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Old versus new: Progress in reaching the goals of the new kidney allocation system

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ABSTRACT

As demand for kidney transplant continues to grow faster than organ availability, appropriate allocation of deceased donor kidneys is an acute priority. Increased longevity matching is central to this effort. To foster equitable and efficient utilization of deceased donor kidneys, a new kidney allocation system (KAS) was introduced in December 2014. Major achievements in the 1 year after its implementation include a reduction in age-mismatch and an increase in access to transplant for historically disadvantaged candidates, such as those with very high levels of panel-reactive antibodies or long dialysis duration. However, the rate of discarded kidneys has not decreased, and an increase in A2/A2B transplants has yet to be realized. Organs are now shared more often at the regional and national levels, with some regions experiencing an increase in transplants and other a decrease. While implementation of the KAS has been associated with the attainment of key goals, the kidney transplant community must remain vigilant about potential untoward consequences, including reductions in transplant rates for specific groups such as pediatric patients. More time is required before firm conclusions about the long-term effects of the new KAS can be rendered.

1. Introduction

Kidney transplant is associated with increased longevity and improved quality of life compared with maintenance dialysis in patients with end-stage renal disease (ESRD) [1]. These benefits are not confined to the most ideal transplant candidates, but extend to older patients and to those with diabetes, cardiovascular disease, and other comorbid conditions [2,3]. The combination of a trend toward less restrictive criteria for listing candidates for transplant and an increase in the prevalent dialysis population [4] has resulted in marked growth of the waiting list, which increased from ≈58,000 in 2004 to ≈99,000 in 2014 [5]. Unfortunately, over the same period, the availability of deceased donor kidneys increased only from ≈7150 to ≈8500, or by about 20% [6]. Thus, the shortage of kidneys, or "kidney gap," has become steadily larger.

The increasing kidney gap has given rise to twin challenges: to increase effective utilization of scarce organ resources by maximizing graft longevity and, simultaneously, to ensure equitable access to kidney transplant by reducing disparities in care. The former requires allocation of kidneys of higher quality to recipients projected to have a longer life span, while the latter demands that traditional barriers to transplant, such as high sensitization, unfavorable blood type, long dialysis duration, and geographic disadvantage, be reduced. The key principles underpinning optimal organ allocation policies are therefore utility and equity, and their roles within the conceptual framework of organ allocation have been reviewed previously [7,8].

To confront these twin challenges, the Organ Procurement and Transplantation Network (OPTN) Kidney Transplantation Committee approved a new deceased donor kidney allocation system (KAS) in December 2014, an effort more than a decade in the making. To improve utility, two new tools were created, the kidney donor pro-

Abbreviations: CIT, cold ischemia time; cPRA, calculated panel-reactive antibody; DGF, delayed graft function; ECD, expanded criteria donor; EPTS, estimated posttransplant survival; ESRD, end-stage renal disease; HLA, human leukocyte antigen; KAS, kidney allocation system; KDPI, kidney donor profile index; OPTN, Organ Procurement and Transplantation Network; SRTR, Scientific Registry of Transplant Recipients.

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file index (KDPI) and the estimated posttransplant survival (EPTS) metric. The KDPI is a measure of deceased donor kidney quality, while the EPTS is an estimate of the recipient's life expectancy. Collectively, these tools are designed to address the problem of "longevity mismatch," which occurs when recipients with long projected lifespans are allocated kidneys of lower quality, or *vice versa*. Simultaneously, to improve equity, a new prioritization framework was developed that incorporates a revised point allocation system designed to increase access to transplant for disadvantaged candidates.

In this review, we present the early results of the new KAS and evaluate whether it has begun to meet its designated goals. Specifically, we discuss the impact of the new KAS on the transplant waiting list, organ utilization, kidney allocation, and graft outcomes, contextualizing these initial results within the overarching guiding principles of balancing utility and equity.

This review used data from the Scientific Registry of Transplant Recipients (SRTR). The SRTR data system includes data on all donors, waitlisted candidates, and transplant recipients in the US, submitted by the members of the OPTN. The Health Resources and Services Administration, US Department of Health and Human Services, provides oversight of the activities of the OPTN and SRTR contractors.

2. Waiting list

While the new KAS does not specifically seek to affect characteristics of the waiting list, its adoption could possible indirectly do so, perhaps adversely. We review the early evidence for how the new KAS may have affected waiting list characteristics, including center readiness, waiting list size, active status percentage, distribution of candidates by various demographic and clinical characteristics, and waitlist mortality.

Center readiness is defined by administrative compliance with data collection mandates upon which the implementation of the new KAS is dependent. Transplant centers must verify information required for calculation of the EPTS (a measure required, along with the KDPI, to facilitate longevity matching), calculated panel-reactive antibody titer (cPRA, a score permitting prioritization for highly sensitized candidates), and anti-A antibody titers (a test required to assess eligibility of B blood type candidates to receive kidneys from A2/A2B donors).

In preparation for implementation of the new KAS, center adherence to EPTS and cPRA reporting requirements increased rapidly, with the data required for EPTS and cPRA calculation and verification available for more than 90% of candidates [9]. Over the first 6 months after the new KAS implementation, the rates continued to increase, albeit slowly: the percentage of calculable EPTS scores eventually reached 98% and calculable cPRA values approached/exceeded 94% (Fig. 1). Unfortunately, information on blood type, essential for increasing transplant of A2/A2B blood type kidneys into B blood type recipients (thereby reducing the disproportionately long waiting times for such candidates) remains lacking: such information was available for only 4.0% of active candidates and 2.9% of all waitlisted candidates 6 months after implementation of the new KAS. This amounts to less than 600 of the 14,000 waitlisted B blood type candidates.

The total size of the kidney waiting list remained similar 6 and 12 months after implementation of the new KAS, ≈109,000, and the number of new registrations remained unchanged [9]. The percentage of waitlisted candidates with active status also remained constant, at ≈60%, at 12 months [10]. However, the distribution of candidate waitlist characteristics changed in certain respects. A year into the new KAS, there has been a substantial 13.0% reduction in candidates with dialysis duration 10 years or longer, and an 11.7% reduction in candidates with cPRA 99% or higher [11]. This may be a sign that the aims of new KAS are being realized: candidates with these traditional barriers to transplant are now undergoing transplant at a substantially higher rate than before, resulting in a decreased waitlist prevalence of high-cPRA and long-dialysis-duration candidates. In contrast, the distribution of demographic characteristics (age, race, and sex) and causes of ESRD are initially unchanged [10]. Given the small number of kidney transplants relative to the size of the waiting list, more long-term data are required before the effect of the KAS on these variables can be accurately assessed.

Waitlist mortality appears to have remained stable at 12 months [10], but it is too early to form definitive conclusions about the impact of the new KAS.

3. Kidney procurement and utilization

An important aim of the new KAS is to increase the procurement and utilization of what were previously known as expanded criteria donor (ECD) kidneys (colloquially termed "marginal kidneys"). While introduction of the KDPI makes the term "ECD" obsolete, kidneys considered marginal now correspond to those with KDPI scores higher than 85% (henceforth termed "high-KDPI kidneys"). More than 40% of such kidneys are discarded [12], and as such they represent a potentially valuable resource if they can be successfully matched to appropriate candidates. Whereas in the past such kidneys would typically have been shared only at the local level, the KAS now mandates sharing at the regional level in an attempt to decrease discard rates. Thus, implementation of the KAS could be expected to increase the procurement and utilization of high-KDPI kidneys.

To date, there is no evidence that procurement of high-KDPI kidneys has increased. While the procurement rate of all deceased donor kidneys increased by 4.0% in the first 6 months [9] and 6.2% in the first 12 months [10], the percentage of procured high-KDPI kidneys was unchanged. Likewise, utilization of high-KDPI kidneys did not improve. The overall discard rate (a measure of utilization) actually increased, in relative terms, by 9.7% at 6 months. This effect occurred for kidneys at all levels of KDPI, except for the best kidneys (those with KDPI < 20%); discard rates increased by 17.7% for kidneys with KDPI 21%–34%, by 10.3% for kidneys with KDPI 35%–85%, and by 11.3% for kidneys with KDPI higher than 85%. Beyond 6 months, interpretation of the data on discard rates is more complex. While data from an OPTN report suggest that 7–10 months after adoption of the KAS, discard rates for kidneys at all KDPI levels (including high-KDPI kidneys) are returning to pre-KAS levels [9], a study by Massie et al. reported that the odds ratio of discard for a kidney with KDPI higher than 70% increased by 29% at 9 months post-KAS implementation [13].

It may appear somewhat paradoxical that increased sharing has not, thus far, led to increased utilization of high-KDPI kidneys. While procurement rates of these kidneys are unchanged, utilization appears to be reduced. One possible explanation that should be investigated is whether high-KDPI kidneys are now being biopsied more often. Given that poor findings on procurement biopsy remain the most common reason for kidney discard, and that increased biopsy rates are associated, perhaps inappropriately, with increased discard rates [14], it is plausible that more high-KDPI kidneys are now being biopsied, leading to discarded organs.

In summary, while procurement rates have increased overall, procurement of high-KDPI kidneys has not. Discard rates for all but the best kidneys increased after implementation of the KAS, but may now be returning to pre-KAS levels. Thus, the long-term effects of the KAS on discard rates, and therefore on utilization, remain to be seen.

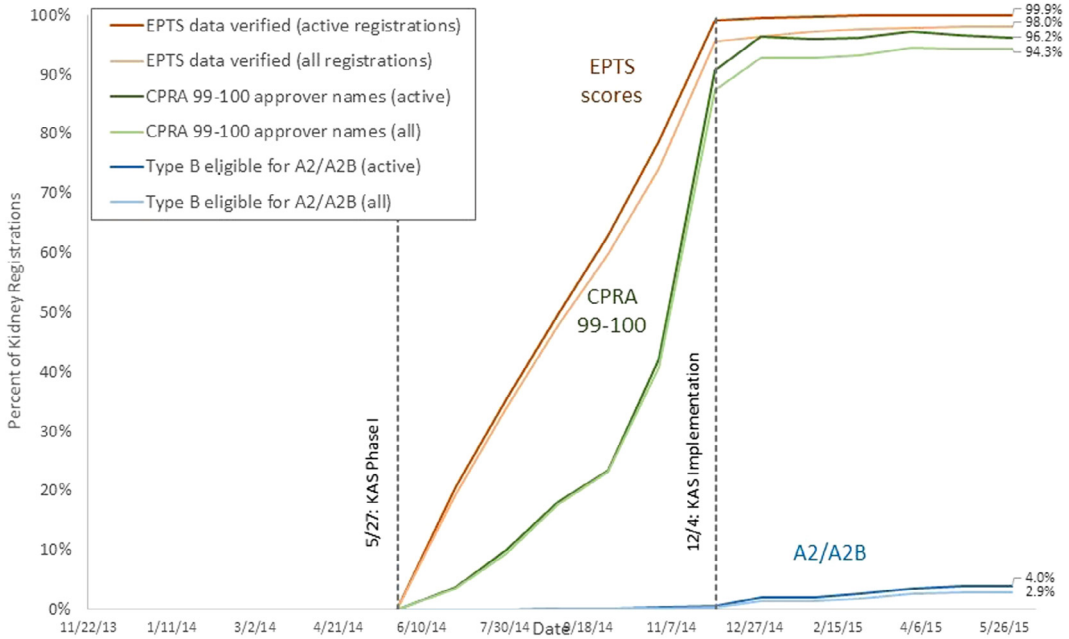

Fig. 1. Trends in reporting verified data required for transplant allocation before and after the new KAS. cPRA, calculated panel-reactive antibody; EPTS, estimated posttransplant survival; KAS, kidney allocation system. From: Stewart, D; Beck, J; Kucheryavaya, A. The new kidney allocation system (KAS): the first six months. Organ Procurement and Transplantation Network presentation, slide 6. Available at: https://www.transplantpro.org/wp-content/uploads/sites/3/KAS_analysis_6month.pdf. Accessed on May 25, 2016. Used with permission.

4. Kidney transplant

While growth in the overall number of kidneys transplanted annually is not an explicit goal of the new KAS, its effect on transplant volumes is obviously an area for scrutiny. One year after implementation of the new KAS, deceased donor kidney transplants increased by 4.6% [10]. However, before implementation of the KAS, the annual rate of increase over the past 3 years consistently ranged between 2% and 5% [6]. Therefore, in quantitative terms, it appears that the new KAS has not had a meaningful net effect on overall deceased donor transplants.

Qualitatively, however, the KAS was designed to alter the distribution of deceased donor kidneys. In Section 4.1 below, we discuss the effects of the KAS on transplants with regard to geographic distribution, share type (local vs. non-local), cold ischemic time (CIT, which could be affected by changes in organ distribution patterns), degree of human leukocyte antigen (HLA) mismatch, and distribution of deceased donor recipients with various characteristics (cPRA, dialysis duration, blood type, age, race, and primary cause of ESRD).

4.1. Geographic distribution and share type

A longstanding goal of the Department of Health and Human Services is to achieve what has been termed "geographic parity" in organ allocation, the concept that location of residency should not impair a patient's ability to undergo kidney transplant [15]. This is an important goal because waiting times are substantially longer, and thus waitlist mortality higher, in some donation service areas than in others. Several organ-sharing mechanisms of the new KAS encourage reduction in these geographic disparities. For example, before implementation of the new KAS, candidates with very high cPRA ($\geqslant$98%), for whom matching with immunologically compatible donors is difficult, had national access only to the highest-quality kidneys (those from standard criteria donors aged <35 years); under the new KAS, all kidneys, regardless of KDPI score, can be offered regionally and nationally to very-high-cPRA candidates. The poorest-quality kidneys (KDPI > 85%) are immediately shared at both the local and regional levels, rather than being shared sequentially in escalating fashion from the local to national levels.

The new KAS was predicted to increase the sharing of kidneys beyond the local level by about 14% in relative terms [16]. However, an analysis of the effect of the KAS at 1 year by Stewart et al. demonstrated an even larger "sharing effect" than anticipated [11]: regionally shared kidneys increased by 44.3% (from 8.8% to 12.7%), and nationally shared kidneys by fully 49.2% (from 12.6% to 18.8%) (Fig. 2). This is likely driven largely by increased sharing of kidneys being transplanted into very-high-cPRA recipients. As a result, the rate of kidneys placed locally was substantially reduced, from 69.2% to 50.9%. Perhaps due to this increased non-local sharing and other factors, some of the 11 regions experienced an increase in total transplants while others experienced a decrease: for example, Region 9 experienced a relative increase of 8.1%, while Region 6 experienced a relative decrease of 15.6% [10]. Collectively, these findings suggest that the new KAS may be working to reduce geographic disparity in kidney transplants, but the long-term effects on waiting times, waitlist mortality, and transplant rates remain to be seen.

4.2. Calculated panel-reactive antibody

One of the most significant changes associated with the KAS is the dramatic rise of transplants in candidates with high cPRA ($\geqslant$99%). This is as designed, since extremely heavy weight was assigned to highly sensitized candidates. For example, under the new KAS, 202.1 priority points are given to candidates with cPRA 100%, and 50.1 points to candidates with cPRA 99%. The transplant rate in this highly sensitized group increased from 2.4% to 12.3% at 12 months; all other cPRA groups received fewer transplants as a result. However, this increase may not persist: as shown in Fig. 3, the monthly transplant rate of high cPRA candidates is trending down as time from KAS implementation has increased [10]. In parallel, the number of waitlisted candidates with high cPRA is

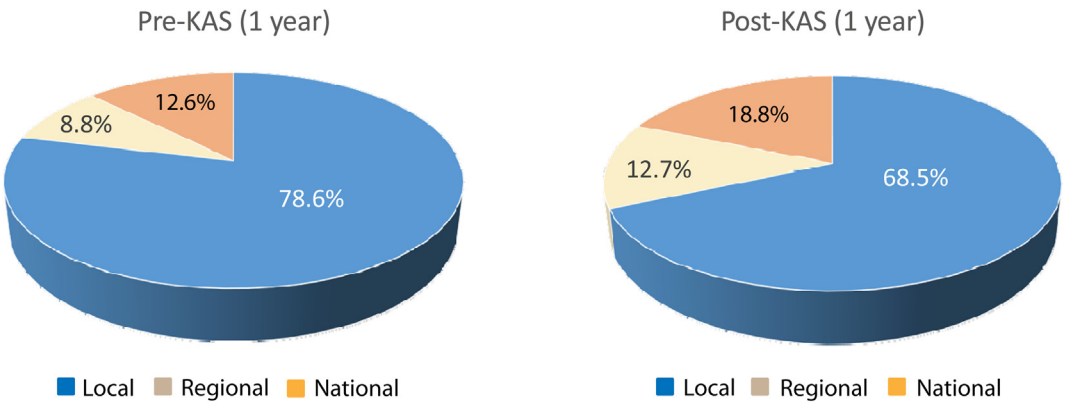

Fig. 2. Trends in kidney sharing at local, regional and national levels. KAS, kidney allocation system. From: Stewart, D; Beck, J; Kucheryavaya, A. The new kidney allocation system (KAS): the first year. Organ Procurement and Transplantation Network presentation, slide 41. Available at: https://www.transplantpro.org/wp-content/uploads/sites/3/KAS_12month_analysis.pdf. Accessed on May 25, 2016. Used with permission.

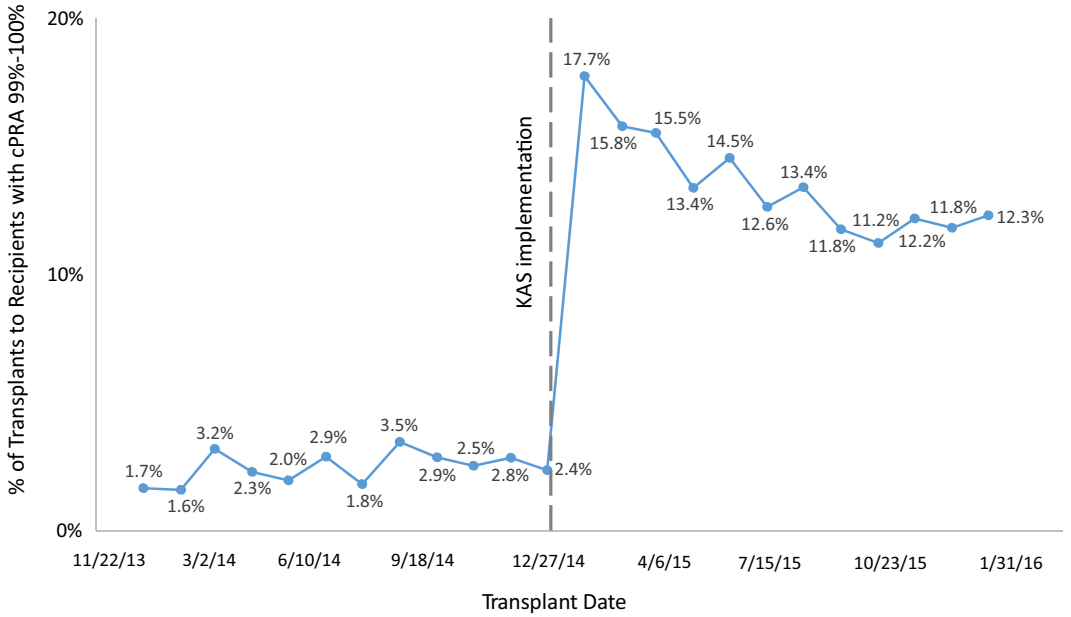

Fig. 3. Trends in kidney transplants in recipients with cPRA ⩾ 99%. cPRA, calculated panel-reactive antibody; KAS, kidney allocation system. From: Stewart, D; Beck, J; Kucheryavaya, A. The new kidney allocation system (KAS): the first year. Organ Procurement and Transplantation Network presentation, slide 21. Available at: https://www.transplantpro.org/wp-content/uploads/sites/3/KAS_12month_analysis.pdf. Accessed on May 25, 2016. Used with permission.

decreasing; the absolute number of candidates decreased by more than 1000. This has been referred to a "bolus effect" of the new KAS [11]; as this effect diminishes, a new equilibrium will likely be reached.

4.3. Cold ischemia time

With the emphasis on increased distant sharing of high-KDPI kidneys (>85%) and on high-cPRA candidates (⩾98%), there has been appropriate concern about the potential increase in CIT. Stewart et al. reported that the average travel distance rose from 194 to 267 miles, a 37.6% increase [11]. Additionally, the increased emphasis on transplants in high-cPRA candidates could possibly result in a higher rate of positive crossmatches, and thus a higher rate of declined offers and the attendant need to find additional potential recipients (all of which could increase the time from procurement to transplant). Due to these or to other factors, mean CIT increased slightly from 17.0 to 17.9 h 12 months post-KAS. Over the same period, the percentage of kidneys with CIT longer than 24 h increased from 18.3% to 21.3%, relatively modest increases, but important on a national scale.

Despite the fact that high-KDPI kidneys are now being shared at greater rates regionally and nationally (that is, non-locally), use of high-KDPI kidneys does not seem to be the main reason for the increase in CIT. The CIT for high-KDPI kidneys has increased, on average, by 6.7%, comparable to the increase in CIT across the entire program. Rather, it appears that the kidneys being allocated to high-cPRA candidates are contributing disproportionately to CIT, with a mean increase in CIT of 14.4%. That these kidneys are now traveling an average of 706 miles, compared with 441 miles before the new KAS, may account for this [11].

4.4. Degree of HLA mismatch

Degree of HLA mismatch is assigned priority points toward allocation, but only for zero-ABDR mismatch and zero-DR mismatch. While zero-ABDR mismatched kidneys were assigned top priority under the previous allocation system, cPRA is now afforded top

priority, and zero-ABDR mismatched kidneys are given second-level priority. As a result, the rate of zero-ABDR-mismatched kidneys transplanted decreased from 8.2% to 4.7% in the first 12 months of the new KAS [10]; similarly, transplants of zero-DR-mismatched kidneys decreased from 19.8% to 16.8% in this period (Fig. 4). Because increasing allograft survival remains the overarching goal of the new KAS, and because zero-ABDR mismatched kidneys have longer mean survival times than mismatched kidneys, the effect of the KAS on the rate of transplant of zero-ABDR mismatched kidneys requires close monitoring.

Table 1
Effects of longevity matching: distribution of kidneys with KDPI < 20%, by age group.

Recipient age (yr)	KDPI 0%–20%	
	Pre-new KAS	Post-new KAS
0–17	13.4	11.7
18–34	12.5	30.4
35–49	26.4	38.7
50–64	33.0	14.3
⩾65	14.6	4.8

KAS, kidney allocation system; KDPI, kidney donor profile index.

4.5. Age

A major goal is of the new KAS is to maximize the potential "life" of the transplanted kidney by allocating the best-quality kidneys (KDPI < 20%) to the candidates with the longest project lifespan (EPTS < 20%). Candidates with the longest projected lifespan also have equal access to kidneys throughout the rest of the KDPI range. Since age is a key determinant of the EPTS score, younger patients are therefore substantially more likely to undergo transplant than older patients.

As predicted, 12 months after implementation of the new KAS, there was a 45.9% relative increase in transplants among candidates aged 18–34 years, and a 15.8% relative increase among those aged 35–49 years. Rates for older candidates decreased; for example, there was a 20.9% relative decrease in transplants among candidates aged 65 years or older [10]. A major contributing factor is the relatively higher acceptance rate among younger candidates, which is likely a reflection, in part, of younger candidates being offered superior kidneys.

The new KAS appears to have improved "longevity matching," at least at this early stage. Longevity matching has two major components: age matching (that is, reducing the age differential between donor and recipient) and what might be termed "quality matching" (that is, transplanting the kidneys with the lowest KDPI into young patients with low EPTS). The age mismatch component has been reduced: at 12 months, the rate of kidney transplants in which the age mismatch is more than 30 years (that is, the donor is >30 years older than the recipient, or the reverse) has been reduced by 22.6%, while more optimal matches (e.g., an age differential between donor and recipient of <10 years) increased by 7.7%. In parallel, quality matching has improved (Table 1). Allocation of the highest quality kidneys (KDPI < 20%) to recipients aged younger than 40 years increased by 81.7%, and to recipients aged older than 65 years decreased by 65.8% in relative terms [10].

Despite promising signs that the new KAS is achieving some important goals, the optimal method of allocating kidneys to older patients, specifically those aged older than 65 years, remains a matter of debate. This is an increasingly important issue, since this age group constitutes the most rapidly growing group requiring maintenance dialysis [4], and the most rapidly growing group being added to the waiting list [17]. Despite their high burden of comorbidity, older patients who undergo transplant have substantially longer projected survival than their age-matched counterparts who remain on dialysis [2,3]. Less access to kidneys, compared with younger patients, will mean increasing waitlist mortality rates for these candidates. Thus, the transplant community should continue to investigate ways to expand the pool of donor organs available to all candidates, especially older ones, such as increasing acceptance rates of more marginal kidneys and encouraging living donation.

4.6. Dialysis duration

Another significant change in kidney allocation patterns relates to candidates with dialysis duration longer than 5 years. Candidates on dialysis at the time of listing now receive points for dialysis duration, not just for time on the waiting list. As a result, the transplant rate increased by 33.2% at 12 months for candidates with dialysis duration of 5–10 years, and by 138.1% for candidates with dialysis duration longer than10 years [10]. Thus, transplant rates for patients with shorter dialysis duration decreased. The bolus effect mentioned in Section 4.2 is likely operative here as well.

4.7. Blood type

Transplant of kidneys from donors with blood type A2/A2B into recipients with blood type B (A2/A2B to B) is actively promoted by

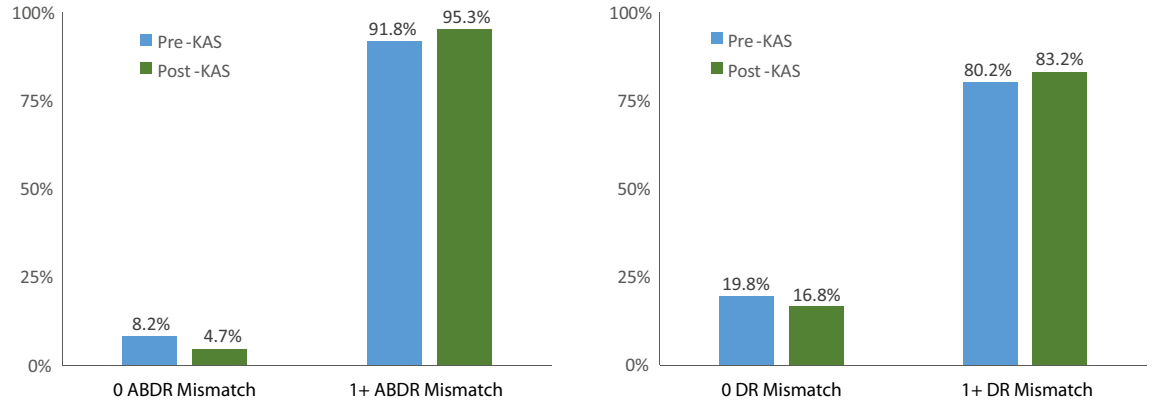

Fig. 4. Distribution of kidney transplants by levels of HLA mismatch. HLA, human leukocyte antigen; KAS, kidney allocation system. From: Stewart, D; Beck, J; Kucheryavaya, A. The new kidney allocation system (KAS): the first year. Organ Procurement and Transplantation Network presentation, slide 22. Available at: https://www.transplantpro.org/wp-content/uploads/sites/3/KAS_12month_analysis.pdf. Accessed on May 25, 2016. Used with permission.

the new KAS to reduce the disproportionately long waiting times for B blood type recipients. While the rate of A2/A2B to B transplants increased markedly in the first 12 months of the new KAS, from 0.2% to 1.0%, the absolute increase is only 90 cases, meaning that the overall distribution of kidney transplants by blood type has changed little [10].

As a result, candidates with blood type B remain significantly underserved relative to their representation on the waiting list. The reason is likely a result of under-identification: as described in Section 2, 6 months into the implementation of the new KAS, only 2.9% of all B blood type candidates were reported to be eligible, because centers do not appear to be reliably ascertaining the level of anti-A titers (the prime determinant of eligibility). In theory, more than 80% of all B blood type candidates, representing roughly 14,000 individuals, could be eligible to receive an A2/A2B kidney were complete candidate information available.

4.8. Race/ethnicity

While the issue of racial disparities in access to kidney transplant is not specifically addressed in the new KAS, changes in allocation priority might be expected to affect allocation of kidneys to candidates of different races. For example, increased transplant rates for candidates with higher cPRA, longer dialysis duration, and blood type B would likely result in more transplants in African Americans, given their higher prevalence of these barriers to transplant.

With the adoption of the new KAS, redistribution of transplanted kidneys among the various racial and ethnic groups has indeed been significant. The greatest increase was for African Americans (Fig. 5), a relative increase of 16.6% in the first 12 months. African Americans now undergo 36.8% of total annual kidney transplants, actually exceeding their waitlist prevalence of 34.4%. Similarly, Hispanics experienced a relative increase of 9.1% at 12 months. In contrast, whites experienced a relative decrease of 15.3%, and Asians a decrease of 6.6% [10]. Whether transplant rates by race eventually match the racial distribution of the waiting list requires further follow-up. Over the long term, African Americans and Asians, who have the highest frequency of B blood type (at 19% and 25%, respectively) [18], will presumably be relative beneficiaries of efforts designed to increase A2/A2B to B transplants.

4.9. Diabetes as cause of ESRD

Patients with diabetes have traditionally undergone transplant at a lower rate than their representation on the waiting list would suggest. Further, the transplant rate in diabetic patients has decreased 13.5% in the 12 months since implementation of the KAS [10]. As with older age, presence of diabetes negatively affects the EPTS score, reducing the chances that diabetic patients will have access to the best kidneys (KDPI < 20%), which make up about one-fifth of the total organ pool. While EPTS is not a factor in access to other kidneys (KDPI $\geqslant$ 20), the net effect of this change is lower overall access to kidneys. This could increase the waitlist mortality rate in diabetic patients, so the effect of the new KAS on access to transplant for diabetic patients must be followed closely. Interventions such as increasing use of high-KDPI kidneys or fostering greater use of living donor kidneys in this vulnerable population should be considered.

5. Outcomes

5.1. Delayed graft function

Changes in the patterns of organ allocation are likely to have affected rates of delayed graft function (DGF). Some of these changes would be expected to increase the DGF rate, such as more transplants in recipients with high cPRA or long dialysis duration, and more non-local distribution of donor kidneys (with resultant increases in CIT). In contrast, some observed changes would be expected to decrease the DGF rate, such as the fewer kidneys from donors of advanced age or with high-KDPI, and fewer transplants in candidates of advanced age or with diabetes.

Overall, the observed DGF rate increased by 25.7%, in relative terms, from 24.5% to 30.8%, over the first 6 months of the KAS [9]. There appears to be very modest improvement over the ensuing 6 months, such that the 12-month DGF rate rose 19.7% in relative terms (from 24.4% to 29.2%) [10]. The precise factors responsible remain to be elucidated; while a recent report by Stewart et al. suggested no evidence of individual effects attributable to cPRA, KDPI, CIT, or dialysis duration [11], no multivariable modeling was presented, making it difficult to quantify the influence of the respective risk factors on the outcome of DGF. Whether higher

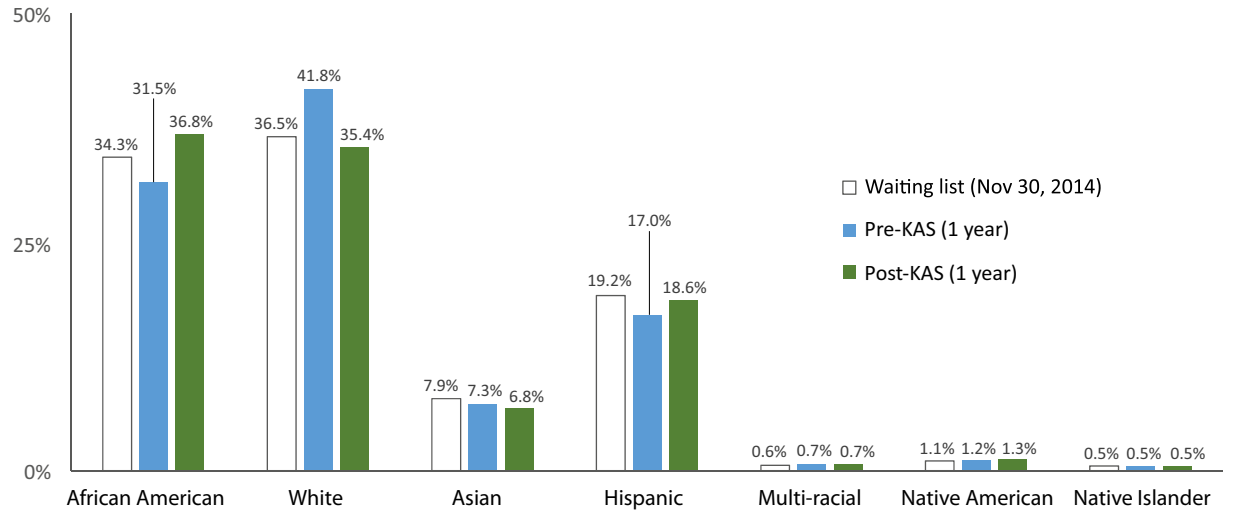

Fig. 5. Distribution of waitlisting and kidney transplants before and after the new KAS, by recipient race/ethnicity. KAS, kidney allocation system. From: Stewart, D; Beck, J; Kucheryavaya, A. The new kidney allocation system (KAS): the first year. Organ Procurement and Transplantation Network presentation, slide 27. Available at: https://www.transplantpro.org/wp-content/uploads/sites/3/KAS_12month_analysis.pdf. Accessed on May 25, 2016. Used with permission.

DGF rates will be a permanent result of the implementation of the new KAS remains to be seen.

5.2. Six-month graft survival

Graft survival could be affected by changes in organ allocation under the new KAS; as with DGF, certain allocation changes likely improved outcomes, while others might have worsened them. Increased observed transplant rates for recipients with high cPRA or long dialysis duration, decreased observed rates of zero-HLA mismatches and longer average CIT, and higher observed rates of DGF likely tended to decrease short-term graft survival. In contrast, lower observed rates of transplant from donors of advanced age or with high-KDPI, combined with lower observed transplant rates in recipients of advanced age or with diabetes, likely favored better graft outcomes. On balance, there was no significant change in 6-month graft survival, which was 95.4% before implementation of the KAS and 95.8% after [11]. Whether the key KAS goal of increased graft survival through longevity matching has been met will require observation over the coming years.

6. Pediatric transplantation

Previously, pediatric transplant candidates received priority for high-quality kidneys, which were classified as those from donors aged younger than 35 years, colloquially known as the "share 35" rule. Under the new KAS, high-quality kidneys are now redefined as those with KDPI less than 35%. It is therefore appropriate to monitor the effects of this change on pediatric transplant rates. In the first 6 months of the new KAS, the pediatric transplant rate fell 16.3% [9], from 4.3% of total transplants to 3.6%. Over the ensuing 6 months, this trend diminished: the relative decrease in pediatric transplant fell 7.1%, from 4.2% to 3.9% when summed over the 12 months [10]. These findings may be explained by the emphasis in the new KAS on transplants in patients with high cPRA levels or long dialysis durations. Possibly, the increased rate of transplants in such candidates has resulted in a decrease in organs available to pediatric candidates, but this is uncertain. If this is the case, pediatric transplant rates may rebound as the list of adult candidates with high cPRA levels or long dialysis durations decreases. This must be monitored closely.

7. Conclusions

The new KAS was ambitiously designed to aid the transplant community in accomplishing several major goals, judiciously balancing equity and utility. In the year since the new KAS was implemented, several of these goals have been met, while others remain unrealized. Major achievements include a reduction in age-mismatch (a critical component for maximizing allograft life-years) and an increase in access to transplant for historically disadvantaged candidates (such as those with very high cPRA or long dialysis durations.) In contrast, the discard rate has not improved, and an increase in A2/A2B transplants has not yet been observed. Concerning the latter, there is reason for cautious optimism since increased emphasis is likely to be placed on the measurement of anti-A titers by transplant centers in the coming years. In the laudable quest to maximize valuable societal organ resources by reducing age-mismatch, the kidney transplant community must remain vigilant about potential untoward consequences of the new KAS, such as reductions in the rate of transplants in pediatric candidates. While hope that equilibrium in transplantation will be reached across various categories of transplant candidates, more time is needed before firm conclusions about the long-term effects of the new KAS can be drawn.

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