**Supplemental Material**

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**Appendix A:** Data quality description

At the onset of the study in 2010, investigators from five transplant centers (University of Pennsylvania, Barnabas Health, Mount Sinai Recanati/Miller Transplantation Institute, Harper Hospital, and Yale-New Haven Hospital) collaborated to perform retrospective chart reviews of the respective recipients of kidneys at their centers from the donors that were enrolled by each of the five participating organ procurement organizations (Gift of Life Donor Program in Philadelphia, Gift of Life Michigan, LiveOnNY, NJ Sharing Network, and New England Donor Services). With funding renewal from the National Institutes of Health in 2016, recipient chart abstraction was expanded by recruiting the additional centers that had transplanted the greatest numbers of kidneys from enrolled donors. A total of 132 different centers had transplanted at least one kidney from enrolled donors, and 13 of the top centers agreed to participate with data for this analysis. Trained study participants at each site recorded recipient data on standardized case report forms using a secure, online database (OnCore). Outcomes were adjudicated by site investigators, and extensive data quality control checks were performed by study monitors from Yale University. Study monitors validated data abstraction processes via secondary review of submitted paper charts and then continuously reviewed all data points following form completion by site coordinators to confirm data quality and accuracy.

This study utilized various methods such as rigorous study documentation, in-depth coordinator training, independent data monitoring, and principal investigator (PI) involvement to increase the quality of the data collected. A detailed protocol and a manual of operations were created to facilitate consistency in data collection practices across all participating research centers. Coordinators were required to attend two separate web-based trainings provided by a co-investigator, a study monitor (hired from the Yale Center for Clinical Investigation – separate from our department), and a project coordinator. The trainings demonstrated how to use

OnCore and provided detailed explanation of important data variables and key practices to utilize during chart abstraction.

Research centers were all required to send the first five completed charts to the study monitor for data verification from source documents. All of the remaining charts were validated remotely by following defined guidelines for data quality developed by the Data Coordinating Center. Queries were used for quality control checks to identify potential data anomalies such as missing data or forms, out-of-range or erroneous data, and inconsistent data. Statisticians also conducted separate back-end data checks. For instance, if the baseline form indicated a biopsy report was available at 3 month, the statistician would check to see if the biopsy details were provided in the 3-month follow-up form. If it was not, sites would be queried to enter the information. Participants who met the study stopping criteria were verified by each site PI. Monthly PI and coordinator calls were utilized to inform sites about timelines and any other updates that required their attention.

**Appendix B:** Participating transplant center BKV testing protocols

| Site | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Screening frequency | Urine at month 1 and 3, then every 3 months for 2 years (usually plasma testing after initial urine) | Plasma at month 1, 3, 6 and 12; then yearly | Urine at 1, 2, 3, 6, 9 and 12 months | Plasma monthly first 6 months; then at month 9 and 12; then yearly | Plasma for cause after rise in serum creatinine | Plasma at month 1, 2, 3, 4, 5, 6, 9 and 12; then yearly | Plasma at month 4 and 12; then yearly | Plasma at month 1, 3, 6, 9 and 12 | Urine at month 1 and 3, then every 3 months for 2 years (usually plasma testing after initial urine) | Plasma starting at month 3, then monthly to 1 year; then yearly | Plasma monthly to 1 year; then at month 18 and 24 | Plasma, frequency not available | Plasma, frequency not available |
| Lower limit of detection, copies/mL | 3000 | 500 | 250 | 100 | 7000 until year 2012, then 1500 thereafter | 500 | 400 | 1000 | 500 | 100 | 30 | Not available | Not available |

**Supplemental Table S1.** Donor (kidney) and recipient characteristics by inclusion/exclusion in the DDS cohort

| | | All (N=1132) | Excluded (N=107) | Included (N=1025) | P-value[1] |
|---|---|---|---|---|---|
| ***Donor (kidney) characteristics*** | | | | | |
| Age, years | | 41 ± 15 | 43 ± 14 | 41 ± 15 | 0.25 |
| Male | | 698 (62%) | 65 (61%) | 633 (62%) | 0.84 |
| Black race | | 183 (16%) | 16 (15%) | 167 (16%) | 0.72 |
| BMI, kg/m$^2$ | | 28 ± 7 | 29 ± 9 | 28 ± 7 | 0.66 |
| DCD | | 217 (19%) | 24 (23%) | 193 (19%) | 0.34 |
| ECD | | 235 (21%) | 23 (22%) | 212 (21%) | 0.81 |
| Hypertension | | 351 (31%) | 38 (36%) | 313 (31%) | 0.26 |
| Diabetes | | 116 (10%) | 8 (8%) | 108 (11%) | 0.33 |
| Cause of death | Head trauma | 304 (27%) | 24 (23%) | 280 (28%) | 0.72 |
| | Anoxia | 410 (37%) | 41 (39%) | 369 (36%) | |
| | Stroke | 389 (35%) | 39 (37%) | 350 (35%) | |
| | Other | 16 (1%) | 1 (1%) | 15 (1%) | |
| Hepatitis C seropositive | | 30 (3%) | 7 (7%) | 23 (2%) | **0.008** |
| KDRI | | 1.31 ± 0.43 | 1.35 ± 0.39 | 1.31 ± 0.43 | 0.12 |
| KDPI | | 49% ± 27% | 53% ± 27% | 49% ± 27% | 0.12 |
| Admission serum creatinine, mg/dl | | 1.11 ± 0.63 | 1.11 ± 0.8 | 1.11 ± 0.61 | 0.71 |
| Terminal serum creatinine, mg/dl | | 1.21 ± 0.93 | 1.19 ± 0.76 | 1.21 ± 0.95 | 0.82 |
| No AKI | | 827 (73%) | 73 (69%) | 754 (74%) | 0.48 |
| Stage 1 AKI | | 184 (16%) | 18 (17%) | 166 (16%) | |
| Stage 2 AKI | | 69 (6%) | 10 (9%) | 59 (6%) | |
| Stage 3 AKI | | 51 (5%) | 5 (5%) | 46 (4%) | |
| ***Recipient characteristics*** | | | | | |
| Age, years | | 54 ± 13 | 53 ± 14 | 54 ± 13 | 0.77 |
| Male | | 690 (61%) | 61 (58%) | 629 (61%) | 0.44 |
| Black race | | 527 (47%) | 51 (48%) | 476 (46%) | 0.74 |
| BMI, kg/m$^2$ | | 28 ± 6 | 28 ± 6 | 28 ± 6 | 0.51 |
| Cause of ESRD | Diabetes | 355 (31%) | 29 (27%) | 326 (32%) | 0.47 |
| | Hypertension | 319 (28%) | 30 (28%) | 289 (28%) | |
| | Glomerulonephritis | 183 (16%) | 14 (13%) | 169 (16%) | |
| | Graft failure | 91 (8%) | 11 (10%) | 80 (8%) | |
| | Other or unknown | 183 (16%) | 22 (21%) | 161 (16%) | |

| | | | | | |
|---|---|---|---|---|---|
| Peak panel reactive antibody | 0% | 726 (64%) | 65 (61%) | 661 (64%) | 0.61 |
| | 1-20% | 86 (8%) | 7 (7%) | 79 (8%) | |
| | 21-80% | 146 (13%) | 18 (17%) | 128 (12%) | |
| | >80% | 173 (15%) | 16 (15%) | 157 (15%) | |
| ESRD duration, months | | 48 ± 37 | 55 ± 40 | 47 ± 36 | 0.046 |
| Pre-emptive transplant | | 117 (10%) | 7 (7%) | 110 (11%) | 0.18 |
| Previous kidney transplant | | 161 (14%) | 17 (16%) | 144 (14%) | 0.58 |
| Private insurance | | 318 (28%) | 27 (25%) | 291 (28%) | 0.49 |
| HLA mismatches | | 4.4 ± 1.3 | 4.4 ± 1.3 | 4.4 ± 1.3 | 0.54 |
| Cold ischemia time, hours | | 16.3 ± 7.06.9 | 17.1 ± 7.5 | 16.3 ± 6.9 | 0.19 |
| Kidney biopsied | | 591 (52%) | 53 (50%) | 538 (52%) | 0.63 |
| Kidney pumped | | 541 (48%) | 46 (43%) | 495 (48%) | 0.34 |

**Supplemental Table S2.** Available information about BKV DNAemia viral loads in the DDS cohort

| BKV DNAemia results in the 1st year | | Non-missing values | Peak (highest observed) value | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min | 25th Pctl | 50th Pctl | 75th Pctl | Max | Mean | Std Dev |
| "Positive" | Blood Quant Copies/mL | 256 | 3.5 | 408 | 1300 | 7150 | 136,000,000 | 642,620 | 8,516,737 |
| | Blood Quant Log Score | 256 | 2.5 | 3.3 | 4.3 | 5.5 | 500 | 23.5 | 66.3 |
| "Negative" | Blood Quant Copies/mL | 769 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Blood Quant Log Score | 769 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Note, the likely impossible maximum copy number and log score shown here were considered reporting errors; however, the patient had other positive blood BK polyomavirus (BKV) tests in the first year suggesting true DNAemia.

**Supplemental Table S3.** Donor (kidney) and recipient characteristics by graft failure attributed to BKV in the OPTN cohort

| | | All (N=76,953) | No graft failure due to BKV (N=76,681) | Graft failure due to BKV (N=272) | P-value[1] |
|---|---|---|---|---|---|
| ***Donor (kidney) characteristics*** | | | | | |
| Age, years | | 39 ± 14 | 39 ± 14 | 42 ± 15 | 0.08 |
| Male | | 47,283 (61%) | 47,140 (61%) | 143 (53%) | **0.003** |
| Black race | | 10,579 (14%) | 10,535 (14%) | 44 (16%) | 0.24 |
| BMI, kg/m$^2$ | | 28 ± 7 | 28 ± 7 | 28 ± 7 | 0.95 |
| DCD | | 10,855 (14%) | 10,819 (14%) | 36 (13%) | 0.68 |
| ECD | | 10,622 (14%) | 10,557 (14%) | 65 (24%) | **<0.001** |
| Hypertension | | 28,447 (32%) | 28,348 (32%) | 99 (36%) | 0.13 |
| Diabetes | | 5,275 (7%) | 5,262 (7%) | 13 (5%) | 0.18 |
| Cause of death | Head trauma | 28,244 (37%) | 28,166 (37%) | 78 (29%) | **<0.001** |
| | Anoxia | 23,770 (31%) | 23,695 (31%) | 75 (28%) | |
| | Stroke | 22,714 (30%) | 22,602 (29%) | 112 (41%) | |
| | CNS tumor | 327 (0%) | 327 (0%) | 0 (0%) | |
| | Other | 1,898 (2%) | 1,891 (2%) | 7 (3%) | |
| Hepatitis C seropositive | | 2,172 (3%) | 2,171 (3%) | 1 (0%) | **0.01** |
| KDRI | | 1.2 ± 0.37 | 1.2 ± 0.37 | 1.31 ± 0.43 | **<0.001** |
| KDPI | | 42% ± 26% | 42% ± 26% | 49% ± 29% | **<0.001** |
| Admission serum creatinine, mg/dl | | 1.03 ± 0.43 | 1.03 ± 0.43 | 1.02 ± 0.42 | 0.48 |
| Terminal serum creatinine, mg/dl | | 1.17 ± 0.95 | 1.17 ± 0.95 | 1.13 ± 1.33 | 0.60 |
| No AKI | | 54,416 (71%) | 54,210 (71%) | 206 (76%) | 0.08 |
| Stage 1 AKI | | 14,909 (19%) | 14,858 (19%) | 51 (19%) | |
| Stage 2 AKI | | 4,719 (6%) | 4,708 (6%) | 11 (4%) | |
| Stage 3 AKI | | 2,909 (4%) | 2,905 (4%) | 4 (1%) | |
| ***Recipient characteristics*** | | | | | |
| Age, years | | 51 ± 15 | 51 ± 15 | 52 ± 15 | 0.55 |
| Male | | 632 (61%) | 477 (62%) | 155 (60%) | 0.76 |
| Black race | | 24,701 (32%) | 24,582 (32%) | 119 (44%) | **<0.001** |
| BMI, kg/m$^2$ | | 28 ± 6 | 28 ± 6 | 28 ± 6 | 0.87 |
| Cause of ESRD | Diabetes | 23,916 (31%) | 23,839 (31%) | 77 (28%) | **0.03** |
| | Hypertension | 17,052 (22%) | 16,970 (22%) | 82 (30%) | |
| | Glomerulonephritis | 12,452 (16%) | 12,411 (16%) | 41 (15%) | |
| | Graft failure | 6014 (8%) | 5994 (8%) | 20 (7%) | |
| | Other or unknown | 17,519 (23%) | 17,467 (23%) | 52 (19%) | |
| Peak panel reactive | 0% | 47,446 (62%) | 47,261 (62%) | 185 (68%) | 0.16 |

| | | | | | |
|---|---|---|---|---|---|
| antibody | 1-20% | 5917 (8%) | 5897 (8%) | 20 (7%) | |
| | 21-80% | 11,762 (15%) | 11,727 (15%) | 35 (13%) | |
| | >80% | 11,828 (15%) | 11,796 (15%) | 32 (12%) | |
| ESRD duration, months | | 52 ± 41 | 53 ± 41 | 57 ± 41 | 0.054 |
| Pre-emptive transplant | | 9,201 (12%) | 9,179 (12%) | 22 (8%) | **0.049** |
| Previous kidney transplant | | 9,460 (12%) | 9,429 (12%) | 31 (11%) | 0.65 |
| Private insurance | | 18,733 (24%) | 18,676 (24%) | 57 (21%) | 0.19 |
| HLA mismatches | | 4.1 ± 1.5 | 4.1 ± 1.5 | 4.6 ± 1.3 | **<0.001** |
| Cold ischemia time, hours | | 16.7 (8.8) | 16.7 (8.8) | 16.3 (9.1) | 0.33 |
| Kidney biopsied | | 35,240 (46%) | 35,109 (46%) | 131 (48%) | 0.43 |
| Kidney pumped | | 33,369 (43%) | 33,252 (43%) | 117 (43%) | 0.91 |

Values are mean ± SD or n (%). BKV, BK polyomavirus; OPTN, Organ Procurement and Transplantation Network; BMI, body mass index; DCD, donation after circulatory death; ECD, expanded-criteria donor; CNS, central nervous system; KDRI, kidney donor risk index; KDPI, kidney donor profile index; AKI, acute kidney injury; ESRD, end-stage renal disease; HLA, human leukocyte antigen.

***1.*** Kruskal-Wallis test for continuous variables and Chi-Square test for categorical variables