



Supplemental Figure S1: Discard rate trends for deceased donor kidneys in the United States by organ recovery year and major events (kidney allocation policy changes and COVID-19 pandemic), stratified by Kidney Donor Profile Index (KDPI) category

Supplemental Table S1: Deceased donor kidneys recovered for transplantation in the United States between October 31, 2008, and March 31, 2022, by era (defined by major events).

Time interval	pre-KAS since DonorNet implemented	KAS	COVID-19 Pandemic	Continuation of COVID-19 Pandemic and implementation of KAS-250 (removal of DSA & UNOS Region from KAS)
	10/31/2008 – 12/03/2014	12/04/2014 – 03/10/2020	03/11/2020 – 03/14/2021	03/15/2021 – 03/31/2022
Kidneys discarded, $n^{\S}$ (rate)	16621 (18.47%)	19852 (19.66%)	5222 (21.81%)	6889 (24.78%)
Discard Reason, $n$ (%)				
Anatomical abnormalities	1100 ( 6.62%)	1019 ( 5.13%)	194 ( 3.72%)	198 ( 3.00%)
Biopsy findings	5993 (36.06%)	5428 (27.35%)	974 (18.67%)	957 (14.50%)
Diseased organ	518 ( 3.12%)	534 ( 2.69%)	93 ( 1.78%)	79 ( 1.20%)
Donor medical history	106 ( 0.64%)	185 ( 0.93%)	45 ( 0.86%)	69 ( 1.05%)
Donor social history	34 ( 0.20%)	22 ( 0.11%)	4 ( 0.08%)	0 ( 0.00%)
Inadequate urine output	0 ( 0.00%)	0 ( 0.00%)	2 ( 0.04%)	2 ( 0.03%)
Infection	37 ( 0.22%)	37 ( 0.19%)	5 ( 0.10%)	15 ( 0.23%)
No recipient located - list exhausted	3412 (20.53%)	7974 (40.18%)	2785 (53.38%)	4081 (61.84%)
Organ not as described	44 ( 0.26%)	56 ( 0.28%)	12 ( 0.23%)	10 ( 0.15%)
Organ trauma	224 ( 1.35%)	233 ( 1.17%)	45 ( 0.86%)	35 ( 0.53%)
Other, specify	2656 (15.98%)	2434 (12.26%)	634 (12.15%)	634 ( 9.61%)
Poor organ function	1530 ( 9.21%)	1096 ( 5.52%)	259 ( 4.96%)	273 ( 4.14%)
Positive CMV	1 ( 0.01%)	0 ( 0.00%)	0 ( 0.00%)	0 ( 0.00%)
Positive Hepatitis	158 ( 0.95%)	106 ( 0.53%)	13 ( 0.25%)	15 ( 0.23%)
Positive HIV	6 ( 0.04%)	2 ( 0.01%)	0 ( 0.00%)	3 ( 0.05%)
Recipient determined to be unsuitable for TX in OR	95 ( 0.57%)	78 ( 0.39%)	17 ( 0.33%)	12 ( 0.18%)
Too old on ice	223 ( 1.34%)	223 ( 1.12%)	41 ( 0.79%)	91 ( 1.38%)
Too old on pump	67 ( 0.40%)	74 ( 0.37%)	12 ( 0.23%)	17 ( 0.26%)
Ureteral damage	33 ( 0.20%)	53 ( 0.27%)	12 ( 0.23%)	23 ( 0.35%)
Vascular damage	258 ( 1.55%)	214 ( 1.08%)	46 ( 0.88%)	41 ( 0.62%)
Warm ischemic time too long	126 ( 0.76%)	80 ( 0.40%)	24 ( 0.46%)	44 ( 0.67%)
KDPI of kidneys recovered for transplantation, $n^{\P}$ (%)				
0-20%	22809 (25.48%)	23802 (23.58%)	4799 (20.04%)	5309 (19.10%)
21-34%	12107 (13.53%)	14305 (14.17%)	3360 (14.03%)	3540 (12.73%)
35-85%	42802 (47.82%)	49824 (49.35%)	12189 (50.90%)	14454 (51.99%)
86-100%	11795 (13.18%)	13028 (12.90%)	3598 (15.03%)	4499 (16.18%)
Kidneys discarded by KDPI, $n^{\S,\P}$ (rate)				
0-20%	738 ( 3.24%)	683 ( 2.87%)	129 ( 2.69%)	179 ( 3.37%)
21-34%	717 ( 5.92%)	933 ( 6.52%)	210 ( 6.25%)	260 ( 7.34%)
35-85%	8409 (19.65%)	10175 (20.42%)	2582 (21.18%)	3459 (23.93%)
86-100%	6651 (56.39%)	8055 (61.83%)	2301 (63.95%)	2991 (66.48%)

<sup>§</sup> Number of kidneys recovered for transplantation but not transplanted.

<sup>¶</sup> Missing KDPI values are ignored when reporting summary statistics.

*Abbreviations:* CMV: Cytomegalovirus; COVID-19: Novel Coronavirus disease; DSA: Donation Service Area; HIV: Human Immunodeficiency Virus; KAS: Kidney Allocation System; KDPI: Kidney Donor Profile Index; OR: Operating Room; TX: Transplant; UNOS: United Network for Organ Sharing.

Supplemental Table S2: Deceased donor kidneys recovered for transplantation in the United States between October 31, 2008, and March 31, 2022: Statistical comparison between eras.

Covariate	<i>p</i> -value <sup>†</sup>						
	All ways	pre-KAS <i>vs.</i>			KAS <i>vs.</i>		COVID-19 <i>vs.</i>
		KAS	COVID-19	KAS-250	COVID-19	KAS-250	KAS-250
Kidney discard rate	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Discard reason proportion	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.17
KDPI of kidneys recovered for transplantation	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Kidney discard rate by KDPI							
0-20%	< 0.01	0.15	0.26	0.97	0.93	0.30	0.26
21-34%	< 0.01	0.27	0.92	0.03	0.95	0.36	0.33
35-85%	< 0.01	0.04	< 0.01	< 0.01	0.33	< 0.01	< 0.01
86-100%	< 0.01	< 0.01	< 0.01	< 0.01	0.15	< 0.01	0.15

<sup>†</sup> Results from chi-squared test for categorical variables (kidney discard reason) and Wilcoxon rank test for numerical variables (kidney discard rate)  
*Abbreviations:* COVID-19: Novel Coronavirus disease; KAS: Kidney Allocation System; KDPI: Kidney Donor Profile Index.

Supplemental Table S3. Inverse probability of treatment weighting (IPTW)\* adjusted multivariable mixed effect logistic regression to predict deceased donor discard in the United States between 10/30/2008 and 3/31/2022 (N=236,584).

Grouping information	Number of groups	Observations per Group		
		Minimum	Average	Maximum
Group variable				
Organ Procurement Organization (OPO)**	58	1,087	4065	12,494
Donor characteristics predicting discard	Odds Ratio (OR)	Standard Error**	P-value	95% Confidence Interval
Donor recovery era (pre-KAS ref)				
KAS	1.02	0.0353	0.56	0.95-1.09
COVID-19	1.12	0.0488	0.01	1.03-1.22
KAS-250	1.24	0.0600	<0.001	1.13-1.36
Kidney donor profile index category	3.42	0.0828	<0.001	3.26-3.59
Machine perfusion, yes	0.54	0.0449	<0.001	0.45-0.63
Recovery kidney biopsy done, yes	3.17	0.2077	<0.001	2.79-3.60
COVID-19 nucleic acid testing (NAT), positive	1.80	0.1525	<0.001	1.53-2.13
Tattoo, yes	0.91	0.0177	<0.001	0.88-0.95
Tobacco smoking, yes	1.19	0.0243	<0.001	1.14-1.24
Cocaine use, yes	0.90	0.0260	<0.001	0.85-0.96
Intravenous drug use, yes	1.11	0.0524	0.02	1.02-1.22
Hepatitis B core antibody (HBC Ab), positive	1.19	0.0399	<0.001	1.12-1.27
Hepatitis B surface antigen (HBS Ag), positive	2.87	0.5230	<0.001	2.01-4.10
Constant	0.0038	0.0003	<0.001	0.0032-0.0045
OPO constant	0.0495	0.0107		0.0032-0.0045

Abbreviation: OPO, organ procurement organization; KAS, kidney allocation system; COVID-19, coronavirus disease-19.

\*A propensity score (PS) analysis, inverse probability of treatment weighting (IPTW)<sup>1</sup>, was used to adjust for measured confounding in our retrospective observational study. IPTW uses the PS to balance baseline patient characteristics among intervention groups. There are two main steps involved in IPTW: 1) calculation of probability (propensity) of being exposed to an intervention (eras), given a patient's characteristics; 2) weights are calculated as the inverse of the PS. We used polytomous logistic regression (Stata mlogit function to fit multinomial logit model) to estimate the propensity score. The PS was calculated using following donor characteristics: KDPI category, machine perfusion utilization, recovery kidney biopsy status, presence of tattoos, tobacco smoking status, history of cocaine use, history of IVDU, PHS-IR status, HBC Ab/HBS Ag/ CMV Ab serology positivity status, ABO blood type. Our primary dependent variable was the deceased donor kidney discard, the exposure (intervention) was 4-eras (the control group being pre-KAS and the intervention arms being KAS era, COVID-19 era, and KAS-250 era) in the kidney allocation system (defined by major events – pandemic or the allocation policy changes). We assumed that all confounders have been measured and appropriately modelled. In addition, the balance among intervention groups for all baseline characteristics both before and after weighting were assessed. The final IPTW adjusted multivariable mixed effect logistic regression (adjusting for OPO's random effect) model was fitted to estimate the odds ratios associated with the era effects on discard. The final model was adjusted to following confounders: KDPI category, machine perfusion utilization, recovery kidney biopsy status, COVID-19 NAT testing positivity, presence of tattoos, tobacco smoking status, history of cocaine use, history of IVDU, HBC Ab and HBS Ag serology positivity status.

\*\*Standard errors are adjusted for 58 clusters in OPO group.

#### **Supplemental Reference:**

1. Freemantle N, Marston L, Walters K, Wood J, Reynolds MR, Petersen I. Making inferences on treatment effects from real world data: propensity scores, confounding by indication, and other perils for the unwary in observational research. *BMJ* 2013;347: f6409. 24217206