Delayed Graft Function (DGF) in Kidney Transplantation Patients: An Analysis of Disease Burden

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Background

Kidney transplant (KT) patients with DGF are at greater risk of graft failure and mortality, as well as additional disease burden. Hospitals are sensitive to both short- and medium-term costs as they are reimbursed through a 90-day Diagnosis Related Group (DRG) code and must manage all related expenses within the bundled payment. This study aims to assess patient characteristics, health resource utilization (HRU) and costs for KT subjects with and without DGF in the inpatient hospital setting.

Methods

Study Design

Retrospective analysis of HRU endpoints and costs in adult KT subjects from the Premier Hospital Database (PHD) from January 2014 to December 2018

Study Population

The study population consisted of inpatient admissions for KT patients aged ≥18 years presenting from Jan 1, 2014 to Dec 31, 2018. KT admissions were defined by the presence of at least one renal allotransplant-related charge code or all of the following: (1) a kidney transplant ICD-9 or ICD-10 procedure code, (2) a charge code for at least one immunosuppressant drug, and (3) a charge code for at least one organ harvest or kidney procurement within the same admission. Subjects with multiple transplants in the same admission were excluded.

Endpoints and Statistical Analysis

- DGF was defined as presence of dialysis procedure code within 1 week of KT.
- High-volume hospitals were defined as hospitals with 50 or more KT procedures per year.
- Baseline characteristics at the hospital- and patient-level were examined for the overall population and by hospital volume, DGF status and dialysis utilization.
- Statistical tests of significance for observed differences between groups were conducted using chi-squared or Fisher's exact test or t-tests (when appropriate). ANOVA was performed when comparing three groups.
- Admissions with costs below the first or above the 99th percentile for the sample were excluded. All costs were inflated to 2018 US dollars using the medical component of the Consumer Price Index produced by the US Bureau of Labor.
- All statistical analyses were performed using SAS version 9.4 (SAS Institute Inc, Cary, NC).

Results

Subject Characteristics (Table 1):

- The analysis included 12,097 KT admissions across 56 hospitals.
- A quarter (n=3,087) of KT admissions were defined as DGF, 48.1% (n=1,485) associated with 1 dialysis and the remainder with ≥2 dialyses.
- Medicare was identified as the primary insurer for most admissions (67.7%).

General Costs and HRU:

- Mean hospital cost for all KT was $109,425 (SD: $52,823); **Figures 1, 3** show other cost totals.
- Mean LOS was 8.6 days (SD: 7.6); 56.8% of subjects required ICU admission. Mean ICU-related LOS was 2.5 days (SD: 6.3) (**Figure 2**). **Figure 4** shows LOS for readmissions.
- One-third of KT (34.1%, n=4,129) were readmitted to the same hospital within 90 days.

Table 1: Study Sample Demographics and Hospital Characteristics

	All Admissions	Hospital Volume		DGF Status		Dialysis Utilization	
	n = 12,097	High Volume n = 8,715	Low Volume n = 3,382	DGF n = 3,087	Non-DGF n = 9,010	1 dialysis n = 1,485	≥ 2 dialyses n = 1,602
Patient age at admission (years)							
Mean (SD)	51.7 (13.4)	51.2 (13.3)	53.0 (13.6)	53.31 (12.5)	51.16 (13.6)	52.63 (12.9)	53.95 (12.2)
Gender, n (%)							
Male	7,393 (61.1%)	5,302 (60.8%)	2,091 (61.8%)	1,982 (64.2%)	5,411 (60.1%)	913 (61.5%)	1,069 (66.7%)
Race, n (%)							
Black	2,716 (22.5%)	2,048 (23.5%)	668 (19.8%)	991 (32.1%)	1,725 (19.2%)	446 (30.0%)	545 (34.0%)
White	6,468 (53.5%)	4,411 (50.6%)	2,057 (60.8%)	1,360 (44.1%)	5,108 (56.7%)	680 (45.8%)	680 (42.5%)
Other	2,548 (21.1%)	1,986 (22.8%)	562 (16.6%)	659 (21.4%)	1,889 (21.0%)	321 (21.6%)	338 (21.1%)
Unknown	365 (3.0%)	270 (3.1%)	95 (2.8%)	77 (2.5%)	288 (3.2%)	38 (2.6%)	39 (2.4%)
Teaching hospital status, n (%)							
Yes	9,824 (81.2%)	6,970 (80.0%)	2,854 (84.4%)	2,670 (86.5%)	7,154 (79.4%)	1,251 (84.2%)	1,419 (88.6%)
No	2,273 (18.8%)	1,745 (20.0%)	528 (15.6%)	417 (13.5%)	1,856 (20.6%)	234 (15.8%)	183 (11.4%)
Hospital bed size, n (%)							
0-299	16 (0.1%)	0 (0%)	16 (0.4%)	3 (0.0%)	13 (0.0%)	0 (0%)	3 (0.1%)
300-399	2,182 (18.0%)	1,745 (20.0%)	437 (12.9%)	423 (13.7%)	1,759 (19.5%)	222 (15.0%)	201 (12.6%)
400-499	321 (2.7%)	110 (1.3%)	211 (6.2%)	116 (3.8%)	205 (2.3%)	48 (3.2%)	68 (4.2%)
500+	9,578 (79.2%)	6,860 (78.7%)	2,718 (80.4%)	2,545 (82.4%)	7,033 (78.1%)	1,215 (81.8%)	1,330 (83.0%)

Figure 1: Mean Cost of Initial KT Admissions ($)

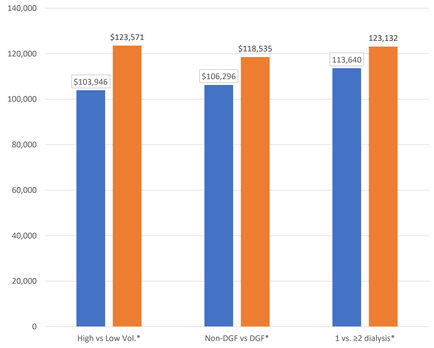


Figure 3: Mean Cost of KT Admissions and Readmissions within 90 Days ($)

Figure 2: Mean LOS for Initial KT Admissions (days)

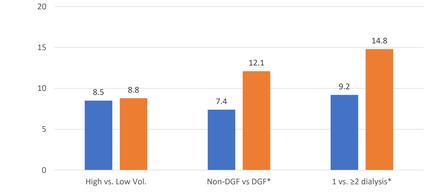
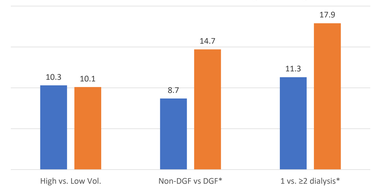


Figure 4: Mean LOS for KT Admissions and Readmissions within 90 Days (days)



*p<0.05

Results (cont.)

HRU and Costs by Hospital Volume:

- Lower costs were observed among high- vs low-volume hospital admissions (**Figures 1, 3**).
- Total LOS did not vary significantly by hospital volume (**Figures 2, 4**).
- ICU admission rates were higher in high-volume compared to low-volume hospitals (58.9% vs. 51.2%, *p<0.0001*), but mean ICU-related LOS was shorter (2.3 vs 3.0, *p<0.0001*).
- Same-hospital readmissions within 90 days were slightly lower for low- vs high-volume hospitals (32.6% vs 34.7%, respectively, *p=0.0314*).

HRU and Costs by DGF Status and Hospital Volume:

- Regardless of hospital volume, DGF status was associated with higher costs and HRU.
- Mean initial costs for DGF admissions were higher than for non-DGF admissions (**Figure 1**).
- LOS, ICU admissions and ICU-related LOS were significantly higher for DGF than non-DGF admissions (**Figures 2, 4**), with substantial variation observed in total LOS and ICU-related LOS for DGF admissions across high- and low-volume hospitals.
- Readmission costs were higher for DGF patients compared to non-DGF patients (**Figure 3**).

HRU and Costs by Dialysis Utilization and Hospital Volume:

- Nearly half of DGF admissions required ≥2 dialysis; these admissions were more costly than admissions with 1 dialysis (**Figure 1**).
- LOS was significantly longer for the higher dialysis utilization group (**Figure 2**).
- Patterns of HRU and cost by dialysis utilization within high- and low-volume hospitals were similar to those within the broader analysis by DGF status.
- Initial admission costs were lower for high-volume hospitals regardless of dialysis utilization.
- ICU admission rates for DGF admissions with 1 dialysis were substantially higher for high-volume hospitals – but with lower ICU LOS – compared to low-volume hospitals.
- Readmissions to the same hospital within 90-days were significantly higher for patients who received ≥2 dialyses (52.7% vs 38.0%, respectively, *p<0.0001*).

Discussion

This study demonstrates the burden of DGF and dialysis utilization in inpatient adult KT patients across low- and high-volume hospitals. The data show a pattern of increased costs and HRU associated with DGF versus non-DGF admissions; ≥2 dialyses was associated with additional costs. High-volume hospitals generally had lower costs, regardless of DGF or dialysis utilization. Increased dialysis utilization was associated with increased ICU admissions.

Conclusions

DGF leads to longer hospital stay, with a greater percentage of patients being admitted to the ICU, and significantly higher admission costs.