Implications of the Statewide Sharing Variance on Kidney Transplantation Geographic Inequity and Allocation Efficiency

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Abbreviations: SS: Statewide Sharing, CIT: Cold-Ischemic Time, DSA: Donor Service Area, DDKT: Deceased Donor Kidney Transplant, OPTN: Organ Procurement Transplant Network, UNOS: United Network for Organ Sharing, HHS: Department of Health and Human Services, US: United States

Abstract

The Statewide Sharing (SS) local allocation variance offers non-locally allocated kidneys to patients listed in other Donor Service Areas (DSA) within the state of procurement before offering regionally and nationally. Two states adopted the variance in the early 1990s, but its effect on statewide allocation equity and efficiency has not been assessed. A retrospective analysis of OPTN data files was performed for 1987-2009 to analyze the SS variance's impact on equity by proxy of four performance indicators: deceased donor kidney transplant rates, waiting time to transplantation, cumulative dialysis time, and five year graft survival. Allocation efficiency was assessed by comparing cold-ischemic time for statewide versus local kidney allocation. Performance indicators and allocation efficiency were compared with states with the same amount of DSAs. Prior to SS variance implementation (1987-1992), inequity and inefficiency existed for all states. After implementation (2005-2009), states adopting the SS variance demonstrated higher statewide equity for each equity indicator and efficiency significantly improved, while they persisted and worsened in the other states. We demonstrate that the SS variance, a small change to current policy, significantly improved allocation equity and efficiency. Such findings should be considered as allocation and remapping of the allocation system are considered by UNOS.

Introduction

Over 94,000 end stage renal disease patients are presently listed for kidney transplantation, but only 16,813 kidney transplants were performed in 2011 (1,2). The current United Network for Organ Sharing (UNOS) kidney allocation policy allocates kidneys first within the Donor Service Area (DSA) where the kidney is procured. If the kidney is not accepted within the DSA of procurement, it is offered next to the UNOS region of procurement, and ultimately if not placed within the region it is offered nationally (3).

In 1998, the Department of Health and Human Services (HHS) released a 'Final Rule' mandating geographic equity in organ allocation (4). The 'Final Rule' supports the use of Local Allocation Variances to test experimental policies that could potentially improve organ allocation (4). As of April 2010, twenty-seven Local Allocation Variances were used for kidney allocation within the Organ Procurement and Transplant Network (OPTN) (5). Despite the implementation of these variances, the maximum difference in median waiting times to kidney transplantation between the 58 DSA was 4.7 years in 2009 (6). This is an increase from the maximal difference of 3.3 years in 2000 (6).

However, one local allocation variance, called the Statewide Sharing (SS) variance, might be of particular interest. The SS variance allocates kidneys first within the DSA of procurement (local), and then introduces an additional step by allocating within the state, prior to allocating regionally (UNOS), and finally nationally (5). To date, two states, one with two DSAs and one with four DSAs, have adopted the SS variance for deceased donor kidney allocation. The impact of the SS variance on the geographic equity, as mandated by the Final Rule, as well as the allocation efficiency has not been assessed.

We therefore studied the impact of the SS variance on the geographic equity and allocation efficiency between the DSAs within those two states that implemented the SS variance and compared them to states that did not implement the SS variance prior and after implementation of the SS variance. Kidney transplantation geographic equity was measured using four performance indicators: deceased donor kidney transplant (DDKT) rates, waiting time to transplantation, cumulative dialysis time, and five year graft survival. Cold ischemic time (CIT) was used to measure allocation efficiency.

Materials and Methods

Data and Data Sources

OPTN Standard Transplant Analysis and Research (STAR) data files were used to analyze patients listed for kidney transplantation (transplant candidates) and DDKT recipients from January 1, 1987 to December 31, 2009.

One of the two states which adopted the SS variance has two and the other four DSAs within the state. Therefore, we limited our analysis to those states, which had either two or four DSAs. In total, there are four states with two DSAs, one of which implemented the SS variance, and four states with four DSAs, one of which implemented the SS variance. Each state with SS variance was compared to the other three states, with the same amount of DSAs. The study population included 192,787 transplant candidates and 75,792 DDKT recipients.

Transplant Candidate Demographics

The following transplant candidate demographics were captured in Table 1: age, gender, race (Non-Hispanic White (NHW), Non-Hispanic Black (NHB), Hispanic, Asian, and Other), panel reactive antibodies (PRA) (non-sensitized (0-20%), sensitized (20-80%), and highly sensitized (80-100%)), primary diagnosis (diabetes, glomerulosclerosis, hypertension, polycystic kidneys, graft failure, and other), primary insurance (private, Medicare, Medicaid, and other), educational attainment (some college, high school or less), and preemptive listing for transplantation, defined as listing prior to initiation of dialysis.

Analysis

DSA Performance Indicators: DSA performance indicators were calculated for each state annually: Mean transplant rate, median waiting time, median cumulative dialysis time and five year graft survival. The DSA mean transplant rate was calculated as the mean annual number of transplant candidates waitlisted divided by the DDKTs performed within the DSA. The five year graft survival was calculated using the Kaplan-Meier method. The annual allocation efficiency was measured by calculating the mean CIT of those kidneys used for transplantation, stratified by transplant location type (local, statewide).

Allocation Equity within the State: The geographic equity among the DSAs within the state was measured applying an *equity ratio.* The equity ratio calculated as the ratio between the highest and the lowest performance indicator between the DSAs in a particular state. An equity ratio which equals 1.0 suggests that there is perfect geographic allocation equity with respect to this particular performance indicator. Allocation inequity increases as the equity ratio rises above 1.0. The allocation equity ratio was assessed annually. Furthermore, the *improvement ratio* which measures the percent improvement in equity relative to the total possible improvement between the pre-SS variance period (1987-1992) and the post-SS variance period (2005-2009) was calculated for each performance indicator. For example if this ratio is negative, then the geographic allocation equity within the state got worse over time. If the improvement ratio is close to 1.0, then the geographic allocation equity has greatly improved over time.

Allocation Efficiency within the State: To assess the allocation efficiency the *CIT difference* was calculated as the difference between the mean CIT of DDKT allocated locally versus those allocated statewide. We calculated the *CIT reduction* in each state by subtracting the mean CIT difference during the pre-SS variance period (1987-1992) from the mean CIT difference during the post-SS variance period (2005-2009). A large value suggests that the allocation efficiency has greatly improved over time, while a small value indicates no significant change in allocation efficiency.

Data were summarized using descriptive statistics (mean, median, standard deviation, frequency, and proportions). Chi-squared tests were used for categorical variables and t-tests were used for continuous variables to compare for significant differences across kidney transplant candidate populations. All p-values less than 0.05 were considered statistically significant.

All analysis was conducted using SAS Version 9.3 (SAS Institute Inc, Cary, North Carolina). Northwestern University Institutional Review Board approval was obtained prior to collection of any data.

Results

Overview

State A implemented the SS variance in November 1, 1992 (5) had two DSA and was compared with the three other states, which have two DSAs (State B, C, D). State E, which has four DSAs within the state, implemented the SS variance on June 17, 1991 (5), and was compared to the three other states that had four DSAs (State F, G, H).

Allocation Equity and Efficiency in States with SS Variance (States A and E):

Figure 1 compares the equity ratios for each performance indicator from 1987 to 2009 for States A and E. After implementing the SS variance, both states saw improvement over time for each performance indicator. In State A, the effect of the SS variance was more rapid with the equity ratios falling from 1.53 to 1.05 between 1992 and 1995 for mean transplant rates, from 1.88 to 1.24 for the median waiting time, from 1.46 to 1.10 for the median cumulative dialysis time, and from 1.41 to 1.06 for the five year graft survival. After 1995, geographic allocation equity was sustained in State A with equity ratios maintained between 1.00-1.22 for transplant rates, between 1.00-1.33 for median waiting time, between 1.01-1.34 for the median cumulative dialysis time, and between1.01-1.15 for the five year graft survival. In State E, the effect of the SS variance implementation was more gradual. The equity ratios during 1992-2005 fell from 1.89 to 1.37 for the transplant rates, from 3.97 to 1.14 for the median waiting time, from 2.18 to 1.43 for median cumulative dialysis time and from 1.39 to 1.15 for the five year graft survival. After 2005, the achieved geographic equity was maintained in State E with equity ratios ranging between 1.24-1.46 for transplant rates, between 1.02-1.23 for median waiting time, and between1.16-1.43 for the median cumulative dialysis time. The allocation efficiency also improved for both states after SS variance implementation. The CIT differences from 1992 to 2009 between locally allocated kidneys and statewide allocated kidney fell from 7.0 hours to 1.3 hours in State A and from 7.3 hours to 0.7 hours in State E.

Population Demographics

Transplant candidate characteristics are listed in Table 1. During 1987-2009, 192,787 transplant candidates were listed for kidney transplantation and 75,792 DDKTs were performed in this cohort. Transplant candidates in State A were significantly younger, were less likely to be listed preemptively for transplant, were less likely insured privately, were less likely to suffer from glomerulosclerosis, and were diagnosed with hypertension more often than transplant candidates in the other states with two DSAs. In contrast transplant candidates in State E were significantly older, were more likely to suffer from glomerulosclerosis, and had higher educational attainment when compared to other three states with four statewide DSAs.

Pre- and Post-SS Variance Comparisons: 2 DSA States

Figure 2 demonstrates the changes for each performance indicator between 1987 and 2009. In addition, Table 2 shows the equity ratio and the improvement ratio over time for each DSA by performance indicator.

*Mean Transplant Rate (*Figure 2A, Table 2): In the pre-SS variance period, the equity ratio ranged between 1.27 and 1.97. After implementation of the SS variance the mean transplant rate equity ratio in State A is 1.12, while the equity ratio for the transplant rates in States B, C, and D do not improve over time.

*Median Waiting Time (*Figure 2B, Table 2): In the pre-SS variance period, the equity ratios ranged between 1.33 and 2.21. After implementation of the SS variance in State A, the mean equity ratio fell to 1.07, while the ratios ranged between 1.78 and 2.14 for States B, C, and D. Both States A and C had positive improvement ratios, but State A's improvement ratio was 2.7 times larger.

Median Cumulative Dialysis Time (Figure 2C, Table 2): In the pre-SS variance period, the mean equity ratios ranged from 1.17-1.55. In the post-SS variance period, State A's mean equity ratio reduced to 1.14, while States B, C and D maintained equity ratios between 1.19-1.46. States A and State C both had positive improvement ratios, but the improvement was 5.7 times larger in State A compared to State C (0.74 and 0.13).

*Mean Five Year Graft Survival (*Figure 2D, Table 2): In the pre-SS variance period, the equity ratio ranged from 1.13-1.35. Because the five year graft survival is not available for the time period the equity ratio for five year graft survival was assessed for 2000-2004. The mean equity ratio for State A was dropped to 1.03 while states B, C, and D maintained their equity ratios between 1.19-1.22. State A and B had positive improvement ratios for the time period, but the improvement in State A was 5.1 times larger (0.92 and 0.18).

Pre- and Post-SS Variance: 4 DSA States

Figure 3 demonstrates the changes for each performance indicator between 1987 and 2009. In addition, Table 2 shows the equity ratio and the improvement ratio over time for each DSA by performance indicator.

*Mean Transplant Rate (*Figure 3A, Table 2): In the pre-SS variance period, the equity ratio ranged between 1.59 and 2.01. After implementation of the SS variance the mean transplant rate equity ratio in State E is 1.38, while the equity ratio for the transplant rates in States F, G, and H do not improve over time.

*Median Waiting Time (*Figure 3B, Table 2): In the pre-SS variance period, the equity ratios ranged between 1.97 and 3.86. After implementation of the SS variance in State E the mean equity ratio fell to 1.12, while the ratios ranged between 2.35 and 2.68 for States F, G, and H. States E, F, and H had positive improvement ratios, but State E's improvement ratio was 3.8 times larger than in State F and 5.6 times larger than in State H.

Median Cumulative Dialysis Time (Figure 3C, Table 2): In the pre-SS variance period, the mean equity ratios ranged from 1.75-2.38. In the post-SS variance period, State E's mean equity ratio reduced to 1.25, while States F, G and H maintained equity ratios between 1.56-1.68. All states had positive improvement ratios, but the improvement in State E was 1.5, 1.3, and 2.4 times larger than in States F, G, and H, respectively.

*Mean Five Year Graft Survival (*Figure 3D, Table 2): In the pre-SS variance period, the equity ratio ranged from 1.24-1.44. Because the five year graft survival is not available for the time period the equity ratio for five year graft survival was assessed for 2000-2004. The mean equity ratio for State E was dropped to 1.24 while the equity ratio in States F, G, and H do not improve over time.

Allocation Efficiency between DSA within a State

Figure 4 shows the difference between the mean CIT for kidneys that were allocated and used locally versus statewide. For State A, the CIT difference decreased after the SS variance implementation, ranging between 1.1 hours to 2.4 hours (Figure 4A). States B, C, and D maintain large differences in CIT and large fluctuations in CIT difference over time, ranging between 2.3-11.9 hours. Similarly, after the SS variance implementation in State E the CIT difference decreases over time, (Figure 4B) ranging between 0.7 and 2.7

hours, while states F, G, and H maintained a high fluctuation and no reduction in CIT difference, ranging from 5.1 to 8.1 hours.

Table 3 demonstrates the overall CIT reduction after implementation of the SS variance for all eight states. The CIT reduction for State A was 6.2 hours falling from 8.2 hours (1987-1992) to 2.0 hours (2005-2009). The CIT reduction for States B and C was negative, which means that CIT differences increased by 2.8 hours. State D reduced CIT by 1.9 hours. The CIT reduction in State E was 5.6 hours falling from 6.9 hours to 1.3 hours. The CIT reduction for States F and H was negative, which means that the CIT differences increased by 3.0 and 2.5 hours respectively. The CIT reduction in State G was 0.4 hours.

Furthermore, in State A, the percentage of kidneys used statewide increased from 1.8% to 13.8%. States B, C and D did not significantly change their allocation patterns. In State E, both the local and statewide use of kidneys increased from 46.4% to 70.8% and from 9.0% to 11.3%, respectively. Statewide use of kidneys in State F dropped from 28.7% to 4.8%, while the local use increased from 51.0% to 75.1%. In States G and H, no considerable changes in local and statewide usage were seen.

Discussion

In our study we demonstrate that geographic inequities in kidney allocation exist despite the federal mandate to resolve them (4,5). However, attempts have been made to resolve inequities and inefficiencies through variances to the allocation system with statewide variance being one of many that were implemented, allowing for statewide allocation after allocation within the DSA of procurement, but before regional allocation. Our analysis demonstrates that these variances in allocation have successfully improved geographic equity among the DSAs within the two states that implemented these changes. We demonstrate that other states that have the same number of DSAs did not successfully reduce the existing geographic inequity, while those that implemented the variance successfully improved the transplant rates – defined as the ratio between listed and transplanted patients within a DSA. They reduced the variability in waiting time for transplantation and the median cumulative dialysis time, which is associated with reduced death rates, and they increased equity in five year graft survival rates. In addition, higher allocation efficiency was achieved as measured by reduced CIT. We therefore believe that this analysis provides evidence that the SS variance can successfully reduce the generally existing geographic inequity and furthermore increase the allocation efficiency within state boundaries without invasive changes to the current kidney allocation policy. We demonstrate that the SS variance has improved the existing geographic inequities in both the states where it was implemented. It is important to notice that the makeup of those two states is markedly different. While in one of the two states patients are significantly older than in the comparative states, they are significantly younger than the comparative states in the other state with SS variance. The differences also affect the primary causes for ESRD, as well as educational attainment. This is encouraging, because it can be interpreted that the SS variance has a similar effect for different clinical cohorts.

Beyond the improvement, the two states that implemented the SS variance achieved not only improvement across the board on performance indicators, but also achieved stability with little variation after implementation. This stabilization of the transplantation rate was indicated to be a priority by the Institute of Medicine (7). In addition, recent patient-level analyses of the SS variance have shown that the implementation of SS variance increases the rate of transplantation for highly sensitized patients, who are normally a disadvantaged patient population (8,9). In states using the SS variance, shorter waiting times were achieved. This has been shown to reduce mortality on the waiting list, reduce complications prior and after transplantation, improve post-transplant outcomes, be more cost-effective, and improve the quality of life of the recipient (10-20). The stabilization of waiting times within the state grants transplant candidates similar experiences throughout the state and thereby achieves the equity requested by the HHS (4). As implied by the reduction of the waiting times, we were able to demonstrate the implementation of the SS variance improved geographic equity in graft survival rates. This was not true for the states that did not implement the SS variance.

A concern might be that by implementing the SS variance organs might get lost to the procuring DSA. However, we demonstrated that in fact more kidneys were retained after implementation of the SS variance within the DSA and within the state than in the other states without the variance. In comparison four of the six states without the SS variance retained less local organs over time and only one of those six states managed to marginally increase the statewide usage. Therefore, we demonstrate that the DSAs are not disadvantaged but benefit from their participation in the SS variance.

The improvement of allocation efficiency was quite compelling. States with the SS variance experienced a six hour reduction in the mean CIT for kidneys used within the state. Meanwhile, four of the other states increased their CIT difference over time and only two mildly reduced the CIT difference. This might have further consequences as the prolonged CIT may lead to higher kidney discard rates, especially once offered regionally or nationally.

As demonstrated by the SS variance, the existing geographic allocation inequity and inefficiency could successfully be improved by the implementation of the SS variance. This is a rather small change to a highly complex system, with significant improvement in outcome in addition to equity. However, allocation equity improvement was achieved faster in State A with 2 DSAs. In State E with 4 DSAs, improvements were more gradual with less equity achieved over time. These results suggest that the exploration of such variances not only within states, but maybe between neighboring states should be explored thereby creating sharing relationships between a small numbers of DSAs.

The currently proposed kidney allocation policy intends to suspend the use of local allocation variances, including the SS variance (21). Meanwhile, nationwide geographic inequities continue to worsen over time (6). Taking away the SS variance will therefore likely worsen the existing geographic inequities in those states that are currently benefiting from the SS variance. While challengers of maintaining the SS variance in the new allocation policy raise a legitimate concern that those variances might not improve the national inequity problem, the overwhelming success of small changes to the current allocation system should not be underestimated and should be explored with the same force as exploring entirely new allocation systems that inevitably will lead to unanticipated unintended consequences.

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Disclosure

The authors of this manuscript have no conflicts of interest to disclose as described by the *American Journal of Transplantation*.

Figure Legends

Figure 1: Statewide Equity Ratios for Performance indicators (1987-2009)

States A and E adopted the SS Variance in 1991-1992. An equity ratio that equals 1.0 suggests that there is complete geographic equity with respect to a particular performance indicator. Allocation geographic inequity increases as the equity ratio rises above 1.0. Because the five year graft survival is not available for the entire time period the equity ratio for five year graft survival was assessed for 1987-2004. CIT Difference represents the difference between the mean Cold Ischemic Time for kidneys allocated within the state versus allocated locally (Donor Service Area).

Figure 2: Allocation Equity Ratios between DSAs within States with 2 DSAs (1987-2009)

State A adopted the Statewide Sharing variance in 1992. States B, C, and D have not implemented the variance. An equity ratio that equals 1.0 suggests that there is complete geographic equity with respect to a particular performance indicator. Allocation geographic inequity increases as the equity ratio rises above 1.0. Because the five year graft survival is not available for the entire time period the equity ratio for five year graft survival was assessed for 1987-2004.

Figure 3: Allocation Equity Ratios between States with 4 DSAs (1987-2009)

State E adopted the Statewide Sharing variance in 1991. States F, G, and H have not implemented the variance. An equity ratio that equals 1.0 suggests that there is complete geographic equity with respect to a particular performance indicator. Allocation geographic inequity increases as the equity ratio rises above 1.0. Because the five year graft survival is not available for the time period the equity ratio for five year graft survival was assessed for 2000-2004.

Figure 4: Allocation Efficiency between DSAs within a State (1987-2009)

States A and E has adopted the Statewide Sharing variance. All other states have not implemented the variance. Allocation efficiency is measured as the difference between local and statewide mean CIT for DDKT. CIT Difference represents the difference between the mean Cold Ischemic Time for kidneys allocated within the state versus allocated locally (Donor Service Area).

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Tables

Table 1: Patient Characteristics by State of Listing (1987-2009)

State	A	B	C	D		E	F	G	H	
	N=	N=	N=	N=		N=	N=	N=	N=	
Patients	9,802	11,792	31,104	9,811		19,028	63,998	31,819	15,433	
DSA:	N= 2	N=2	N=2	N=2		N=4	N=4	N=4	N=4	
Patient Characteristic	%	%	%	%	p-value	%	%	%	%	p-value
Age at Listing										
0-18	2.5	3.2	3.1	1.9	0.455	3.1	4.1	3.4	2.7	0.206
18-40	28.7	27.9	23.9	25.4	0.181	23.9	25.6	24.5	26.6	0.623
40-65	61.0	60.5	59.4	62.9	0.844	58.1	59.2	59.4	61.2	0.873
65+	7.8	8.4	13.6	9.8	0.000	14.9	11.1	12.7	9.5	0.004
Gender										
Male	62.0	58.4	61.1	58.9	0.708	59.7	59.1	59.8	59.3	0.993
Race										
NHW	58.4	44.6	64.2	71.9	< 0.001	52.8	36.7	46.5	66.1	< 0.001
NHB	39.0	51.4	28.5	17.7	< 0.001	30.4	14.3	31.1	30.3	< 0.001
Hispanic	1.4	1.5	4.5	5.2	< 0.001	13.6	32.3	15.8	1.9	< 0.001
Asian	1.0	1.3	2.4	3.7	0.011	2.6	14.3	5.8	1.4	< 0.001
Other	0.3	1.2	0.4	1.5	0.020	0.6	2.5	0.8	0.3	< 0.001
Panel Reactive Antibodies (PRA)										
0-20	78.6	80.9	83.3	78.0	0.725	83.8	85.0	83.1	79.4	0.632
20-80	13.1	12.5	10.6	12.9	0.493	11.1	9.6	11.8	13.2	0.099
80-100	8.3	6.6	6.1	9.1	0.229	5.1	5.4	5.1	7.4	0.223
Primary Diagnosis										
Diabetes	17.9	22.6	20.9	21.3	0.408	18.5	26.9	22.5	22.1	< 0.001
Glomerulosclerosis	6.1	9.8	7.5	10.4	0.042	9.5	9.2	6.5	8.6	0.012
Hypertension	24.3	19.0	17.4	10.5	< 0.001	20.3	14.9	18.8	13.9	< 0.001
Polycystic Kidneys	6.0	4.9	6.3	7.6	0.351	7.7	4.8	5.5	6.6	0.005
Graft Failure	7.4	6.8	6.1	10.1	0.036	5.8	7.0	6.2	8.7	0.092
Other	38.3	37.0	41.8	40.0	0.400	38.2	37.2	40.5	40.1	0.295
Primary Insurance										
Medicare	54.7	56.5	43.8	38.1	< 0.001	56.5	37.3	42.1	43.6	< 0.001
Private	33.5	37.8	44.9	52.5	< 0.001	38.9	46.1	41.5	48.5	0.007
Medicaid	4.1	4.5	6.2	5.8	0.342	3.3	14.4	15.1	6.9	< 0.001
Other	7.7	1.2	5.1	3.6	< 0.001	1.3	2.2	1.4	1.0	0.080
Educational Attainment										
Some College	48.1	46.9	44.2	52.2	0.140	53.1	46.6	48.8	51.6	0.043
Preemptive Listing										
Yes	51.6	53.3	60.0	64.2	0.018	51.0	52.4	57.1	59.7	0.014

* State A and E implemented SS Variance in 1991-1992

Table 2 Geographic Allocation Equity: Pre-SS Implementation (1987-1992) versus Post-SS Implementation (2005-2009)

Performance Indicator		Transplant Rate		Improvement Ratio	Waiting Time		Improvement Ratio	Cumulative Dialysis Time		Improvement Ratio	Five Year Graft Survival		Improvement Ratio
Phase		Pre-SS	Post-SS		Pre-SS	Post-SS		Pre-SS	Post-SS		Pre-SS	Post-SS	
State	DSA	Mean	Mean		Median	Median		Median	Median		Mean %	Mean %	
A	1	5.94	7.09		0.80	1.37		2.31	2.94		69.6	73.2	
	2	3.02	6.30		0.36	1.47		1.50	2.57		51.5	71.1	
	Equity Ratio	1.97	1.12	0.88	2.21	1.07	0.94	1.55	1.14	0.74	1.35	1.03	0.92
B	1	3.68	5.39		0.98	1.16		1.77	3.01		67.4	79.7	
	2	5.17	9.08		0.65	2.49		2.11	4.09		54.8	67.0	
	Equity Ratio	1.41	1.68	-0.66	1.50	2.14	-1.28	1.26	1.38	-0.42	1.23	1.19	0.18
C	1	3.69	8.75		0.82	1.92		2.03	2.66		58.9	62.4	
	2	2.76	5.28		0.37	1.08		1.88	3.17		66.6	76.2	
	Equity Ratio	1.34	1.66	-0.94	2.20	1.78	0.35	1.22	1.19	0.13	1.13	1.22	-0.72
D	1	4.03	7.83		0.56	1.99		1.45	2.85		56.4	66.7	
	2	3.17	4.32		0.42	1.00		1.32	1.99		73.8	80.7	
	Equity Ratio	1.27	1.81	-2.00	1.33	1.98	-1.97	1.17	1.46	-1.76	1.31	1.21	0.33
E	1	2.83	4.67		0.44	1.15		1.58	2.67		66.7	70.8	
	2	2.96	6.44		0.20	1.17		1.34	3.14		73.7	79.3	
	3	4.08	5.94		0.79	1.29		2.33	2.81		59.2	70.7	
	4	2.03	4.77		0.25	1.20		1.60	2.74		52.5	64.7	
	Equity Ratio	2.01	1.38	0.62	3.86	1.12	0.96	1.75	1.25	0.66	1.44	1.24	0.46
F	1	5.18	23.14		0.39	2.91		1.49	4.43		50.4	57.7	
	2	5.17	10.78		0.26	1.24		1.09	3.64		64.0	64.9	
	3	3.93	11.84		0.72	2.44		2.21	5.43		58.0	69.0	
	4	3.26	8.04		0.65	2.34		2.09	3.61		61.6	79.7	
	Equity Ratio	1.59	2.88	-2.19	2.80	2.35	0.25	2.03	1.56	0.45	1.27	1.38	-0.41
G	1	4.20	5.49		0.49	1.26		1.63	2.47		67.0	81.7	
	2	3.39	11.94		0.80	2.79		1.69	3.60		58.5	66.1	
	3	6.67	18.08		0.98	3.37		3.21	4.04		50.5	58.3	
	4	4.33	8.22		0.73	2.11		1.56	3.07		57.7	69.6	
	Equity Ratio	1.97	3.29	-1.36	1.97	2.68	-0.73	2.38	1.66	0.52	1.33	1.40	-0.23
H	1	6.72	11.22		1.06	2.75		2.37	4.25		54.6	69.1	
	2	4.01	5.72		0.60	1.15		1.51	2.64		60.7	63.2	
	3	5.33	5.40		0.39	1.48		1.23	2.89		67.5	71.7	
	4	3.49	10.20		0.45	1.59		1.96	3.17		62.9	80.8	
	Equity Ratio	1.93	2.80	-0.94	2.69	2.40	0.17	1.95	1.68	0.28	1.24	1.28	-0.18

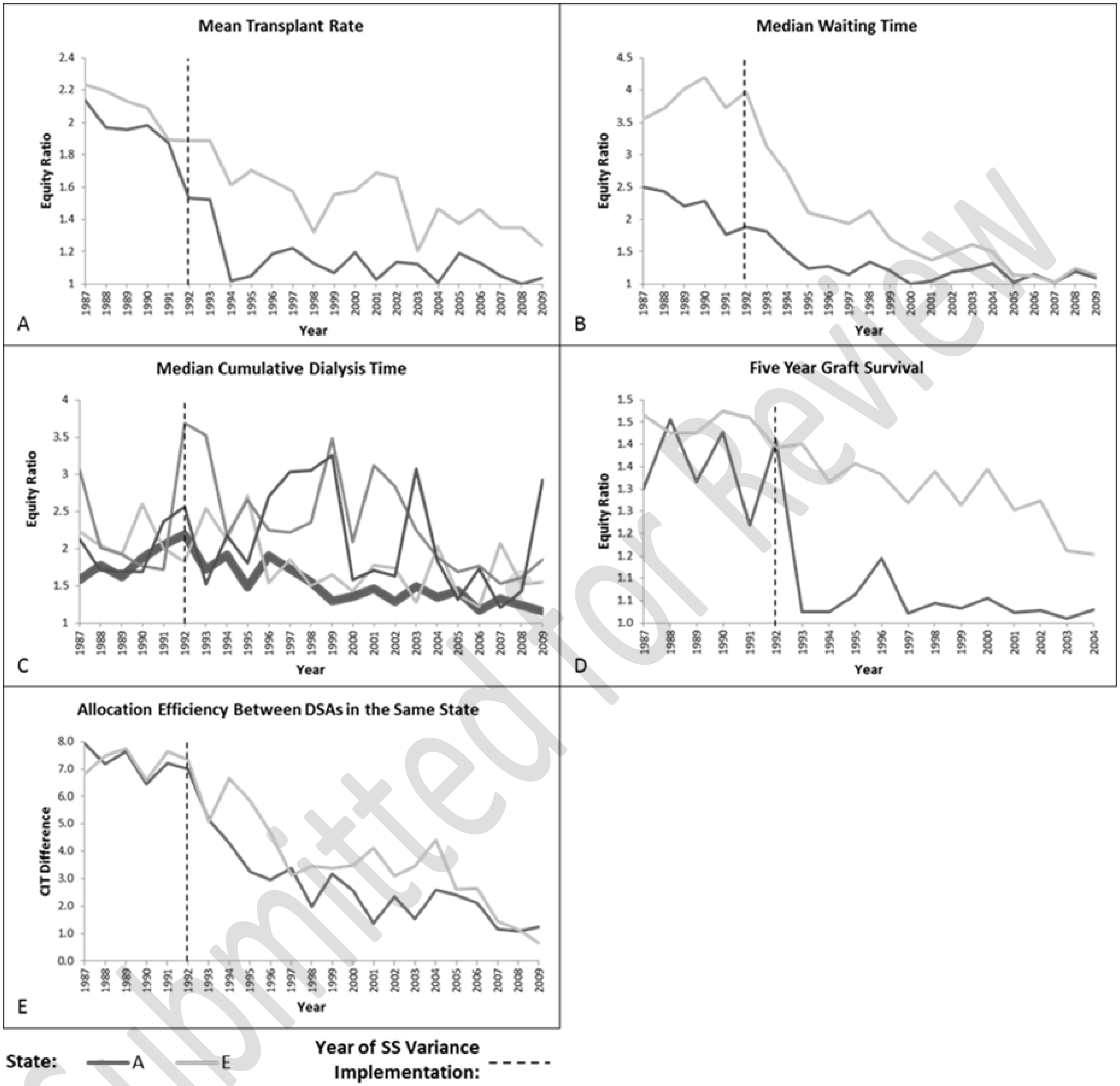
* State A and E implemented SS Variance in 1991-1992
* Pre-SS = Prior to Implementation of SS variance (1987-1992), Post-SS = After Implementation of SS variance (2005-2009)
* Equity Ratio: The ratio between the highest and the lowest performance indicator between the DSAs in a particular state.
* An equity ratio that equals 1.0 suggests that there is complete geographic equity with respect to a particular performance indicator. Allocation geographic inequity increases as the equity ratio rises above 1.0.
* Improvement Ratio: The relative improvement in geographic equity since use of the SS Variance
* If the improvement ratio is negative, then statewide geographic equity got worse over time. If the improvement ratio is close to 1.0, then statewide geographic equity has greatly improved over time.

Table 3: The Cold-Ischemic Time by Kidney Allocation (local versus state) before and after implementation of the SS variance

Share Type:		LOCAL		STATE		OVERALL
State	Phase	Local Allocation (%)	Mean CIT, hrs	Statewide Allocation (%)	Mean CIT, hrs	CIT Reduction, hrs
A	Pre	51.3	18.6	1.8	26.7	6.2
	Post	55.6	16.1	13.8	18.1	
B	Pre	53.7	19.7	1.9	20.6	-2.8
	Post	69.5	20.7	3.0	24.4	
C	Pre	82.4	25.4	2.2	34.1	-2.8
	Post	79.4	16.1	1.8	27.6	
D	Pre	84.2	26.5	1.4	35.3	1.9
	Post	81.8	14.4	0.8	21.3	
E	Pre	46.4	21.7	9.0	28.6	5.6
	Post	70.8	21.6	11.3	22.8	
F	Pre	51.0	23.1	28.7	26.3	-3.0
	Post	75.1	14.0	4.8	20.2	
G	Pre	81.9	24.5	6.7	32.4	0.4
	Post	77.2	16.3	4.0	23.8	
H	Pre	71.6	22.5	3.4	26.7	-2.5
	Post	69.8	13.5	3.4	20.2	

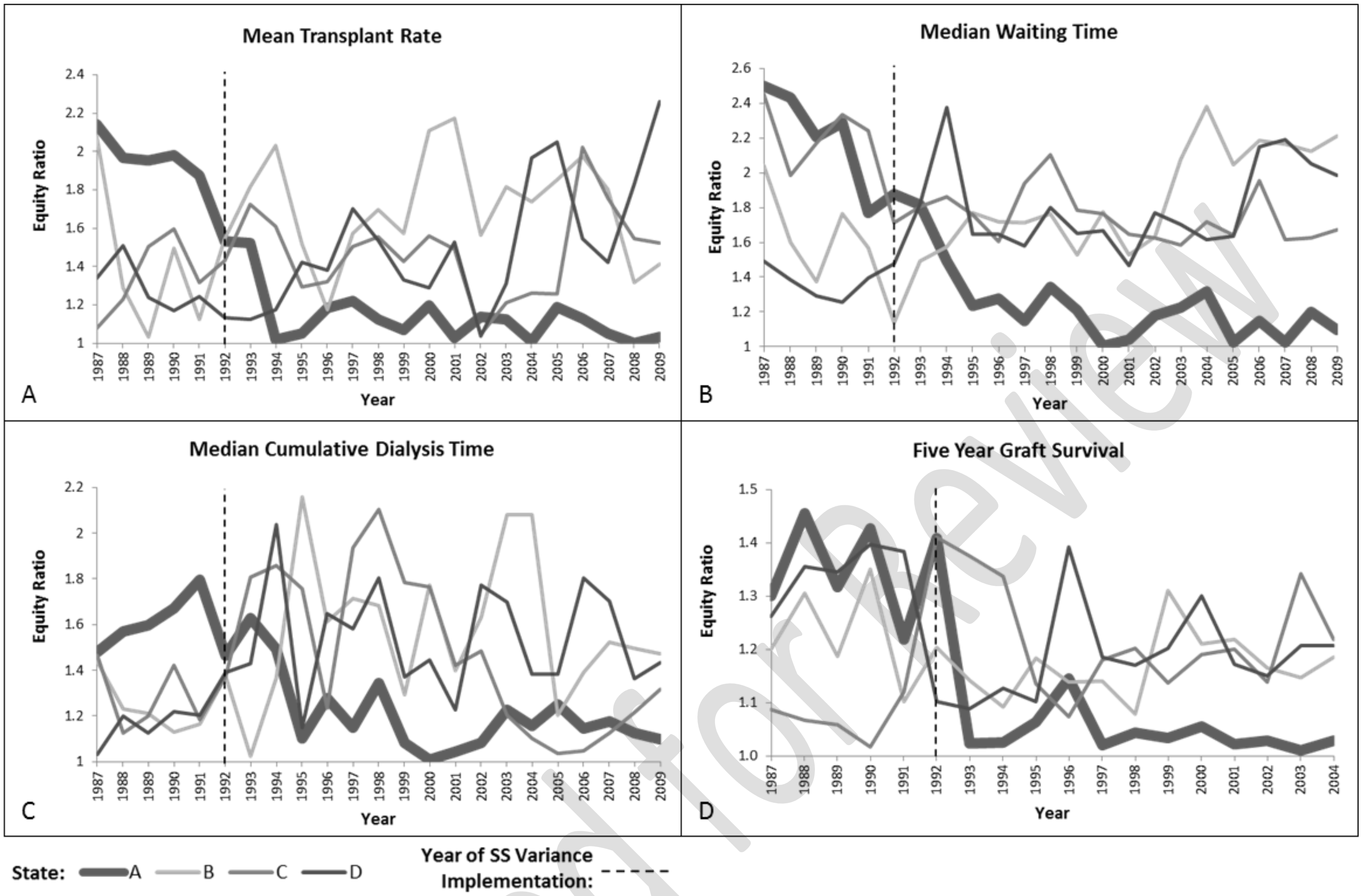
* State A and E implemented SS Variance in 1991-1992
* Pre= Pre SS Variance Implementation (1987-1992)
*Post= After SS Variance Implementation (2005-2009)
*Local/Statewide Allocation %: Percentage of organs procured by the DSA, which are distributed locally versus statewide
* CIT Reduction: The overall achieved reduction of CIT after implementation of the SS variance = (delta CIT state/local prior to SS variance implementation) – (delta CIT state/local after SS variance implementation)

Figure 1: Statewide Equity Ratios for Performance indicators (1987-2009)



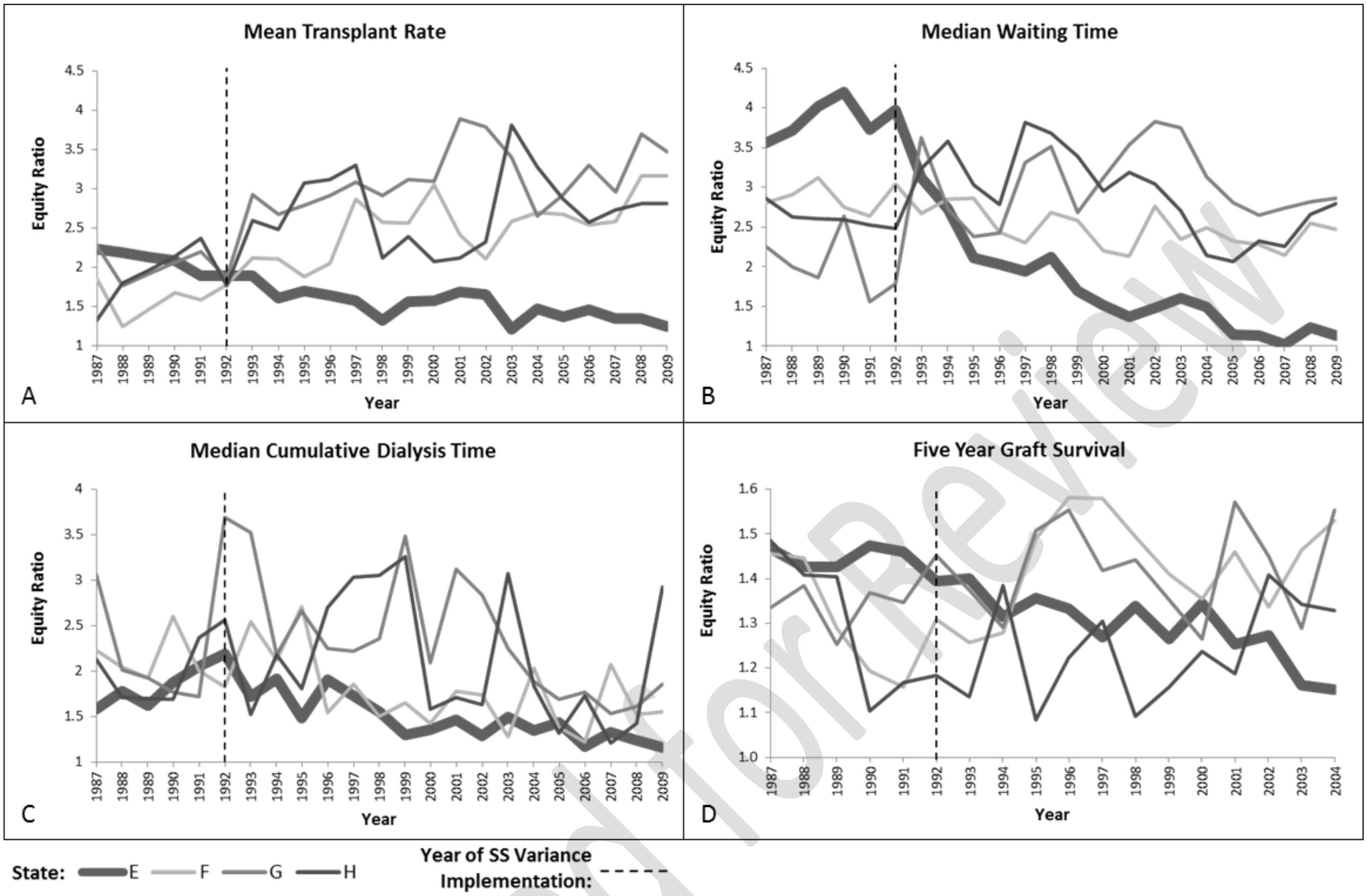
States A and E adopted the SS Variance in 1991-1992. An equity ratio that equals 1.0 suggests that there is complete geographic equity with respect to a particular performance indicator. Allocation geographic inequity increases as the equity ratio rises above 1.0. Because the five year graft survival is not available for the entire time period the equity ratio for five year graft survival was assessed for 1987-2004. CIT Difference represents the difference between the mean Cold Ischemic Time for kidneys allocated within the state versus allocated locally (Donor Service Area).

Figure 2: Allocation Equity Ratios between DSAs within States with 2 DSAs (1987-2009)



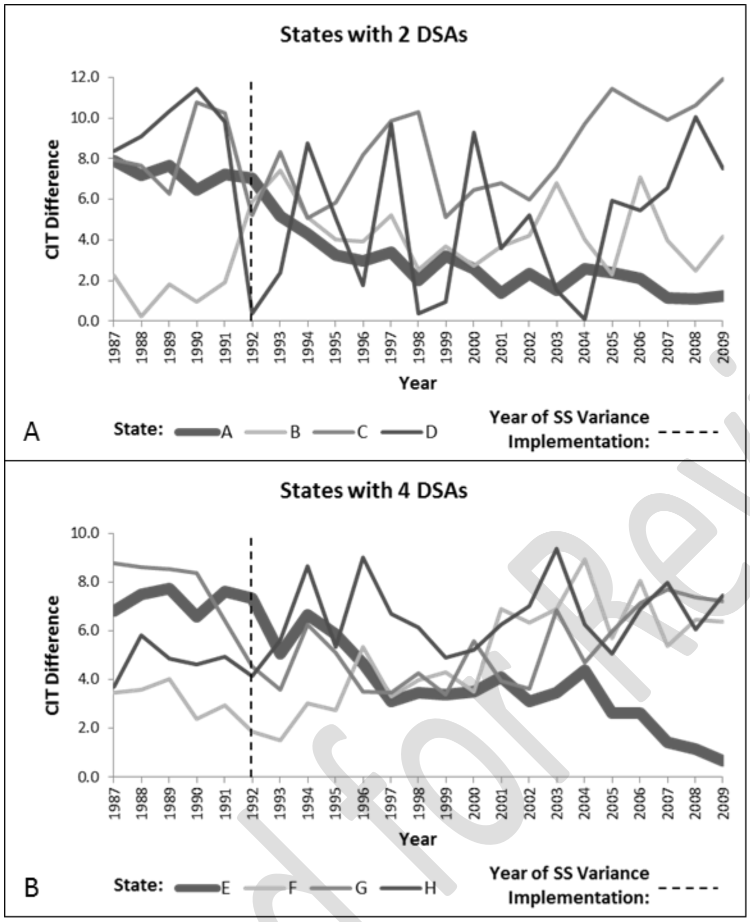
State A adopted the Statewide Sharing variance in 1992. States B, C, and D have not implemented the variance. An equity ratio that equals 1.0 suggests that there is complete geographic equity with respect to a particular performance indicator. Allocation geographic inequity increases as the equity ratio rises above 1.0. Because the five year graft survival is not available for the entire time period the equity ratio for five year graft survival was assessed for 1987-2004.

Figure 3: Allocation Equity Ratios between States with 4 DSAs (1987-2009)



State E adopted the Statewide Sharing variance in 1991. States F, G, and H have not implemented the variance. An equity ratio that equals 1.0 suggests that there is complete geographic equity with respect to a particular performance indicator. Allocation geographic inequity increases as the equity ratio rises above 1.0. Because the five year graft survival is not available for the time period the equity ratio for five year graft survival was assessed for 2000-2004.

Figure 4: Allocation Efficiency between DSAs within a State (1987-2009)



States A and E has adopted the Statewide Sharing variance. All other states have not implemented the variance. Allocation efficiency is measured as the difference between local and statewide mean CIT for DDKT. CIT Difference represents the difference between the mean Cold Ischemic Time for kidneys allocated within the state versus allocated locally (Donor Service Area).