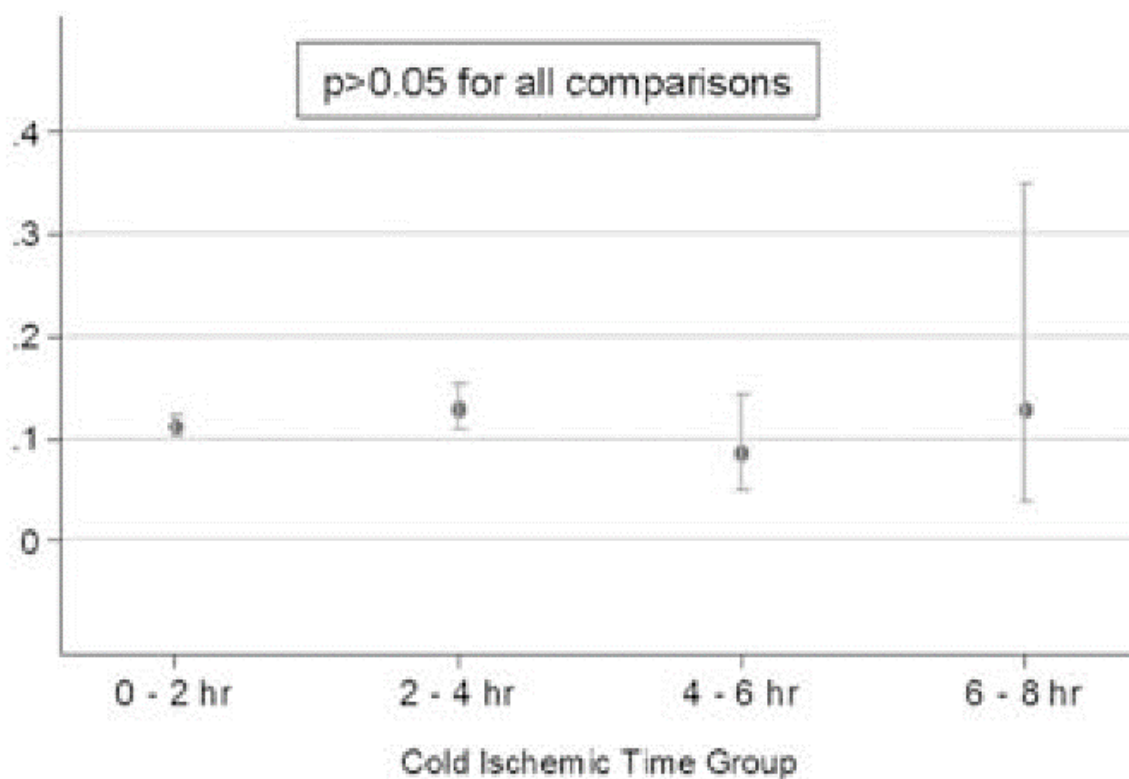
Serum Creatinine (mg/dL)



0 - 2 hr
excludes outliers

B

Adjusted Probability of Rejection

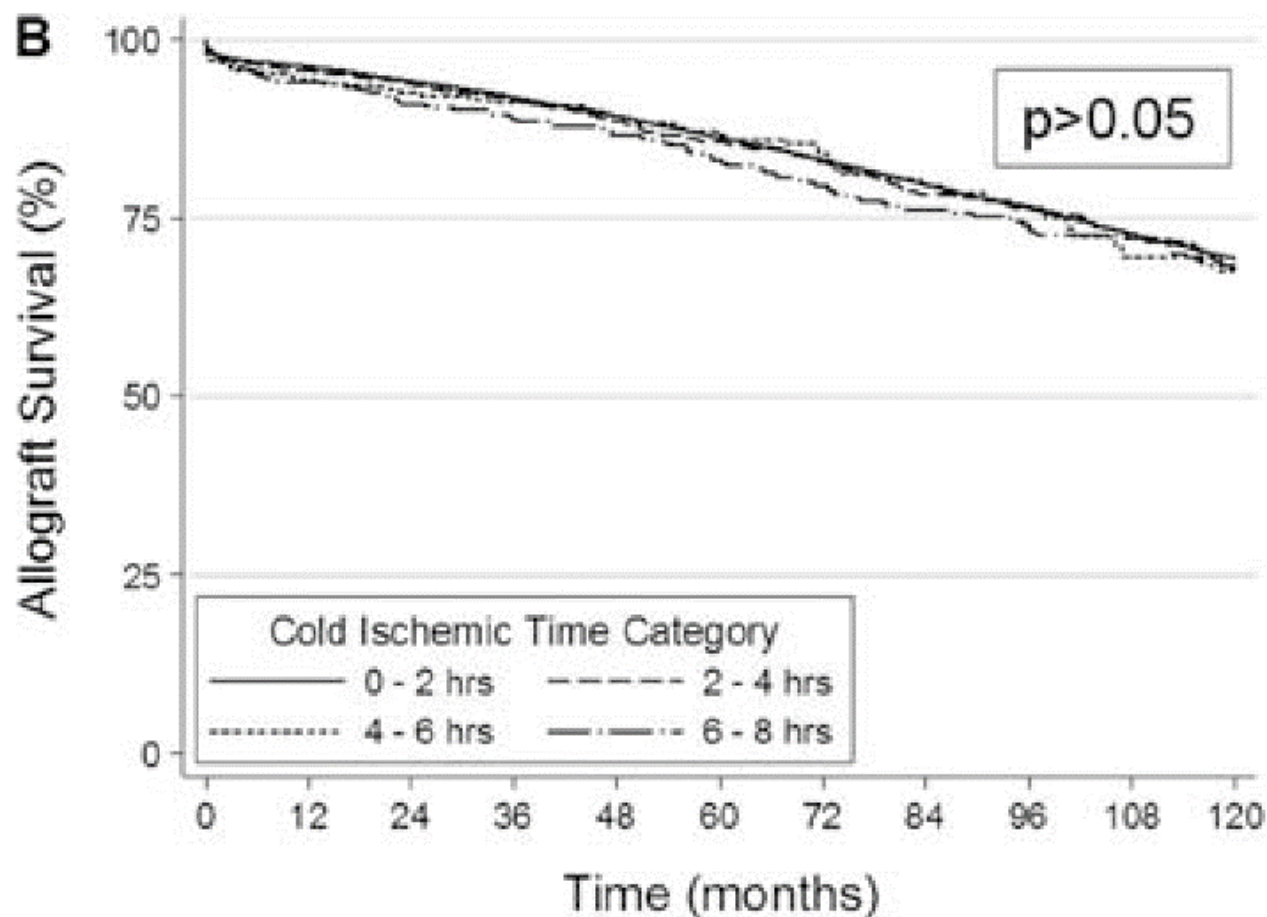


$p > 0.05$ for all comparisons

• Mean — 95% CI

Table 3: Cox proportional hazards models of death-censored renal allograft survival stratified by duration of cold ischemic time

Cold ischemia time	Unadjusted model			Adjusted model		
	Unadjusted HR	95% CI	p-value	Adjusted HR	95% CI	p-value
0–2 h	1.00	Ref	Ref	1.00	Ref	Ref
2–4 h	1.05	0.97–1.15	0.24	1.09	0.98–1.20	0.12
4–6 h	1.07	0.86–1.32	0.54	1.13	0.88–1.46	0.33
6–8 h	1.10	0.91–1.34	0.32	1.05	0.82–1.35	0.69



Case Report

doi: 10.1111/j.1600-6143.2008.02347.x

Successful Three-Way Kidney Paired Donation with Cross-Country Live Donor Allograft Transport

- Just do it: CPMC and JHU
- They had easy-to-match couple
- Our recipient *needed* that donor

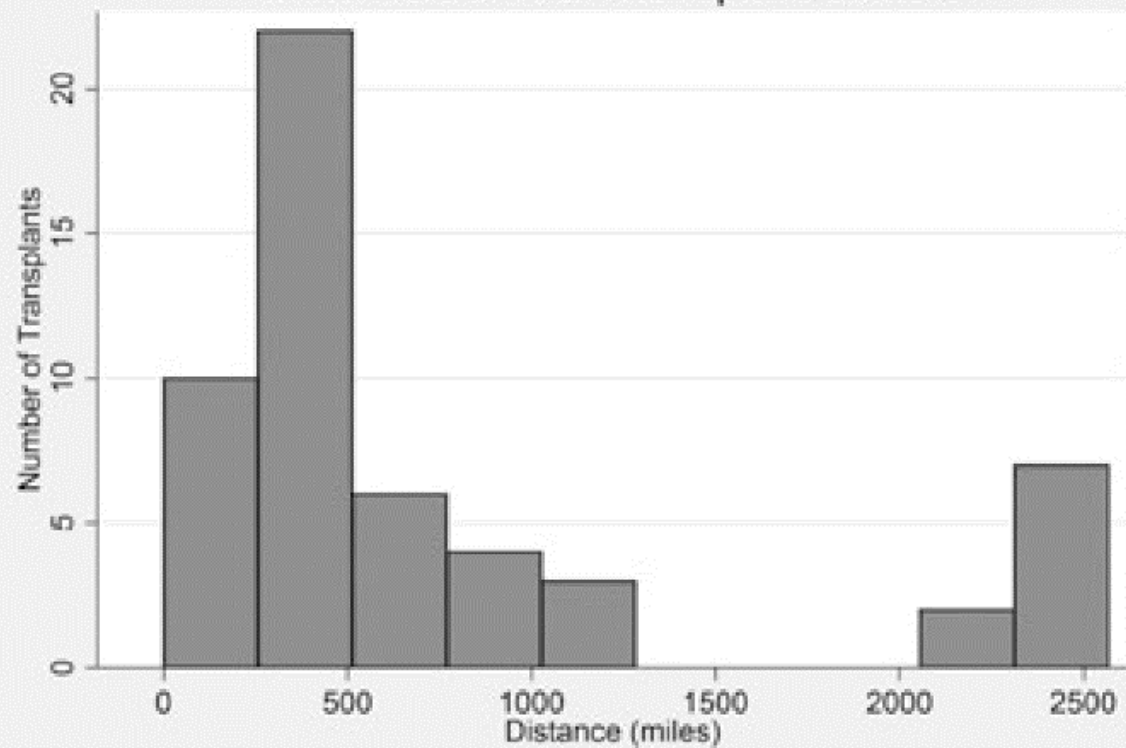
Brief Communication

doi: 10.1111/j.1600-6143.2010.03386.x

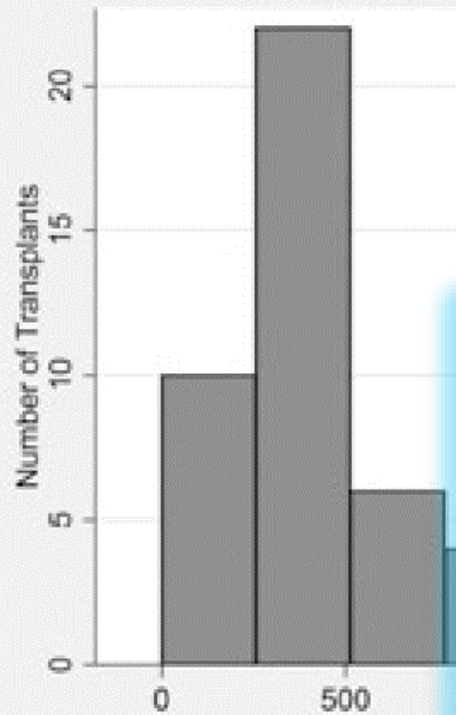
Transporting Live Donor Kidneys for Kidney Paired Donation: Initial National Results

- 30 centers
- 56 transplants
- Median CIT 7.2 h (IQR 5.5–9.7) (range 2.5–14.5)

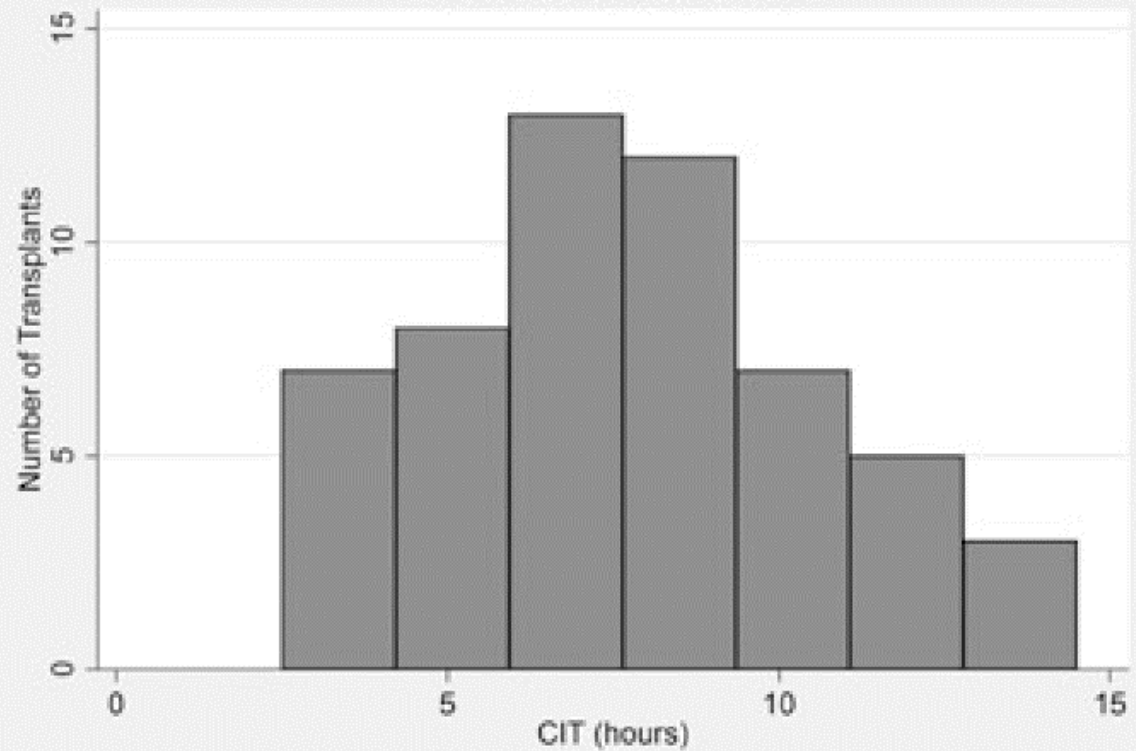
Distance Between Transplant Centers



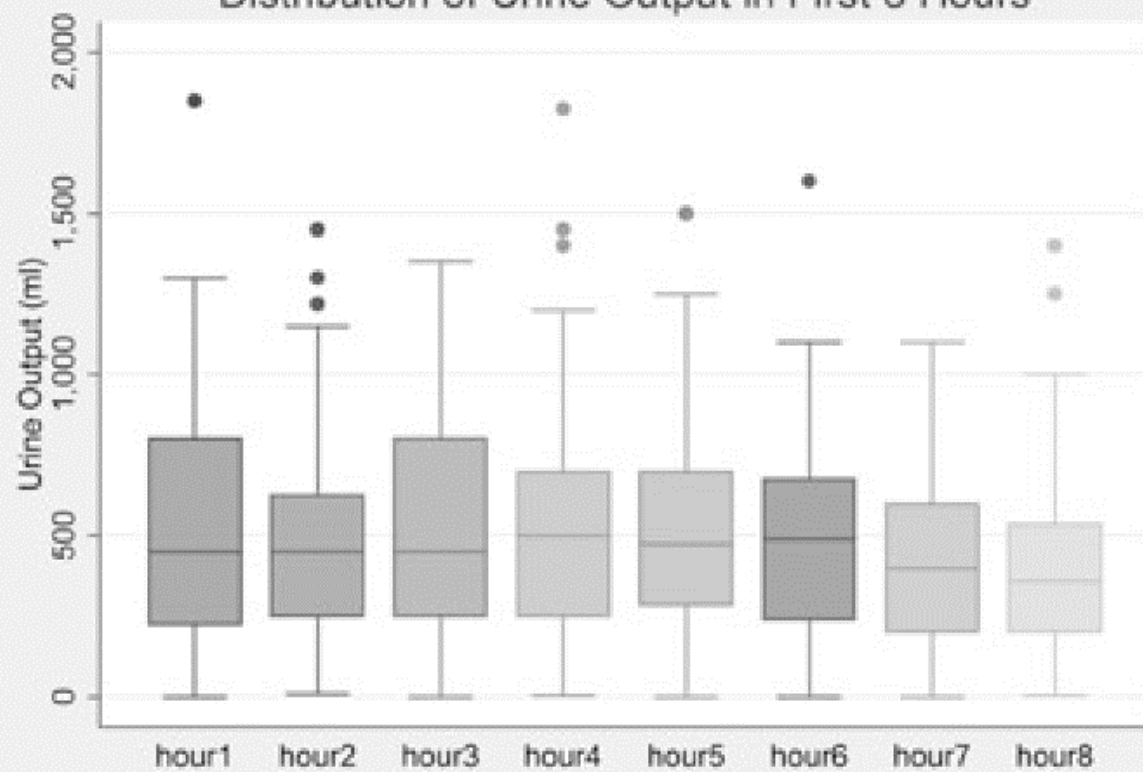
Distance Between Transplant Centers



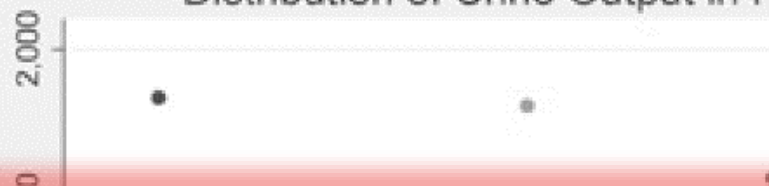
Cold Ischemia Time



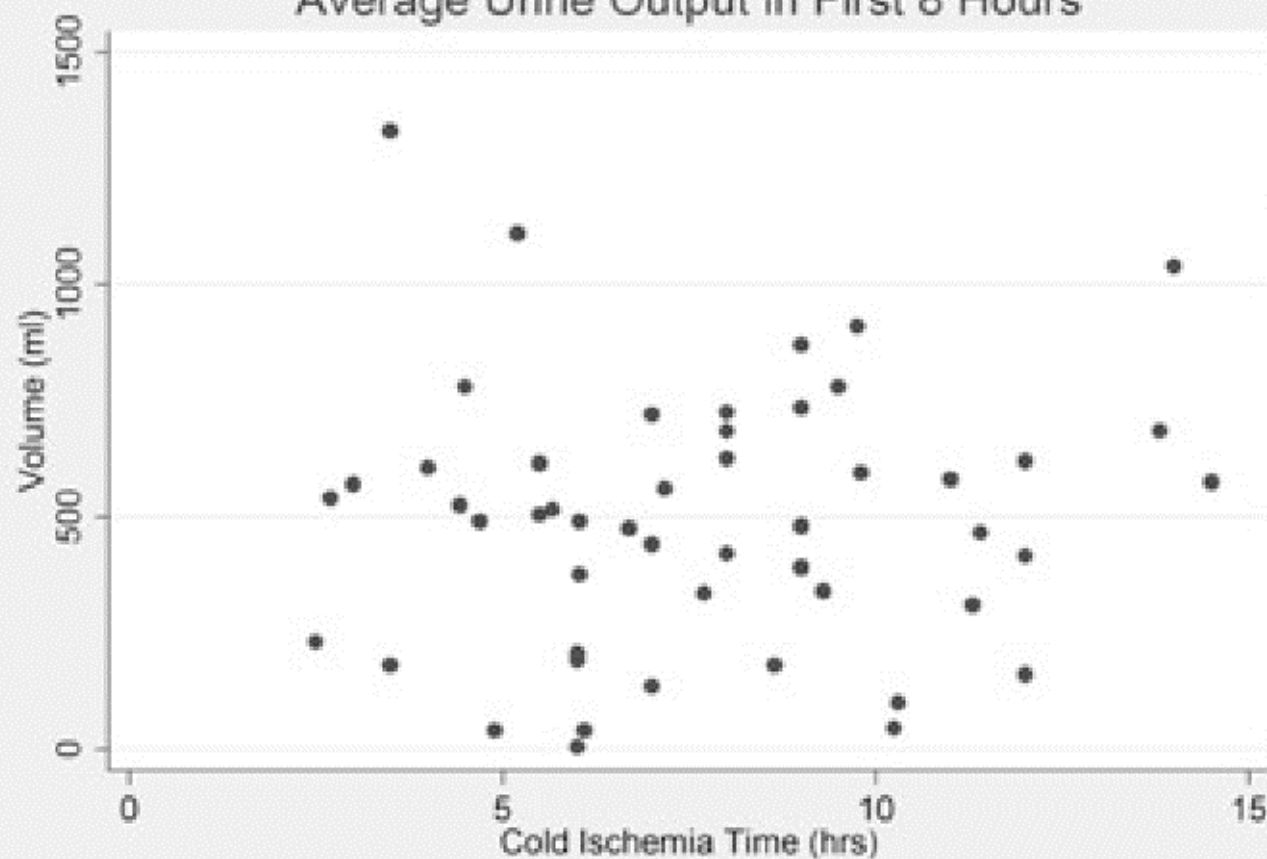
Distribution of Urine Output in First 8 Hours



Distribution of Urine Output in First 8 Hours






Average Urine Output in First 8 Hours



ORIGINAL ARTICLE

Shipping living donor kidneys and transplant recipient outcomes

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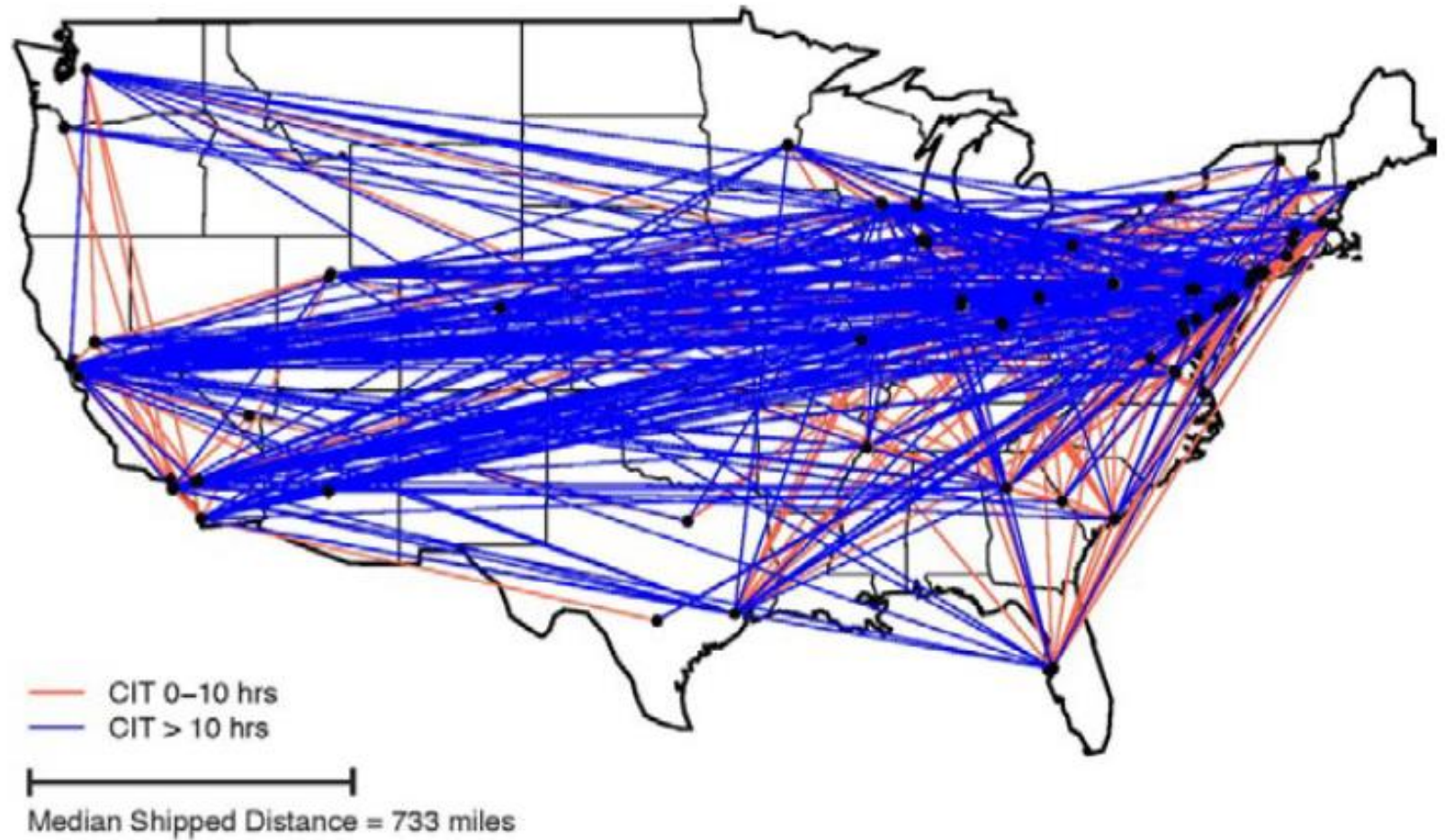
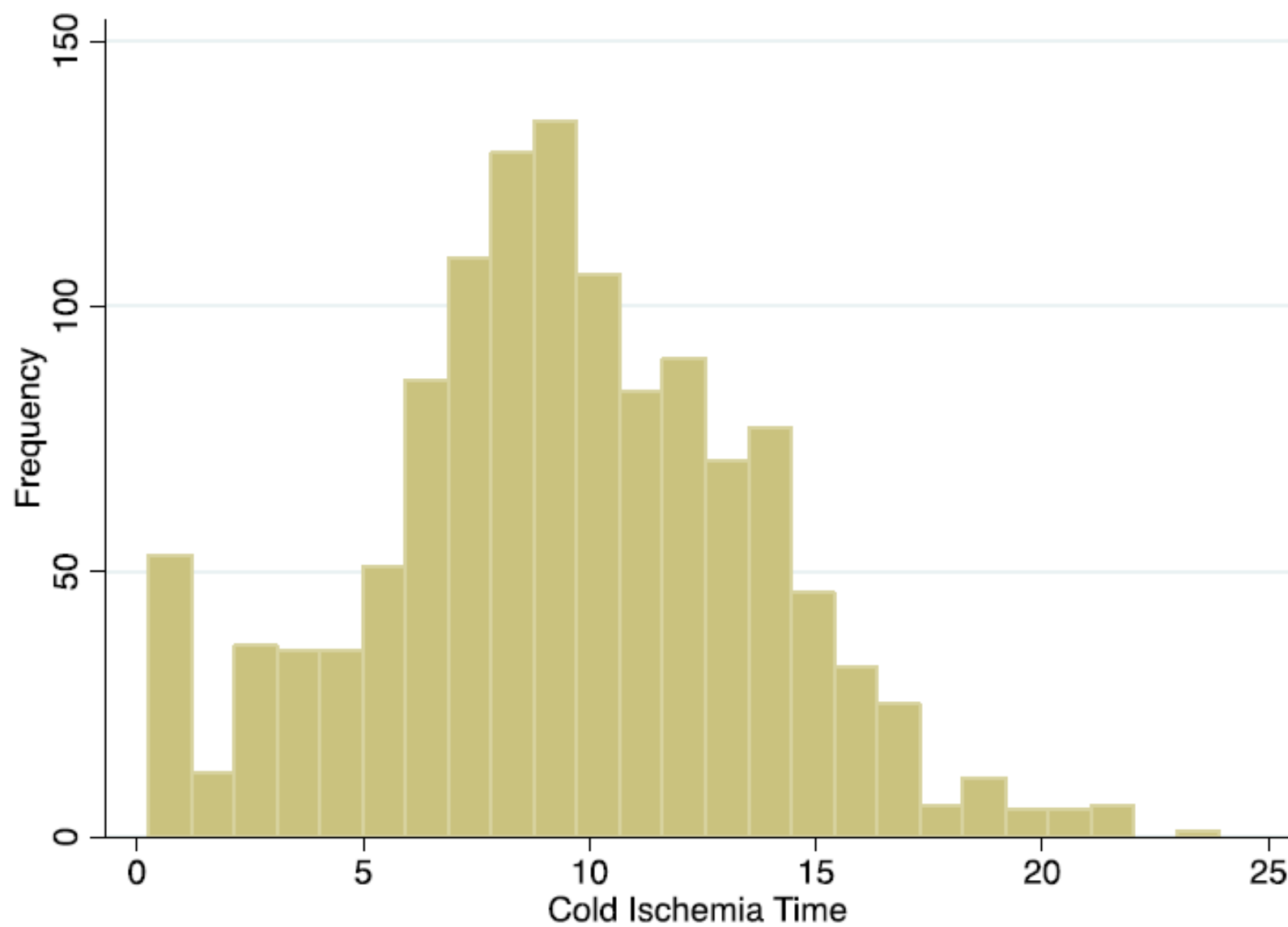


FIGURE 1 Geographic distribution of shipped kidneys. A total of 1267 KPD transplants were shipped. The median shipping distance was 733 miles (1.5-2717 mile range)

A



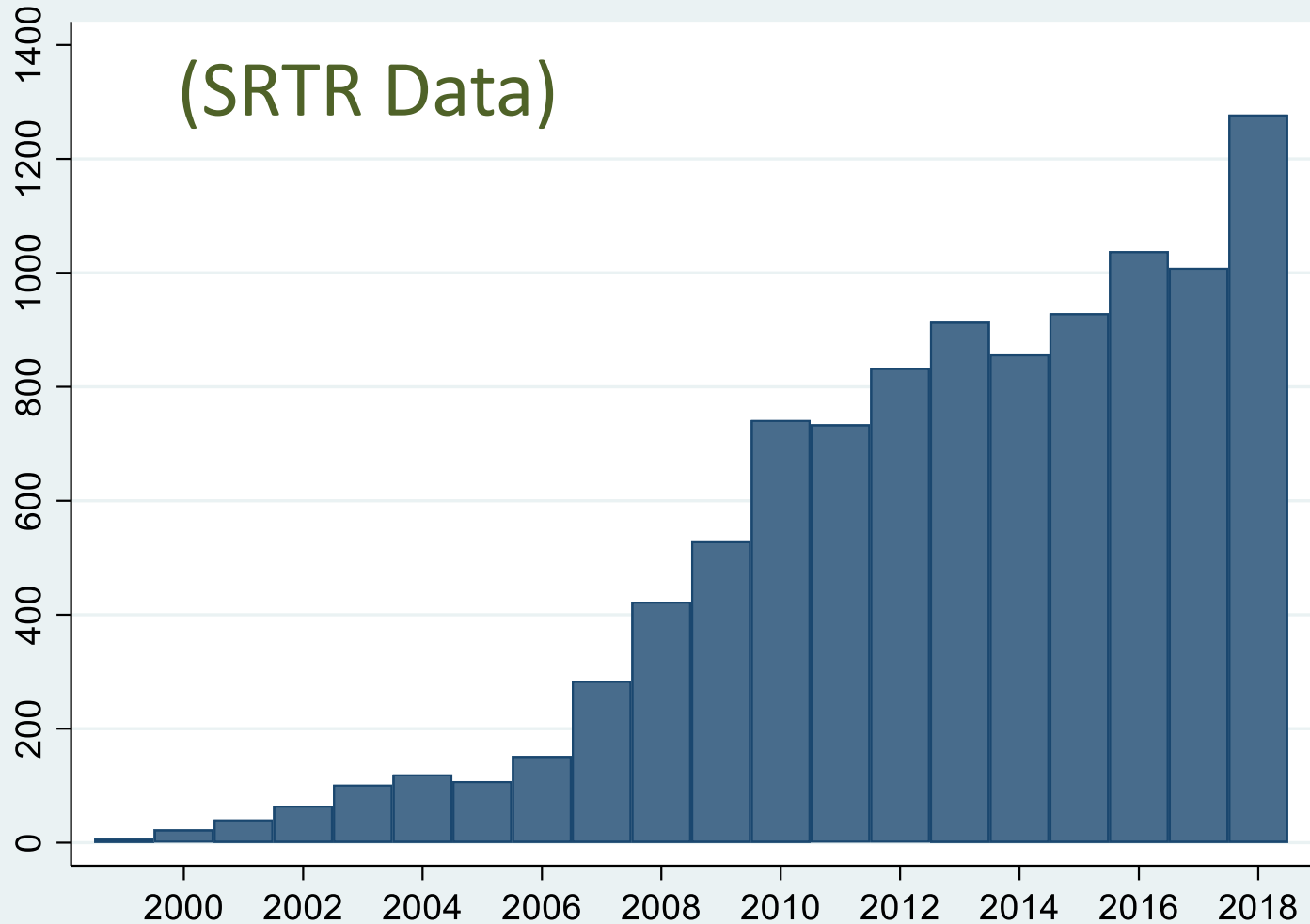
Impact of CIT / Shipped KPD

- Higher risk of DGF: for every hour of CIT, aOR=1.05 (95% CI 1.02-1.09), $p<0.01$
- No impact on all-cause graft loss: aHR=1.01 (95% CI 0.98-1.04), $p=0.4$
- No impact on death-censored graft loss: aHR=1.02 (95% CI 0.98-1.06), $p=0.4$

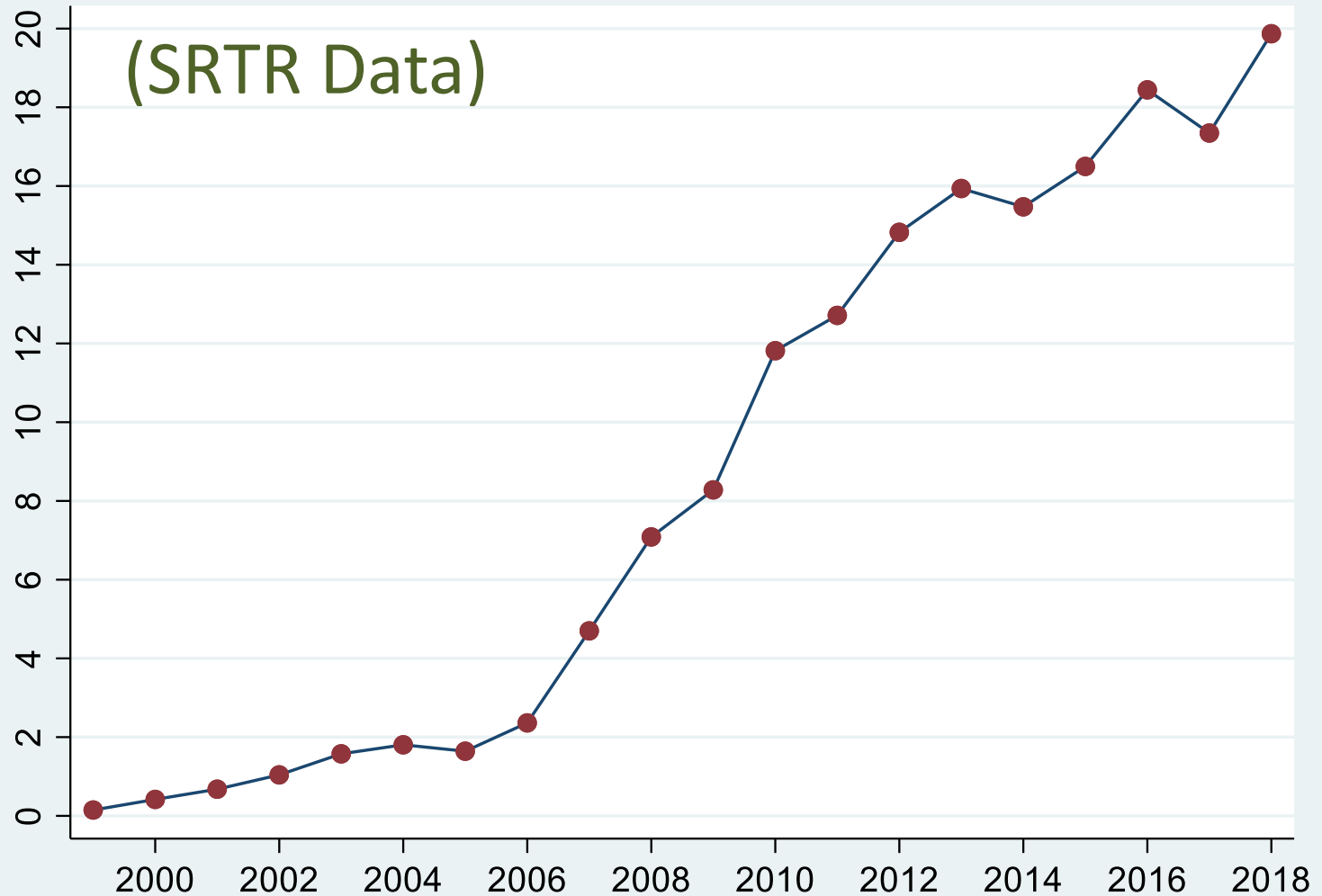
NATIONAL KIDNEY REGISTRY



KPD+NDD in the US: >10,100







KPD+NDD: 20% of LD Transplants



BRIEF COMMUNICATION

Kidney exchange match rates in a large multicenter clearinghouse

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Amy D. Waterman^{3,4} | Jacqueline Garonzik Wang¹ | Allan B. Massie^{1,5} |
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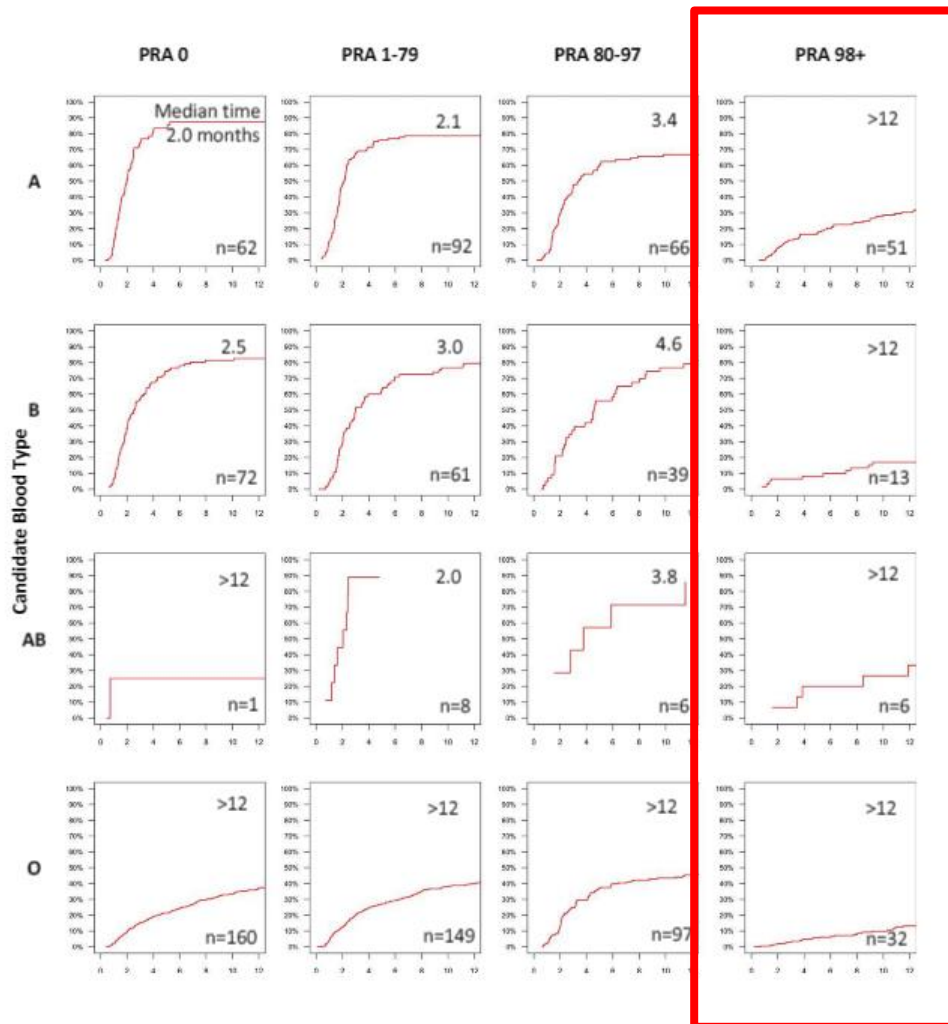
²National Kidney Registry, New York, NY, USA

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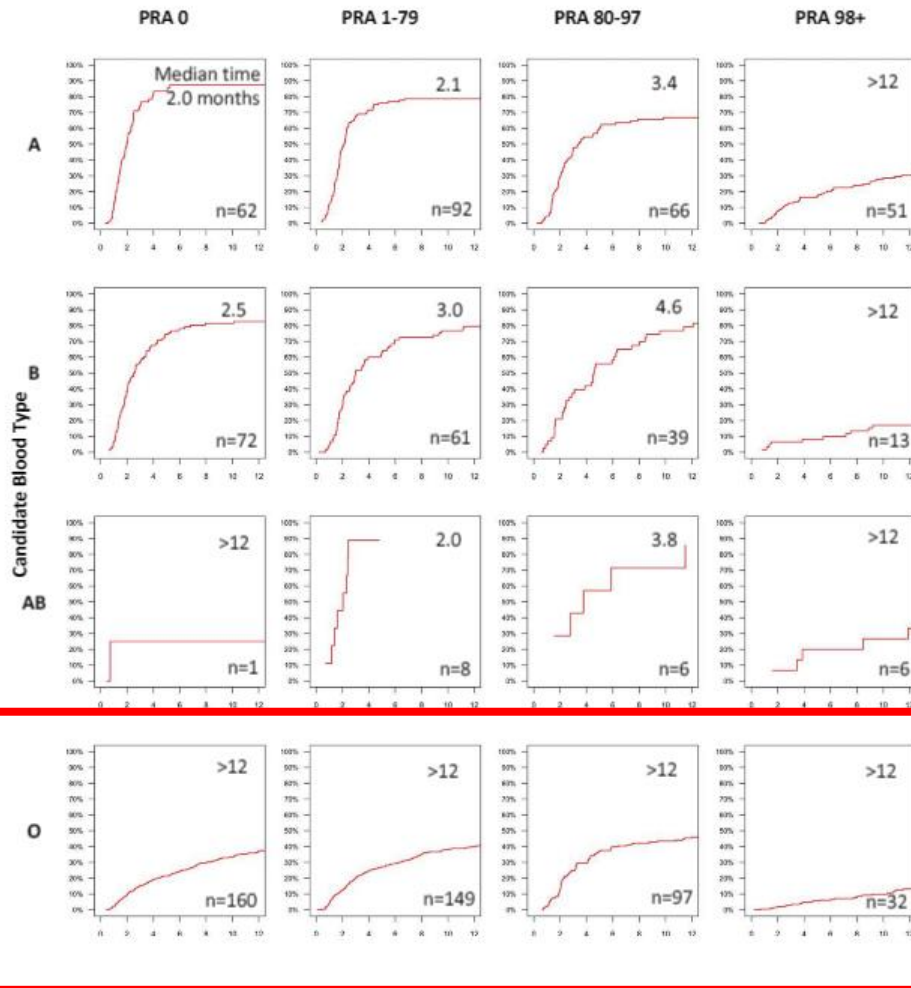
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Kidney paired donation (KPD) can facilitate living donor transplantation for candidates with an incompatible donor, but requires waiting for a match while experiencing the morbidity of dialysis. The balance between waiting for KPD vs desensitization or deceased donor transplantation relies on the ability to estimate KPD wait times. We studied donor/candidate pairs in the National Kidney Registry (NKR), a large multicenter KPD clearinghouse, between October 2011 and September 2015 using a competing-risk framework. Among 1894 candidates, 52% were male, median age was 50 years, 66% were white, 59% had blood type O, 42% had panel reactive antibody (PRA) >80, and 50% obtained KPD through NKR. Median times to KPD ranged from 2 months for candidates with ABO-A and PRA 0. to over a year for



- Competing risk analysis
- Candidates with PRA 98%+ take >1 year to find a KPD match, regardless of ABO type



- Competing risk analysis
- Candidates with PRA 98%+ take >1 year to find a KPD match, regardless of ABO type
- Candidates with blood type O take >1 year to match, regardless of PRA

**BRIEF COMMUNICATION**

AJT

Temporal changes in the composition of a large multicenter kidney exchange clearinghouse: Do the hard-to-match accumulate?

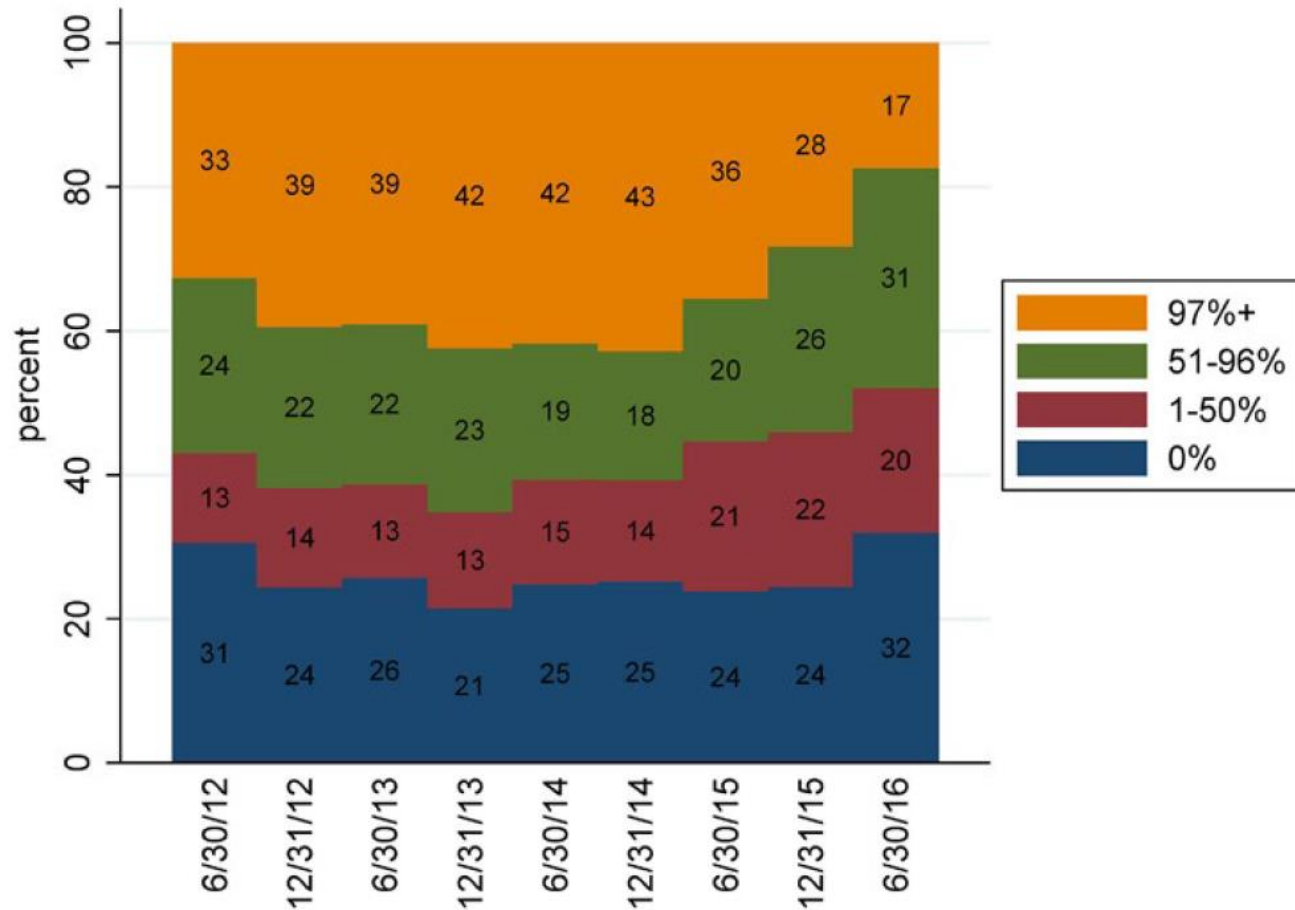
Courtenay M. Holscher¹ | Kyle Jackson¹ | Alvin G. Thomas¹ | Christine E. Haugen¹ |
Sandra R. DiBrito¹ | Karina Covarrubias¹ | Sommer E. Gentry² | Matthew Ronin³ |
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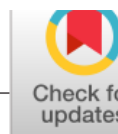
¹Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, MD, USA

²Department of Mathematics, United States Naval Academy, Annapolis, MD, USA

One criticism of kidney paired donation (KPD) is that easy-to-match candidates leave the registry quickly, thus concentrating the pool with hard-to-match sensitized and blood type O candidates. We studied candidate/donor pairs who registered with the National Kidney Registry (NKR), the largest US KPD clearinghouse, from January

PRA of prevalent KPD candidates, NKR



**ORIGINAL ARTICLE**

The first 9 years of kidney paired donation through the National Kidney Registry: Characteristics of donors and recipients compared with National Live Donor Transplant Registries

Stuart M. Flechner¹ | Alvin G. Thomas² | Matthew Ronin³ | Jeffrey L. Veale⁴ |
David B. Leiser⁵ | Sandip Kapur⁶ | John D. Peipert⁷ | Dorry L. Segev² |
Macey L. Henderson² | Ashton A. Shaffer² | Matthew Cooper⁸ | Garet Hil³ |
Amy D. Waterman⁴

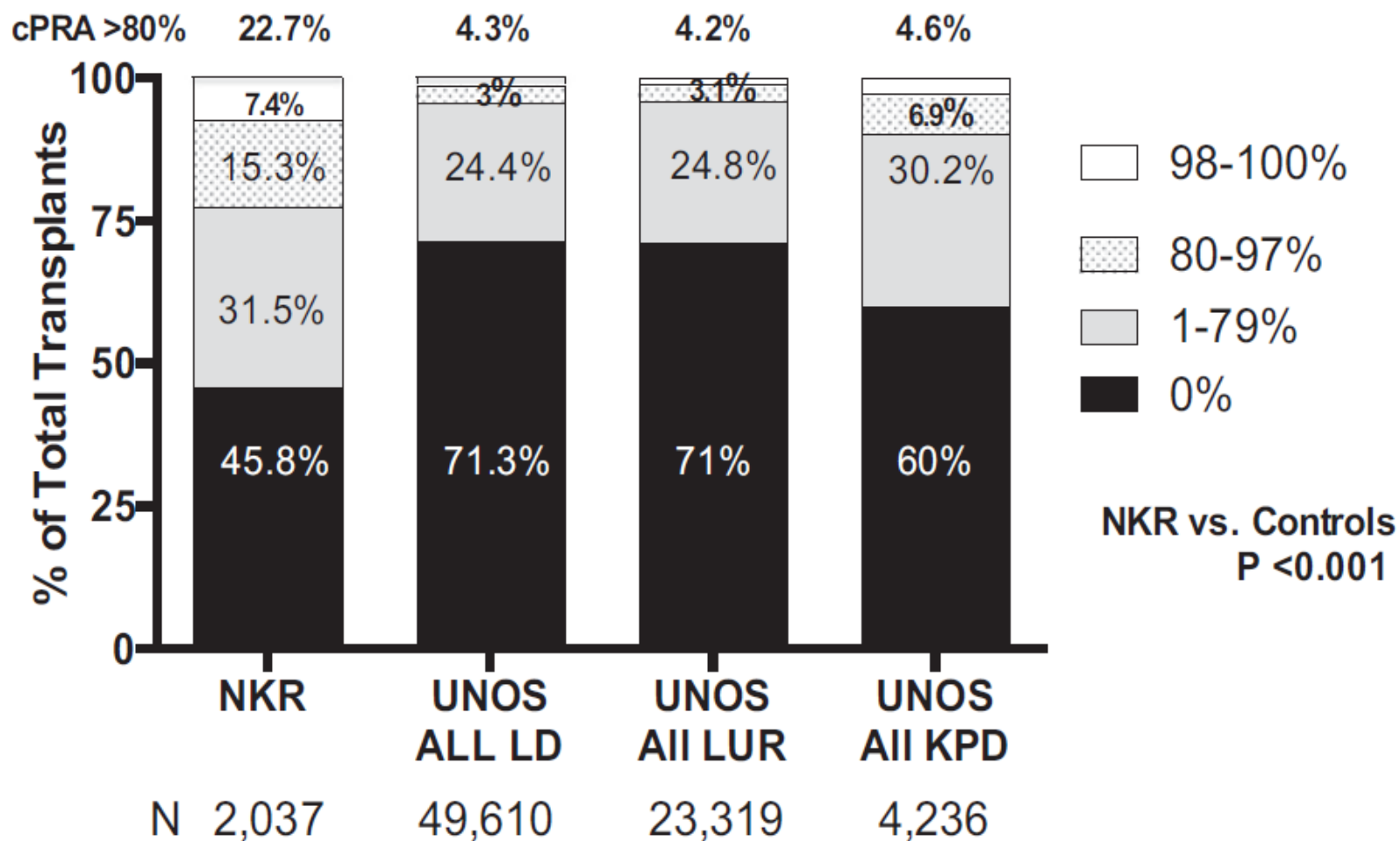
¹Cleveland Clinic, Cleveland, OH, USA

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³National Kidney Registry, Babylon, NY, USA

The practice of kidney paired donation (KPD) is expanding annually, offering the opportunity for live donor kidney transplant to more patients. We sought to identify if voluntary KPD networks such as the National Kidney Registry (NKR) were selecting

cPRA Ranges: NKR vs. UNOS Controls 2008-2017



Bridge donors and broken chains, NKR

Year	Bridge donors, n	Broken chains, n	Broken per year, %
2008	9	3	33
2009	29	2	7
2010	61	2	3
2011	75	0	0
2012	54	4	7
2013	37	3	8
2014	49	4	8
2015	53	1	2
2016	68	2	3
2017	64	1	3
Total	499	22	