

A2 to B Kidney Transplantation in the Post-Kidney Allocation System Era: A 3-year Experience with Anti-A Titers, Outcomes, and Cost

David Shaffer, MD, FACS, Irene D Feurer, PhD, Scott A Rega, MS, Rachel C Forbes, MD, MBA, FACS

- BACKGROUND:** The new kidney allocation systems (KAS) instituted December 2014 permitted A2 to B deceased donor kidney transplantation (DDKTx) to improve access and reduce disparities in wait time for minorities. A recent United Network for Organ Sharing (UNOS) analysis, however, indicated only 4.5% of B candidates were registered for A2 kidneys. Cited barriers to A2 to B DDKTx include titer thresholds, patient eligibility, and increased costs. There are little published data on post-transplantation anti-A titers or outcomes of A2 to B DDKTx since this allocation change.
- STUDY DESIGN:** We conducted a retrospective, single center, cohort analysis of 29 consecutive A2 to B and 50 B to B DDKTx from December 2014 to December 2017. Pre- and postoperative anti-A titers were monitored prospectively. Outcomes included post-transplant anti-A titers, patient and graft survival, renal function, and hospital costs.
- RESULTS:** African Americans comprised 72% of the A2 to B and 60% of the B to B group. There was no difference in mean wait time (58.8 vs 70.8 months). Paired tests indicated that anti-A IgG titers in A2 to B DDKTx were increased at discharge ($p = 0.001$) and at 4 weeks ($p = 0.037$). There were no significant differences in patient or graft survival, serum creatinine (SCr), or estimated glomerular filtration rate (eGFR), but the trajectories of SCr and eGFR differed between groups over the follow-up period. A2 to B had significantly higher mean transplant total hospital costs (\$114,638 vs \$91,697, $p < 0.001$) and hospital costs net organ acquisition costs (\$42,356 vs \$20,983, $p < 0.001$).
- CONCLUSIONS:** Initial experience under KAS shows comparable outcomes for A2 to B vs B to B DDKTx. Anti-A titers increased significantly post-transplantation, but did not adversely affect outcomes. Hospital costs were significantly higher with A2 to B DDKTx. Transplant programs, regulators, and payors will need to weigh improved access for minorities with increased costs. (J Am Coll Surg 2019;228:635–643. © 2019 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

Disclosure Information: Nothing to disclose.

Support: This study was supported by Clinical and Translational Science Award No. UL1TR000445 from the National Center for Advancing Translational Sciences. Its contents are solely the responsibility of the authors and do not necessarily represent official views of the National Center for Advancing Translational Sciences or the National Institutes of Health.

Presented at the Southern Surgical Association 130th Annual Meeting, Palm Beach, FL, December 2018.

Received December 7, 2018; Accepted December 10, 2018.

From the Division of Kidney and Pancreas Transplantation, Department of Surgery (Shaffer, Forbes); the Departments of Surgery and Biostatistics (Feurer), Vanderbilt Transplant Center; and Vanderbilt Transplant Center (Rega), Vanderbilt University Medical Center, Nashville, TN.

Correspondence address: David Shaffer, MD, FACS, Division of Kidney and Pancreas Transplantation, 912 Oxford House, Vanderbilt University Medical Center, Nashville, TN 37232-4750. email: david.shaffer@vumc.org

Historically, blood group B candidates, the majority of whom are minorities, have had lower kidney transplantation rates than blood group O or A candidates.^{1,2} Blood subgroup ABO A2 kidneys express lower levels of A antigen on the cell surface and are therefore less immunogenic toward anti-A immunoglobulin present in blood type B or O recipients.^{3,4} Previous studies have shown that select B recipients of donor A2 kidneys have equivalent outcomes compared with ABO compatible kidney transplants.⁵⁻⁸ A recent multicenter study of an A2 to B allocation variance in 5 donor service areas showed an overall increase of 9.4% in the proportion of B recipients receiving transplants.⁹

In December 2014 the United Network for Organ Sharing (UNOS) instituted a new national Kidney Allocation System (KAS) with a provision to allow centers

Abbreviations and Acronyms

cPRA	=	calculated panel-reactive antibody
DDKtx	=	deceased donor kidney transplantation
DTT	=	dithiothreitol
eGFR	=	estimated glomerular filtration rate
KAS	=	Kidney Allocation System
SCr	=	serum creatinine
UNOS	=	United Network for Organ Sharing

to use blood group A2 kidneys for B recipients, the majority of whom are African American or Hispanic, to improve access and reduce disparities in wait time for these minority populations. Actual terminology in the new KAS is “non-A1/non-A1B” but “A2” is used in this manuscript for simplicity and to be consistent with previous literature.

Eligibility criteria of B recipients for A2 donor kidneys was left up to individual transplant centers, but previous published data required low (<1:8) recipient IgG anti-A titers.^{2,9} Despite the putative advantages, A2 to B kidney transplantation has been underused under KAS,^{10,11} and a recent UNOS analysis indicated only 4.5% of waitlisted B candidates were registered as eligible for A2 donor kidneys.¹² A recent analysis of the Scientific Registry of Transplant Recipients (SRTR) database found that only one-quarter of transplant centers had performed any A2 to B kidney transplants post-KAS.¹³ Cited barriers to using A2 to B transplants include concern over pre-transplant titers and patient eligibility, as well as increased costs.^{10,14} There have been few published data on outcomes of A2 to B deceased donor kidney transplants (DDKtx) since this allocation change, and no studies have prospectively evaluated the relevance of anti-A titers post-transplant.

We report a 3-year experience of A2 to B DDKtx under KAS, including a prospective study of post-transplant anti-A titers and a cost analysis comparing A2 to B with a concurrent group of B to B DDKtx.

METHODS

Study population

This retrospective, single center, cohort analysis included 29 consecutive A2 to B and 50 B to B DDKtx at our institution, from December 2014 to December 2017. Eligibility for A2 to B DDKtx included at least 2 consecutive anti-A IgG titers < 1:8 and anti-A IgG/M titers \leq 1:64. Waitlisted B candidates with pre-transplant anti-A titers of IgG \geq 1:8 or IgG/M \geq 1:128 were not eligible to receive A2 donors. Written informed consent for A2 to B DDKtx was obtained at time of initial

UNOS listing for A2 to B DDKtx and again at the time of transplant. This study protocol was approved by the Vanderbilt University Institutional Review Board (IRB #180388).

Measurement of titers

Anti-A titers were measured quarterly in all blood group B waitlisted candidates pre-transplant and monitored prospectively at discharge, 2 weeks, 1 month, and 3 months post-transplant in A2 to B recipients. Anti-A1 titers were measured in untreated serum (containing both IgG and IgM antibodies) and dithiothreitol (DTT)-treated serum (IgG antibodies only). The DTT pre-treatment consisted of adding 1 part 50 mM DTT to 9 parts of serum and incubating the mixture for 30 minutes in a 37°C water bath. The untreated and DTT-treated sera underwent serial 2-fold dilutions from 1:1 to 1:128. Fifty μ L of a 3% red blood cell suspension of A1 cells was added to 100 μ L of each dilution. The serum and cells were incubated for 30 minutes at room temperature, centrifuged at 3,400 rpm for 15 to 30 seconds, and read for agglutination (Sallyanne Fossey, DCI Labs, personal communication).

Immunosuppression protocol

All A2 to B DDKtx patients received induction with methylprednisolone 500 mg and a single intravenous dose of alemtuzumab 30 mg intraoperatively, followed by a 2-day solumedrol taper of 250 mg on postoperative day 1, 125 mg on postoperative day 2, and maintenance immunosuppression with tacrolimus, mycophenolate mofetil, and prednisone. For anti-A titers IgG < 1:8 and IgM/G \leq 1:8, no additional immunosuppression was given. If IgM/G > 1:8 but \leq 1:64, recipients also received plasma exchange (PLEX) daily for 5 days beginning on postoperative day 1, followed by a single dose of intravenous immunoglobulin (IVIG) 2 g/kg and rituximab 375 mg/m².

All B to B DDKtx received our standard immunosuppression protocol consisting of induction with methylprednisolone and alemtuzumab and methylprednisolone taper as described previously, and maintenance immunosuppression with tacrolimus and mycophenolate mofetil for unsensitized primary transplants or tacrolimus, mycophenolate mofetil, and prednisone for retransplants or sensitized patients.

Outcomes measures

The primary outcomes measures were post-transplant anti-A titers, both IgG and IgG/M, and their change relative to pre-transplant. Additional outcomes measures included pre-transplant waiting time; patient and graft survival; longitudinal post-transplant serum creatinine, and estimated

glomerular filtration rate (eGFR), calculated using the modification of diet in renal disease study equation; the change in anti-A IgG or IgG/M titers measured at 4 weeks; and hospital costs. Calculation of waiting time changed under KAS to begin at initiation of dialysis. Although many patients in both groups were listed before KAS, because calculation of waiting time changed under KAS to begin at initiation of dialysis, we used the dialysis initiation date for calculation of waiting times. For patients receiving transplants before dialysis, we used the listing activation date to calculate wait times. Change in titers at post-transplant week 4 was computed as the difference in dilutions compared with those pre-transplant.

Statistical analysis

Data were analyzed using summary statistics, parametric or nonparametric between-group comparisons as indicated by the data, and Kaplan-Meier survival methods with log rank tests. Mixed effects models that adjusted for kidney donor profile index (KDPI) and waiting time (months) evaluated the effects of change in titers at post-transplant week 4 on longitudinal renal function in A2 to B recipients. Mixed effects models also tested the effects of time and transplant type on longitudinal SCr and eGFR, and whether the trajectory of renal function differed over time on the basis of transplant type. Some data were collected and managed using Research Electronic Data Capture (REDCap) tools hosted at Vanderbilt University Medical Center. REDCap is a secure, web-based application designed to support data capture

for research studies.¹⁵ Data were analyzed using IBM SPSS statistical software (version 24).

RESULTS

Baseline characteristics

Recipient demographic and clinical characteristics are summarized in Table 1. The A2 to B recipients were significantly younger and had a significantly lower calculated panel-reactive antibody (cPRA) than the B to B cohort. There was no significant difference in sex, race, kidney donor profile index, antigen mismatch, or waiting time. African Americans comprised 72% of the A2 to B and 60% of the B to B group. There was no significant between-group difference in mean wait time (58.5 vs 70.8 months, $p = 0.142$) or follow-up time (25.9 vs 25.1 months, $p = 0.773$) for A2 to B and B to B DDKTx, respectively.

The significantly higher cPRA in the B to B group likely reflects the effect of another allocation change under the new KAS, which gives priority to highly sensitized patients. Twelve B to B recipients (24%) had a cPRA of 98% to 100% compared with only 1 (3%) in the A2 to B group ($p = 0.025$).

Anti-A titers

Pre-transplant IgG titers ranged from 1:1 to 1:4 and pre-transplant IgG/M titers ranged from 1:4 to 1:64. Post-transplant IgG titers over the 3-month monitoring period ranged from 1:1 to 1:2,048 and IgG/M titers ranged from 1:2 to 1:2,048.

Table 1. Recipient Characteristics by Group

Characteristic	B to B (n = 50)	A2 to B (n = 29)	p Value	Total, (n = 79)
Age at transplant, y, mean (SD)	47.2 (13.8)	54.0 (10.7)	0.026	49.7 (13.1)
Sex, n (%)			0.098	
Female	24 (48.0)	8 (27.6)		32 (40.5)
Male				47 (59.5)
Race, n (%)			0.337	
African American	30 (60.0)	21 (72.4)		51 (64.6)
White	15 (30.0)	8 (27.6)		23 (29.1)
Asian	4 (8.0)	0 (0.0)		5 (5.1)
Other	1 (2.0)	0 (0.0)		1 (1.3)
KDPI stratum, n (%)			0.327	
A ($\leq 20\%$)	22 (44.0)	7 (24.1)		29 (36.7)
B (21%–34%)	7 (14.0)	6 (20.7)		13 (16.5)
C (35%–85%)	17 (34.0)	14 (48.3)		31 (39.2)
D ($> 85\%$)	4 (8.0)	2 (6.9)		6 (7.6)
cPRA, mean (SD)	35 (45.2)	6.6 (20.8)	< 0.001	24.5 (40.4)
Antigen mismatch, n, median (IQR)	4 (3, 5)		0.774	5 (4, 5)
Waiting time, mo, mean (SD)	70.8 (49.1)	58.5 (24.5)	0.142	66.4 (41.9)

cPRA, calculated panel-reactive antibody; IQR, interquartile range; KDPI, kidney donor profile index.

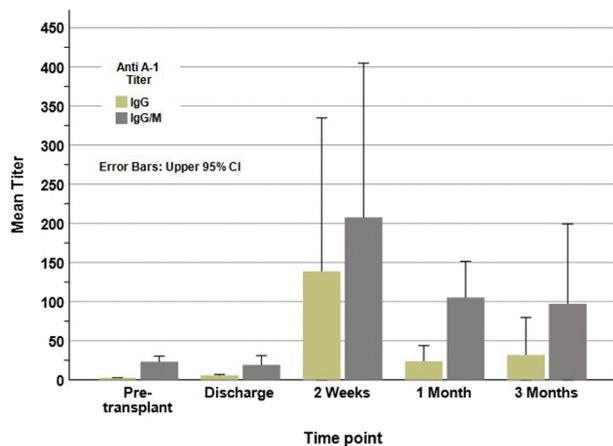


Figure 1. Anti-A titers.

Cross-sectional anti-A titer data are summarized in [Figure 1](#). Paired tests indicated that anti-A IgG titers in A2 to B DDKTx were increased at discharge ($p = 0.001$) and 4 weeks ($p = 0.037$) vs pre-transplant, but not at 2 weeks or 3 months. Anti-A IgG/M titers were increased at 4 weeks ($p = 0.002$) but not at discharge, 2 weeks, or 3 months.

Patient and graft survival

Patient follow-up time did not differ between the recipient groups ($p = 0.773$) and averaged 25.9 ± 12.4 and 25.1 ± 11.8 months in A2 to B and B to B recipients, respectively. One- and 2-year patient survivals were 93% and 88% for A2 to B DDKTx vs 92% and 90% for B to B DDKTx, respectively ([Fig. 2A](#)). One- and 2-year graft survivals were 93% and 88% vs 92% and 87% for A2 to B vs B to B, respectively ([Fig. 2B](#)). There was no significant difference in patient or graft survival between the 2 recipient groups (all log rank $p \geq 0.795$).

Renal function

Cross-sectional analyses demonstrated no between-group differences in renal function as measured either by serum creatinine or eGFR at post-transplant years 1 through 3 (all $p \geq 0.078$) ([Table 2](#)). Longitudinal mixed effects models of post-transplant renal function demonstrated that the trajectories of SCr and eGFR differed between the 2 groups (time by group interaction effects $p \leq 0.007$), with renal function declining over the full follow-up period among A2 to B recipients in comparison to B to B recipients ([Fig. 3](#)).

In A2 to B DDKTx, post-transplant mean anti-A IgG titers were significantly increased at discharge and 4 weeks, and anti-IgG/M titers were increased at 4 weeks. The mixed effects models of longitudinal SCr and

eGFR demonstrated that, after adjusting for the effects of time (all $p \leq 0.0034$) and kidney donor profile index (all $p \leq 0.001$) and the nonsignificant effect of waiting time (all $p \geq 0.689$), there was no relationship between the change in IgG or IgG/M titers at 4 weeks and post-transplant renal function (all $p \geq 0.4308$).

Costs

Pre-transplant anti-A titer screening added total costs of \$76,550 over the 3-year study period, excluding additional administrative and coordinator time costs. For the transplant hospitalization, A2 to B DDKTx had significantly higher mean total hospital costs (\$114,638 vs \$91,697, $p < 0.001$) and hospital costs net organ acquisition costs (\$42,356 vs \$20,983, $p < 0.001$) compared with concurrent B to B DDKTx.

DISCUSSION

The new KAS, adopted nationwide in December 2014, gave transplant centers the option of accepting blood group subtype A2 donor kidneys for eligible waitlisted blood group B candidates, with the goal of reducing disparities in access to transplants for minorities. To our knowledge, this is the first study directly comparing outcomes of B recipients of A2 donor kidneys with a concurrent cohort of B recipients of B donor kidneys since instituting this allocation change. Moreover, this is the first study to report on post-transplant monitoring of anti-A titers and to correlate pre- and post-transplant anti-A titers with outcomes.

Previous studies have shown that low anti-A titers are necessary for good outcomes after A2 to B transplants and the general consensus requires an anti-A IgG titer threshold of $\leq 1:8$ for eligibility.^{2,9,10} There is less consensus regarding the significance of pre-transplant IgG/M titers (ie non-DTT treated serum) and whether they affect eligibility or post-transplant immunosuppression and management. Based on our previous experience with A2 to O living donor transplants¹⁶ and another report of A2 to B and O transplants,¹⁷ we set a pre-transplant IgG/M titer threshold of $\leq 1:64$ and chose to mitigate potential adverse effects of high IgG/M titers with a postoperative protocol of plasma exchange (PLEX), intravenous immunoglobulin (IVIG), and rituximab (Roche) to reduce circulating anti-A antibody. Because 17 (59%) of our A2 to B transplants had IgG/M $> 1:8$ but $\leq 1:64$, restricting eligibility of both IgG and IgG/M to $\leq 1:8$ would significantly limit access of some B recipients to A2 donor kidneys. How relevant pre-transplant IgG/M titers compared with IgG alone are for recipient selection, what titer threshold, if any, should

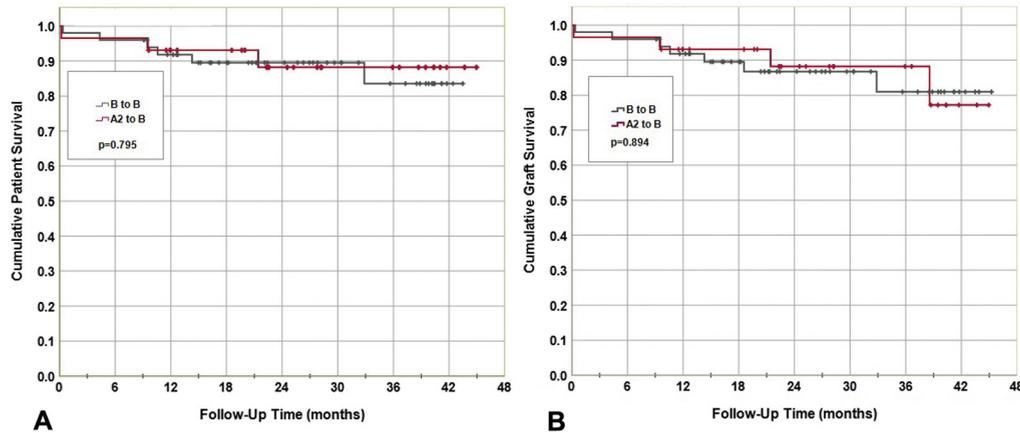


Figure 2. (A) Patient and (B) graft survival.

be set for IgG/M, and whether and/or how much additional immunosuppression is required to attain equivalent outcomes for patients with high IgG/M cannot be answered by this study and should be the focus of future studies.

Although elevated IgG titers in ABO incompatible living donor kidney transplants are associated with acute antibody-mediated rejection,¹⁸ and previous reports noted high post-transplant anti-A IgG titers associated with rejection and graft loss in an A2 to O kidney transplants,^{2,19,20} there are no prospective data on post-transplant anti-A IgG or IgG/M levels after A2 to B transplants, and no data specifically evaluating whether elevated post-transplant anti-A titers have any prognostic significance or require intervention. This study is the first to show that anti-A titers, both IgG and IgM, increased significantly at week 4 post-transplant and then decreased spontaneously back to baseline without intervention and without adversely affecting outcomes. We found no relationship between the change in IgG or IgM titers at 4 weeks and either patient or graft survival or renal function. Therefore, although critical to monitor pre-transplantation, and perhaps intriguing from a biologic standpoint post-transplantation, early elevations in post-transplant anti-A titers do not appear to correlate with

allograft dysfunction, do not appear to require a change in clinical management, and are likely unnecessary to monitor on a routine basis.

A primary objective of KAS is to reduce disparity for minorities, particularly African Americans, as measured by transplant rates and waiting times of blood group B patients, the majority of whom are African Americans. Although previous studies pre-KAS have shown both a decrease in B candidate wait times²¹ and an increase in blood group B and African-American transplant rates^{2,9,22} using an A2 to B allocation variance, in our study, although A2 to B candidates waited 58.8 months vs 70.8 months for B to B candidates, this was not a statistically significant difference. This is may be due to several factors, including small sample size, that most recipients were already waitlisted at time of allocation change, and therefore, their waiting times partially reflect the previous allocation system, and the concomitant allocation change giving priority to high cPRA candidates, which increased access and reduced wait times for highly sensitized B to B DDKTx. To see whether this A2 to B allocation change improves access by reducing wait time will require studies with larger numbers of patients with wait times beginning after the allocation change in December 2014.

Table 2. Renal Function

Variable	A2 to B, mean (SD)	B to B, mean (SD)	p Value
1 y Cr, mg/dL	1.7 (1.1)	1.5 (0.7)	0.358
1 y eGFR, mL/min/1.73 m ²	49.6 (12.3)	49.8 (13.0)	0.941
2 y Cr, mg/dL	1.8 (1.1)	1.3 (0.3)	0.127
2 y eGFR, mL/min/1.73 m ²	46.8 (15.1)	53.7 (8.4)	0.124
3 y Cr, mg/dL	2.4 (1.7)	1.4 (0.4)	0.078
3 y eGFR, mL/min/1.73 m ²	42.9 (19.3)	52.5 (11.5)	0.182

Cr, serum creatinine; eGFR, estimated glomerular filtration rate.

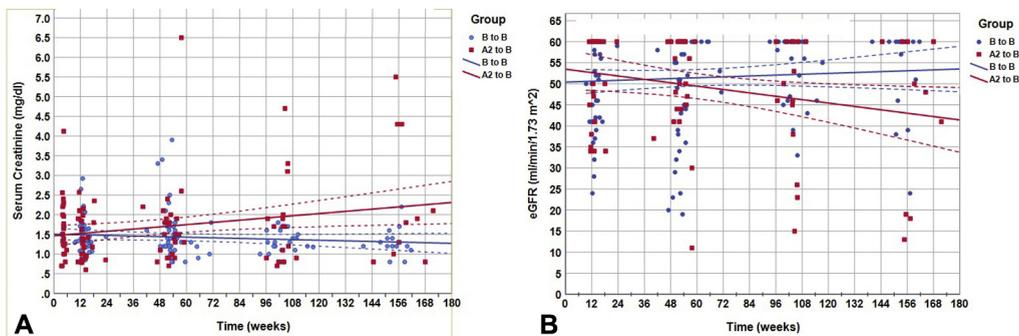


Figure 3. Longitudinal mixed effects model of post-transplant (A) serum creatinine (SCr) and (B) estimated glomerular filtration rate (eGFR).

Seventy-two percent of patients receiving A2 to B transplants at our center were African-American, and this allocation change may be an advantage to this group at our center over time. However, a recent large database evaluation post-KAS failed to show a difference in A2 to B DDKTx in minorities compared with whites,¹³ suggesting that nationwide, the demographics of the relatively few centers offering this option to patients may not have waitlists with a majority of B recipients composed of ethnic minorities.

Although a previous study showed increased overall costs in ABO incompatible kidney transplants,²³ this is the first study to report the effects on costs specifically of A2 to B transplants post-KAS. We found that establishing an A2 to B kidney transplant program increases both pre- and post-transplant costs. Although the frequency of measurement of pre-transplant anti-A titers is up to individual centers per UNOS policy,¹⁰ and without clear published data or guidelines given intra-patient and inter-laboratory variability in titer measurements,^{2,24} we and others have elected to perform this test quarterly for waitlisted patients and require 2 consecutive IgG titers <1:8 for eligibility.^{2,9} With each titer measurement costing \$100/blood group B waitlist candidate/quarter, added pre-transplant lab costs alone over our initial 3-year A2 to B experience amounted to \$76,550, excluding additional administrative and coordinator time costs. (Sallyanne Fossey, DCI Labs, Nashville, TN, personal communication.) Post-transplant, both total hospital costs and hospital costs net organ acquisition costs were significantly higher for A2 to B recipients compared with concurrent B to B recipients. Part of the increased post-transplant hospital cost is certainly due to increased dialysis and pharmacy costs associated with our antibody reduction protocol for high IgG/M titer recipients. Individual transplant programs, payors, and policy makers will need to weigh the desirability and benefits of using A2 to B allocation to try to improve access to kidney

transplants for minorities with apparent increased program and hospital costs.

This study shows, overall, comparable patient and graft survival and renal function with A2 to B compared with a concurrent group of B to B DDKTx at a single center after the introduction of KAS. However, multivariable modeling also indicated that the temporal trajectory of renal function differed between the 2 groups and diverge with a decline in renal function by 2 years in the A2 to B group. Whether this becomes clinically significant or leads to long-term differences in graft survival, retransplant rates, and costs requires longer follow-up.

Strengths of this study are its single center design that afforded uniform pre- and post-transplant protocols, prospective anti-A titer monitoring done in a single lab, long-term follow-up, uniform cost data, and multivariable modeling that shows no adjusted effect of the change in anti-A titers and post-transplant renal function. The primary limitation of this study is the small subject-level sample size, which precluded multivariable modeling for patient and graft survival. Finally, although the decision to use additional measures (PLEX, IVIG, rituximab) to treat high pre-transplant IgG/M titers were based on limited data from our group and others,^{16,17} others have obtained good outcomes with high pre-transplant recipient IgG/M titers without additional immunosuppression,²⁵ and there are no randomized data to support this intensive immunosuppressive protocol, which certainly contributed to increased costs in the A2 to B group. Additional studies are required to determine the significance of elevated pre-transplant IgG/M titers and their management post-transplant.

CONCLUSIONS

In conclusion, we report an initial 3-year experience under KAS showing comparable outcomes with A2 to B vs B to B kidney transplants. The majority of the recipients

of A2 kidneys at our center were African American, so this allocation change may improve access to kidney transplantation for this group, at least in our center. Anti-A titers, both IgG and IgM, increased significantly in the early post-transplant period, but did not portend allograft dysfunction or correlate with 1- or 2-year outcomes and therefore appear unnecessary to routinely monitor. Performing A2 to B transplants appears to significantly increase transplant center and hospital costs. To the extent that increased costs constitute a barrier to more widespread adoption, alternative payments models should be considered for A2 to B DDKTx.

Author Contributions

Study conception and design: Shaffer, Forbes

Acquisition of data: Shaffer, Rega

Analysis and interpretation of data: Shaffer, Feurer, Rega

Drafting of manuscript: Shaffer, Feurer, Forbes

Critical revision: Shaffer, Feurer, Forbes

REFERENCES

- Epstein AM, Ayanian JZ, Keogh JH, et al. Racial disparities in access to renal transplantation. *N Engl J Med* 2000;343:1537–1544.
- Bryan CF, Cherikh WS, Sesok-Pizzini DA. A2/A2B to B renal transplantation: Past, present, and future directions. *Am J Transplant* 2016;16:11–20.
- Breimer ME, Samuelsson BE. The specific distribution of glycolipid-based blood group A antigens in human kidney related to A1/A2, Lewis, and secretor status of single individuals. *Transplantation* 1986;42:86.
- Breimer ME, Moline J, Norden G, et al. Blood group aA and B antigen expression in human kidneys correlated to A1/A2/B, Lewis, and secretor status. *Transplantation* 2006;82:479–485.
- Bryan CF, Winklofer FT, Murillo D, et al. Improving access to kidney transplantation without decreasing graft survival: Long-term outcomes of blood group A2/A2B DD kidneys in B recipients. *Transplantation* 2005;80:75–80.
- Bryan CF, Nelson PW, Shield CF, et al. Transplantation of ABO group A2 kidneys transplanted from live A2 donors to O and B recipients. *Am J Transplant* 2007;7:1181–1184.
- Futagawa Y, Terasaki PI. ABO incompatible kidney transplantation—an analysis of UNOS registry data. *Clinical Transplantation* 2006;20:122–126.
- Forbes RC, Feurer ID, Shaffer D. A2 incompatible kidney transplantation does not adversely affect graft or patient survival. *Clin Transplant* 2016;30:589–597.
- Williams WW, Cherikh WS, Young CJ, et al. First report on the OPTN national variance: Allocation of A2/A2B deceased donor kidneys to blood group B increases minority transplantation. *Am J Transplant* 2015;15:3134–3142.
- OPTN/UNOS. Available at: https://optn.transplant.hrsa.gov/media/2347/mac_guidance_201712.pdf. Accessed January 20, 2019.
- Wang CJ, Wetmore JB, Israni AK. Old versus new: Progress in reaching the goals of the new kidney allocation system. *Human Immunol* 2017;78:9–15.
- The Kidney Allocation System. Available at: https://www.transplantpro.org/wp-content/uploads/sites/3/KAS_First-two-years_041917.pdf. Accessed January 10, 2019.
- Martins PN, Mustian MN, MacLennan PA, et al. Impact of the new kidney allocation system A2/A2B>B policy on access to transplantation among minority candidates. *Am J Transplant* 2018;18:1947–1953.
- Organ Procurement and Transplant Network. Available at: <https://optn.transplant.hrsa.gov/governance/public-comment/guidance-to-increase-nona1-and-nona1b-kidneys-for-type-b-candidates/>. Accessed January 20, 2019.
- Harris PA, Taylor R, Thielke R, et al. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42:377–381.
- Tierney J, Shaffer D. Transplantation of ABO A2 kidneys into O recipients: Do IgM anti-A1 titers matter? *Clin Transplant* 2015;29:379–382.
- Norman DJ, Prather JC, Alkhunaizi AM, et al. Use of A(2) kidneys for B and O kidney transplant recipients: report of a series of patients transplant at a single center spanning a decade. *Transpl Proc* 2001;33:3327–3330.
- Toki D, Ishida H, Setoguchi K, et al. Acute antibody-mediated rejection in living ABO-incompatible kidney transplantation: long-term impact and risk factors. *Am J Transplant* 2009;9:567–577.
- Hanto DW, Brunt EM, Goss JA, Cole BR. Accelerated acute rejection of an A2 renal allograft in an O recipient: association with an increase in anti-A2 antibodies. *Transplantation* 1993;56:1580–1583.
- Pins MR, Saidman SL, Cosimi BA, et al. Accelerated acute rejection of an apparent A2 renal allograft in an O recipient: Report of a case with flow cytometric analysis. *Transplantation* 1997;63:984–988.
- Redfield RR, Parsons RF, Rodriguez E, et al. Underutilization of A2 ABO incompatible kidney transplantation. *Clin Transplant* 2012;26:489–494.
- Nelson PW, Shield CF, Muruve NA, et al. Increased access to transplantation for blood group B cadaveric waiting list candidates by using A2 kidneys: Time for a new national system? *Am J Transplant* 2002;2:94–99.
- Axelrod D, Segev DL, Xiao H, et al. Economic impacts of ABO incompatible live donor kidney transplantation: A national study of Medicare-insured recipients. *Am J Transplant* 2016;16:1465–1473.
- Moore D, Feurer I, Forbes R, et al. Pre-transplant anti-A titers in waitlisted A2 to B kidney transplant candidates [Abstract]. *Am J Transplant* 2016;16[suppl 3].
- Sorenson JB, Grant WJ, Belnap LP, et al. Transplant of ABO group A2 kidneys from living donors into group O and B recipients. *Am J Transplant* 2001;1:296–299.

Discussion



DR ROBERT C HARLAND (Tucson, AZ): This study from the Vanderbilt Transplant Program is particularly relevant because it addresses the disparity in the allocation of kidneys for transplant solely on the basis of differential frequency of blood types in certain populations.