Limitation of Terminal Serum Creatinine as a Kidney Donor Profile Index Variable in Predicting Long-Term Kidney Transplant Outcomes

B. Chopra and K.K. Sureshkumar*

Division of Nephrology and Hypertension, Department of Medicine, Allegheny General Hospital, Pittsburgh, Pennsylvania

ABSTRACT

Background. Donor final serum creatinine (SCr) is a dynamic variable and is 1 of 10 factors used in calculating kidney donor profile index (KDPI). We hypothesize that deceased-donor kidneys (DDKs) with higher SCr were likely accepted for transplantation if procurement biopsy findings were favorable and with long-term outcomes no worse than kidneys with lower final SCr within a KDPI group.

Methods. Using the Organ Procurement and Transplant Network/United Network for Organ Sharing database, we identified DDK transplant recipients from 2000 to 2015 who received induction and calcineurin inhibitor/mycophenolate mofetil maintenance. Patients were divided into 4 KDPI groups: 0–20%, 21%–50%, 51%–85%, and >85%. In each KDPI category, long-term outcomes were compared, with the use of Cox models, between patients who received kidneys with final SCr >2 versus ≤2 mg/dL.

Results. A total of 59,644 patients were divided into KDPI groups 0–20% (SCr >2 mg/dL, $n = 478$; SCr ≤2 mg/dL, $n = 14{,}769$), 21%–50% (SCr >2 mg/dL, $n = 1{,}592$; SCr ≤2 mg/dL, $n = 17{,}762$), 51%-85% (SCr >2 mg/dL; $n = 1{,}388$, SCr ≤2 mg/dL, $n = 18{,}024$), and >85% (SCr >2 mg/dL, $n = 349$; SCr ≤2 mg/dL, $n = 5{,}282$). Adjusted overall graft failure risks (hazard ratio [HR] 0.88, $P = .04$; HR, 0.86, $P = .007$) and patient death risks (HR, 0.86, $P = .04$; HR, 0.84, $P = .01$) for final SCr >2 versus ≤2 mg/dL groups were lower in KDPI categories 21%-50% and 51%-85%, respectively, with similar death-censored graft failure risks.

Discussion. Outcomes of transplanting DDKs with elevated final SCr are no worse than transplanting kidneys with lower final SCr, highlighting the limitation of the single value of final SCr as a variable for calculating KDPI.

KIDNEY donor profile index (KDPI) has been in use in the United States since December 4, 2014, for deceased-donor kidney (DDK) allocation for transplantation and for risk adjustment for outcomes in the periodic Scientific Registry of Transplant Recipients (SRTR) transplant center–specific reports [1]. KDPI is calculated with the use of 10 variables, including donor serum creatinine (SCr), and expressed as a score ranging from 0 to 100%, with lower scores meaning better-quality kidneys with improved projected long-term outcomes [2,3]. Donor SCr is a dynamic variable and can increase from reversible causes, such as volume depletion, hypotension, and drug toxicity, which can result in an increase in KDPI. The United Network of Organ Sharing (UNOS) recalculates the KDPI each time a new SCr is reported by the relevant organ procurement organization during donor management. Typically during DDK offers, the SCr used to calculate the KDPI is obtained early during the donor management, and

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*Address correspondence to Kalathil K Sureshkumar, MD, FRCP(Glasgow), FASN, Division of Nephrology and Hypertension, Allegheny General Hospital, 320 East North Avenue, Pittsburgh, PA 15212. E-mail: kalathil.sureshkumar@ahn.org

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Table 1. Demographic Characteristics

Characteristic	KDPI 0%-20%		KDPI 21%-50%		KDPI 51%-85%		KDPI >85%	
	SCr >2 (n = 478)	SCr ≤2 (n = 1,476)	SCr >2 (n = 1,592)	SCr ≤2 (n = 17,762)	SCr >2 (n = 1,388)	SCr ≤2 (n = 18,024)	SCr >2 (n = 349)	SCr ≤2 (n = 5,282)
Average donor final SCr (mg/dL)	3.2 ± 1.3	0.9 ± 0.3	3.5 ± 2	0.9 ± 0.4	3.5 ± 2.9	0.9 ± 0.4	3.6 ± 3.9	1.1 ± 0.4
Donor age (y)	20.8 ± 4	22.4 ± 6***	28.7 ± 9	34 ± 12***	43 ± 11	46 ± 15***	55 ± 12	59 ± 14***
Average KDPI (%)	15 ± 3.6	10 ± 5.7***	35 ± 8.4	35 ± 8.7^{ns}	67 ± 10	67 ± 10*,^{ns}	93 ± 4	92 ± 4^{ns}
ECD kidney (%)	0	0	0	0.03^{ns}	16.4	22.6***	76.7	83.7***
DCD kidney (%)	6.4	0.8***	7.8	13.2***	7.5	13.3***	3.4	8.7***
HLA mismatch	4.0 ± 1.6	3.7 ± 1.8***	4.1 ± 1.5	3.8 ± 1.8***	4.3 ± 1.4	4.0 ± 1.6***	4.5 ± 1.4	4.4 ± 1.4^{ns}
Recipient age (y)	48 ± 13	47 ± 13*	51 ± 13	49 ± 13***	54 ± 12	53 ± 12**	60 ± 11	60 ± 11^{ns}
Recipient sex male (%)	63	60^{ns}	61	60^{ns}	60.8	60.2^{ns}	63.2	62.4^{ns}
Recipient black (%)	29.4	24.6*	31.8^{ns}	30.6	32.3	31.6^{ns}	34.6	34.1^{ns}
Recipient with diabetes (%)	43	33***	36.4	36.7^{ns}	37.5	36.1^{ns}	45.5	43.8^{ns}
Preemptive kidney Tx (%)	11.2	13.2^{ns}	8.5	11.2**	7.5	8.9**	9.7	8.1^{ns}
Dialysis duration (mo)	48 ± 41	40 ± 39***	52 ± 40	46 ± 40***	49 ± 37	50 ± 42^{ns}	42 ± 30	45 ± 40^{ns}
Calculated PRA	13.3 ± 28	18.4 ± 32***	16.5 ± 31	18.6 ± 33**	12.3 ± 27	15.8 ± 30***	9.8 ± 24	8.2 ± 21^{ns}
Cold ischemia time (h)	19.3 ± 9	15.9 ± 8***	20 ± 10	16.5 ± 8***	21 ± 9.8	17.6 ± 9***	21 ± 11	19 ± 9***
Delayed graft function (%)	33	14.2***	44.5	22***	46.4	28.6***	42.3	31.8***
Steroid maintenance (%)	76	74^{ns}	71	73.8*	70	72.7*	68.7	69.7^{ns}
Previous transplant (%)	10.5	13.6^{ns}	10.3	13.3**	8.0	10.5*	8.4	5.2*
Transplant year	2009 ± 3.7	2008 ± 4***	2010 ± 3	2008 ± 4***	2009 ± 4	2008 ± 4***	2009 ± 4	2008 ± 4***

Note. P values reflect comparison of donor final SCr >2 mg/dL versus ≤2 mg/dL groups in each KDPI category.

Abbreviations: DCD, donation after cardiac death; ECD, expanded-criteria donor; KDPI, kidney donor profile index; PRA, panel reactive antibodies; SCr, serum creatinine; Tx, transplantation.

*P < .05; **P < .005; ***P < .001; ns = nonsignificant.

transplant centers base their organ acceptance based on those early KDPIs. On the other hand, SRTR uses KDPI based on the terminal or final SCr reported in the Organ Procurement and Transplant Network (OPTN) data sets to generate transplant center–specific reports.

Many transplant centers are willing to accept kidneys from donors with elevated SCr, but usually only after procurement biopsy showing potential reversible tubular injury as a cause of elevated SCr with minimal chronic changes. These kidneys, which might initially be deemed "low quality" due to higher KDPI, might in fact provide better long-term outcomes as the acute kidney injury (AKI) recovers. We hypothesized that transplantation of DDKs with higher final SCr within a KDPI group would result in long-term outcomes that are no worse than for kidneys with lower final SCr.

METHODS

The study protocol was approved by the Institutional Review Board. With the use of the OPTN/UNOS database, we identified adult DDK transplant recipients from January 2000 to December 2015 who received perioperative induction and were discharged on calcineurin inhibitor and mycophenolate–based maintenance immunosuppression. Patients were divided into 4 KDPI groups: 0–20%, 21%–50%, 51%–85%, and >85%. KDPIs were calculated retrospectively by OPTN/UNOS with the use of the final donor SCr and is now available in the database. For center-specific reporting purposes, SRTR uses KDPI based on the final donor SCr. Under each KDPI category, patients were subsequently divided into 2 groups based on the final SCr as either >2 mg/dL or ≤2 mg/dL. Multiorgan transplant recipients were excluded from the analysis. Similarly, patients who received no induction or different maintenance immunosuppression were excluded.

With the use of a Cox regression model, adjusted long-term graft and patient outcomes were calculated and compared between recipients of kidneys with final SCr >2 mg/dL versus ≤2 mg/dL in each KDPI category. A graft was considered to have failed if the patient went back on maintenance dialysis, underwent retransplantation, or died. Values were expressed as hazard ratio (HR) with 95% confidence interval (CI). Variables included in the multivariate analysis were: donor related: age, expanded-criteria donor kidney, donation after cardiac death kidney, and cause of donor death; recipient related: age, African American race, diabetes mellitus, preemptive transplant, dialysis duration, panel reactive antibody titers, and HLA mismatch; and transplant related: type of induction, cold ischemia time (CIT), steroid maintenance, delayed graft function (DGF, defined as need for dialysis within the 1st week after transplantation), previous transplant. Values were expressed as either mean ± SD or percentage. A P value of < .05 was considered to be statistically significant. Statistical analysis was performed with the use of SPSS software version 18 (IBM, Armonk, New York).

RESULTS

Median follow-up of the whole study group was 48.1 months (range, 20.7–83.7). Among the 59,644 patients included in the study, 15,247 were in the KDPI 0–20% group (SCr >2 mg/dL, n = 478; SCr ≤2 mg/dL, n = 14,769), 19,354 in the KDPI 21%–50% group (SCr >2 mg/dL, n = 1,592; SCr ≤ 2 mg/dL, n = 17,762), 19,412 in the KDPI 51%–85% group (SCr >2 mg/dL, n = 1,388; SCr ≤2 mg/dL = 18,024), and 5,631 in the KDPI >85% group (SCr >2 mg/dL, n = 349; SCr ≤2 mg/dL = 5,282). Demographic features for the