Emergency Department Visits after Kidney Transplantation

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Abstract

Background and objectives In 2011, there were approximately 131 million visits to an emergency department in the United States. Emergency department visits have increased over time, far outpacing growth of the general population. There is a paucity of data evaluating emergency department visits among kidney transplant recipients. We sought to evaluate the incidence and risk factors for emergency department visits after initial hospital discharge after transplantation in the United States.

Design, setting, participants, & measurements We identified 10,533 kidney transplant recipients from California, New York, and Florida between 2009 and 2012 using the State Inpatient and Emergency Department Databases included in the Healthcare Cost and Utilization Project. We used multivariable Poisson and Cox proportional hazard models to evaluate adjusted incidence rates and time to emergency department visits after transplantation.

Results There were 17,575 emergency department visits over 13,845 follow-up years (overall rate =126.9/100 patient-years; 95% confidence interval, 125.1 to 128.8). The cumulative incidences of emergency department visits at 1, 12, and 24 months were 12%, 40%, and 57%, respectively, with median time =19 months; 48% of emergency department visits led to hospital admission. Risk factors for higher emergency department rates included younger age, women, black and Hispanic race/ethnicity, public insurance, depression, diabetes, peripheral vascular disease, and emergency department use before transplant. There was wide variation in emergency department visits by individual transplant center (10th percentile =70.0/100 patient-years; median =124.6/100 patient-years; and 90th percentile =187.4/100 patient-years).

Conclusions The majority of kidney transplant recipients will visit an emergency department in the first 2 years post-transplantation, with significant variation by patient characteristics and individual centers. As such, coordination of care through the emergency department is a critical component of post-transplant management, and specific acumen of transplant-related care is needed among emergency department providers. Additional research assessing best processes of care for post-transplant management and health care expenditures and outcomes associated with emergency department visits for transplant recipients are warranted.

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Introduction

In 2011, there were approximately 131 million total visits to an emergency department (ED) in the United States (1). Rates of ED visits have increased over the past two decades beyond what is accounted for by growth of the general population (1). Multiple factors are associated with higher rates of ED visits in the general population, including extremes of age (<1 and ≥85 years old), women, public insurance, minority race/ethnicity, and region of the country (2–4). Primary conditions leading to ED visits are sprains, injuries, abdominal pain, and nonspecific chest pain (1). The largest increases in ED visits are associated with septicemia, substance-related disorders, and influenza (1,2).

In recent years, there has been a substantial increased focus on acute care delivery after hospitalizations (5–7). In certain contexts, acute care after hospitalization is considered an indication of poor quality of care, and hospitals with high rates face reduction of Medicare reimbursement (8–10). However, controversies exist regarding the exact interpretations of the use of acute care services and the correlation with quality of care (7,11–13). Health care delivered through the ED can be associated with lower quality of care, higher costs, and lack of coordinated care (14,15). In the context of kidney transplantation, McAdams-Demarco *et al.* (16) documented a 31% incidence of 30-day hospital readmissions. Studies have also shown that higher readmission rates after transplantation vary by center, donor, and recipient factors; have diverse causes; and are associated with higher rates of graft loss and lower measured quality of centers (16–20).

Table 1. Study population characteristics compared with national adult solitary kidney transplant recipients in the United States (2009–2012)

Recipient Characteristics and Level	Study Population	Adult Kidney Transplant Recipients in the United States	*P* Value
Age, yr			
Mean±SD	51.3±13.7	51.4±13.6	0.49
Sex, %			
Women	40.0	39.2	0.14
Primary insurance, %			
Medicare	65.4	56.8	<0.001
Medicaid	5.1	4.0	
Private	28.7	37.5	
Other	0.8	1.7	
Race/ethnicity, %			
White	41.5	52.3	<0.001
Black	19.1	26.0	
Hispanic	22.8	14.6	
Asian/Pacific Islander	8.2	5.9	
Other	8.5	1.2	
Year of transplant, %			
2009	14.7	25.0	<0.001
2010	33.5	25.3	
2011	34.7	25.1	
2012	17.2	24.6	
N	10,533	63,903	

Despite the comprehensive studies evaluating hospital readmissions, there is a paucity of data evaluating the use of the ED after kidney transplantation. Causes for ED visits may have commonalities with hospital readmissions but may also have unique etiology and implications for care management. Unterman *et al.* (21) reported that 265 (70%) patients had at least one ED visit among 395 kidney transplant recipients at a single center between 2000 and 2004 with average follow-up of 31 months. A 2007 study of kidney transplant recipients concluded that pain management was a significant contribution to the frequency of ED use (22). Trzeciak *et al.* (23) concluded that infections were the most common indications for admission after discharge from the ED among transplant recipients, including 12% with severe sepsis. Cumulatively, there are minimal data characterizing ED visits in a broad cohort of kidney transplant recipients. The primary aims of this study were to evaluate the incidence, risk factors, and hospital-level variation of ED visits after kidney transplantation in a representative cohort in the United States.

Materials and Methods

There were two data sources used for this study. The principal data were derived from the Healthcare Cost and Utilization Project administered by the Agency for Healthcare Research and Quality. The datasets were the State Inpatient Databases (SIDs) and State Emergency Department Databases (SEDDs) from California, Florida, and New York (24). These specific states were selected, because they had linked identifiers between subsequent hospitalizations and ED visits, and the states represented large and diverse segments of the transplant population. In addition, we used the Scientific Registry of Transplant Recipients (SRTR) to compare characteristics of the study population with characteristics of the national transplant population over the contemporaneous period. The SRTR data system includes data on all donors, waitlisted candidates, and transplant recipients in the United States submitted by the members of the Organ Procurement and Transplantation Network (OPTN) and has been described elsewhere (25). The Health Resources and Services Administration, US Department of Health and Human Services provides oversight to the activities of the OPTN and SRTR contractors. The clinical and research activities being reported are consistent with the Principles of the Declaration of Istanbul as outlined in the Declaration of Istanbul on Organ Trafficking and Transplant Tourism. The study was approved by the Cleveland Clinic Institutional Review Board.

We identified kidney transplant recipients in the SIDs on the basis of International Classification of Diseases 9 (ICD-9) procedure code 55.6 (labeled transplant of kidney). We excluded patients with state residence other than the state where the transplant was performed given the aim to evaluate longitudinal events. Patients were linked using the identifier "visitlink" with subsequent hospitalizations in the SIDs, which includes admissions that originated through the ED, and the SEDDs, which includes ED visits that did not lead to a hospital admission. We used SID severity files to extract information on comorbid information on the basis of the presence of ICD-9 diagnosis codes and excluded conditions that were rare (*i.e.*, <2% of the study population) to include sufficient patients to evaluate associations with outcomes.

The primary outcome of the study was ED visits after initial discharge for kidney transplantation. We evaluated

Table 2. Rate of emergency department visits by recipient characteristics

Recipient Characteristics and Level (% of Study Population)	Rate of ED Visits after Transplantation per 100 patient-yr (95% CI)	Adjusted Incidence Rate Ratio (95% CI)	*P* Value[a]
Recipient age, yr			
18–29 (8)	153.9 (146.5 to 161.4)	1.28 (1.20 to 1.36)	<0.001
30–44 (25)	131.4 (127.6 to 135.2)	1.08 (1.04 to 1.13)	
45–59 (36)	117.3 (114.3 to 120.3)	0.99 (0.95 to 1.03)	
60+ (32)	127.9 (124.4 to 131.3)	Reference	
Recipient sex[b]			
Women (40)	145.6 (142.4 to 148.8)	1.25 (1.21 to 1.29)	<0.001
Men (60)	114.5 (112.2 to 116.8)	Reference	
Recipient race			
Black (19)	155.5 (150.7 to 160.2)	1.21 (1.16 to 1.26)	<0.001
Hispanic (23)	142.4 (138.2 to 146.6)	1.11 (1.06 to 1.15)	
Asian/Pacific Islander (8)	94.5 (88.8 to 100.1)	0.83 (0.78 to 0.89)	
Other (9)	137.1 (129.6 to 144.6)	1.15 (1.08 to 1.22)	
White (41)	111.0 (108.4 to 113.7)	Reference	
Primary insurance			
Medicare (65)	142.2 (139.7 to 144.6)	1.44 (1.39 to 1.50)	<0.001
Medicaid (5)	181.0 (171.0 to 190.9)	1.73 (1.61 to 1.85)	
Other (1)	112.6 (92.6 to 132.7)	1.20 (1.00 to 1.44)	
Private (29)	84.8 (82.0 to 87.6)	Reference	
Discharge site			
Other facility (2)	180.1 (161.5 to 198.7)	1.21 (1.08 to 1.34)	<0.001
Home health (19)	163.5 (158.6 to 168.3)	1.18 (1.14 to 1.22)	
Home/routine (80)	117.2 (115.2 to 119.2)	Reference	
Median income on the basis of residential zip code[b]			
Lowest income quartile (25)	141.7 (137.7 to 145.7)	0.94 (0.85 to 1.04)	0.17
Second quartile (24)	132.7 (128.7 to 136.6)	1.01 (0.96 to 1.05)	
Third quartile (25)	120.6 (117.0 to 124.2)	0.99 (0.95 to 1.04)	
Highest income quartile (25)	111.7 (108.1 to 115.3)	Reference	
Depression			
Yes (4)	145.5 (135.8 to 155.1)	1.11 (1.04 to 1.19)	0.003
No (96)	126.1 (124.2 to 128.0)	Reference	
Hypertension			
Yes (8)	143.6 (136.4 to 150.8)	1.05 (1.00 to 1.11)	0.07
No (92)	125.5 (123.6 to 127.5)	Reference	
Diabetes, uncomplicated			
Yes (10)	123.8 (117.9 to 129.7)	1.02 (0.97 to 1.07)	0.48
No (90)	127.3 (125.3 to 129.3)	Reference	
Diabetes, with complications			
Yes (19)	165.7 (160.7 to 170.6)	1.32 (1.27 to 1.36)	<0.001
No (81)	118.0 (116.0 to 120.0)	Reference	
Congestive heart failure			
Yes (5)	162.2 (152.2 to 172.1)	1.11 (1.04 to 1.18)	<0.001
No (95)	125.3 (123.4 to 127.2)	Reference	
Peripheral vascular disease			
Yes (6)	176.5 (167.2 to 185.7)	1.29 (1.22 to 1.36)	<0.001
No (94)	123.9 (122.0 to 125.8)	Reference	
Hypothyroidism			
Yes (8)	126.2 (119.8 to 132.6)	1.00 (0.95 to 1.06)	0.96
No (92)	127.0 (125.0 to 129.0)	Reference	
Liver disease			
Yes (4)	137.8 (128.2 to 147.3)	1.08 (1.00 to 1.16)	0.05
No (96)	126.5 (124.6 to 128.4)	Reference	
Arthritis			
Yes (4)	157.1 (145.7 to 168.5)	1.05 (0.98 to 1.14)	0.18
No (96)	125.9 (124.0 to 127.8)	Reference	
Coagulopathy			
Yes (9)	149.5 (142.5 to 156.5)	1.12 (1.06 to 1.18)	<0.001
No (91)	124.8 (122.9 to 126.8)	Reference	

Table 2. (Continued)

Recipient Characteristics and Level (% of Study Population)	Rate of ED Visits after Transplantation per 100 patient-yr (95% CI)	Adjusted Incidence Rate Ratio (95% CI)	*P* Value[a]
Valve disease			
Yes (5)	117.1 (108.6 to 125.6)	0.91 (0.84 to 0.98)	<0.01
No (95)	127.4 (125.5 to 129.3)	Reference	
Length of initial hospital stay, d			
1–4 (30)	94.7 (91.7 to 97.7)	Reference	<0.001
5–6 (36)	118.2 (115.2 to 121.2)	1.13 (1.08 to 1.17)	
7+ (34)	162.3 (158.7 to 165.3)	1.46 (1.41 to 1.53)	
ED visit within 1 yr before transplant			
Yes without admission (21)	155.1 (150.7 to 159.5)	1.58 (1.52 to 1.64)	<0.001
Yes with admission (29)	177.6 (173.3 to 181.8)	1.88 (1.82 to 1.95)	
No (50)	87.2 (85.0 to 89.4)	Reference	
State of residence			
California (47)	121.4 (118.7 to 124.1)	1.03 (0.99 to 1.07)	0.22
Florida (25)	131.5 (127.7 to 135.3)	1.00 (0.96 to 1.04)	
New York (28)	132.5 (128.8 to 136.2)	Reference	
Overall population			
n=10,533	126.9 (125.1 to 128.8)		

ED, emergency department; 95% CI, 95% confidence interval.
[a]Statistical significance of recipient characteristics with adjusted incidence rate ratio.
[b]Results for small proportions of missing values (<2%) not displayed.

the rate of ED visits per 100 patient-years overall and by patient characteristics. Follow-up time was determined on the basis of discharge month (because the exact date is deidentified in the database) to the end of the last calendar year from the applicable state. For recipients in California, the files contained transplants from 2009 to 2011, and for Florida and New York, the files contained transplants from 2010 to 2012. Follow-up was censored at the date of hospitalized death coded in files. We used multivariable Poisson models to evaluate adjusted incidence rate ratios (IRRs) of ED visits using follow-up time as an offset. We evaluated goodness of fit of the model on the basis of the deviance criterion. We evaluated time to first ED visit after discharge using cumulative incidence plots for select characteristics and the Kaplan–Meier product–limit method and log rank test to compare incidence between groups. We characterized severity code at the time of ED visit on the basis of current procedural terminology coding. These codes were only available from the ED databases, which included visits that did not lead to hospital admission. All analyses were conducted in SAS (version 9.2; SAS Institute Inc., Cary, NC).

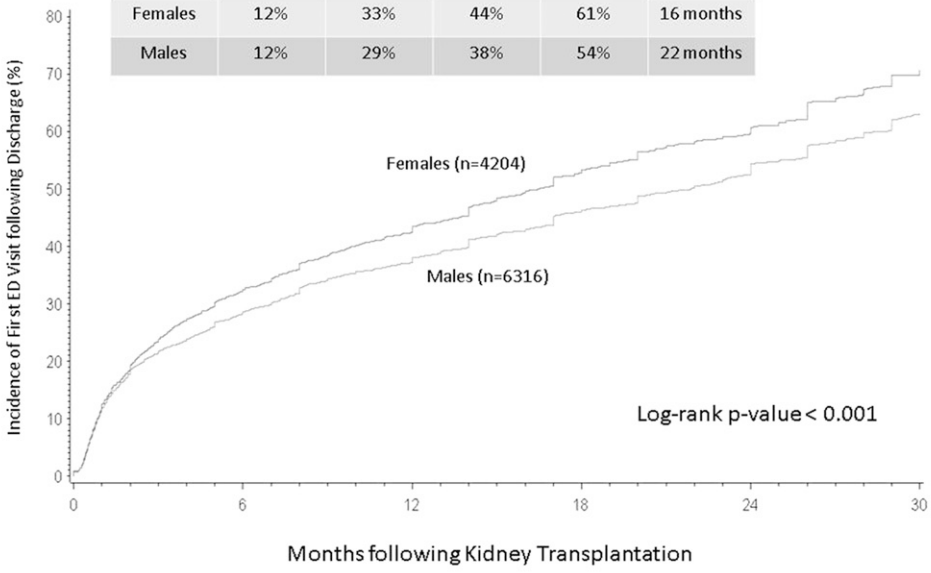
Results

The study population consisted of 10,533 adult (ages ≥18 years old) kidney transplant recipients receiving a transplant between 2009 and 2012 at hospitals located in California, Florida, or New York. Compared with all solitary adult kidney transplants performed in the United States during the period, the study population had similar age and proportion of women but a relatively higher proportion of recipients with public insurance (Table 1). In addition, the distributions of patients by race/ethnicity included lower proportions of whites (42% versus 53%) and blacks (19% versus 26%) and higher proportions of Hispanics (23% versus 15%) and Asians (8% versus 6%) in the study population versus the United States population, respectively. Despite the study population deriving from only three states, the recipients represented approximately 16% of all recipients in the United States over the period. In addition, there were 49 individual hospitals performing transplants during the period within these states, which represented approximately 19% of United States kidney transplant centers. The proportions of patients with documented comorbidities and other process measures are displayed in Table 2. Notable characteristics included 29% of recipients with diabetes diagnoses (19% with and 10% without complications), 80% of recipients discharged to home/routine care, 34% of recipients with at least a 7-day initial hospital stay, and 50% of recipients with documented ED visits in the 1 year before transplantation. There were 109 hospital deaths during the period.

The total number of ED visits during the follow-up was 17,575, and total follow-up years after discharge were 13,845. Of all ED visits, 48% (*n*=8454) led to hospital admission. The rate of ED visits was 126.9 (95% confidence interval [95% CI], 125.1 to 128.8) per 100 patient-years. Unadjusted rates and adjusted IRRs of ED visits stratified by patient characteristics are displayed in Table 2. On basis of the Poisson model adjusted for all variables listed in Table 2, significant independent factors associated with the rate of ED visits included age, sex, race/ethnicity, primary insurance, discharge site, depression, diabetes with complications, congestive heart failure, peripheral vascular disease, liver disease, coagulopathy, valve disease, length of initial hospital stay, and prior ED use. Risk factors for ED visits requiring hospital admissions were

A

Recipient Gender	Incidence of First ED Visit Following Discharge for Kidney Transplantation(%)				Median time to first ED Visit
	1 month	6 months	12 months	24 months	
Females	12%	33%	44%	61%	16 months
Males	12%	29%	38%	54%	22 months



* n=13 missing gender information

B

Recipient Race/ Ethnicity	Incidence of First ED Visit Following Discharge for Kidney Transplantation(%)				Median time to first ED Visit
	1 month	6 months	12 months	24 months	
Hispanic	14%	33%	44%	62%	15 months
Black	14%	36%	46%	63%	14 months
White	10%	28%	37%	54%	22 months
Asian	11%	26%	35%	48%	26 months

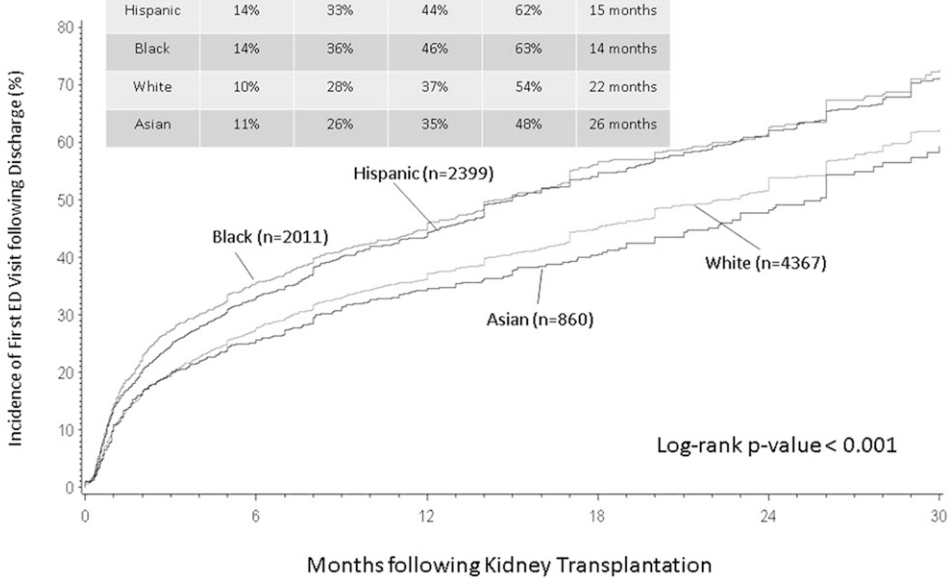
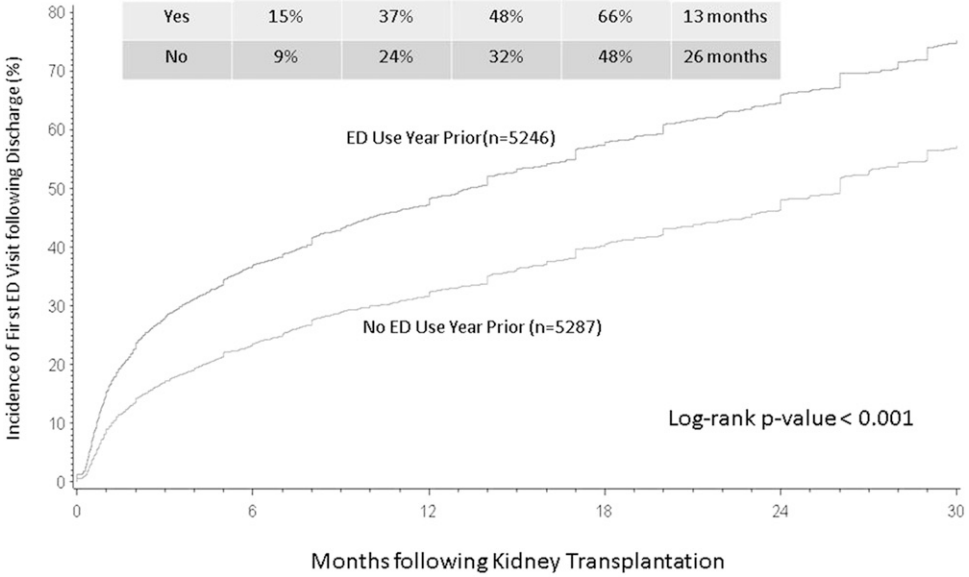


Figure 1. | **Cumulative incidence of first emergency department visit following discharge for kidney transplantation.** Cumulative incidence of time to first emergency department (ED) visit after discharge by (A) sex, (B) race/ethnicity, (C) prior ED use, and (D) primary insurance.

generally similar to those for all ED visits, with exceptions including that younger age and Hispanic ethnicity were no longer significantly associated with higher rates (Supplemental Table 1). In contrast, younger age (18–29 years old) was associated with a significantly higher rate of ED visits not requiring admission (IRR, 1.63; 95% CI, 1.50 to 1.76) relative to older recipients. Among all ED visits requiring admission, 57% were to the initial transplant center hospital. However, this proportion was modified by duration of time after transplantation as follows: admissions within 3 months were to the original hospital in 80% of patients, admissions between 3 and 12 months were to the original hospital in 52% of patients, and admissions after 12 months were to the original hospital in 38% of patients.

C

ED Use Year Prior to Transplant	Incidence of First ED Visit Following Discharge for Kidney Transplantation(%)				Median time to first ED Visit
	1 month	6 months	12 months	24 months	
Yes	15%	37%	48%	66%	13 months
No	9%	24%	32%	48%	26 months



D

Primary Insurance	Incidence of First ED Visit Following Discharge for Kidney Transplantation(%)				Median time to first ED Visit
	1 month	6 months	12 months	24 months	
Medicaid	14%	38%	48%	66%	13 months
Medicare	13%	33%	44%	61%	17 months
Private	9%	22%	32%	47%	26 months

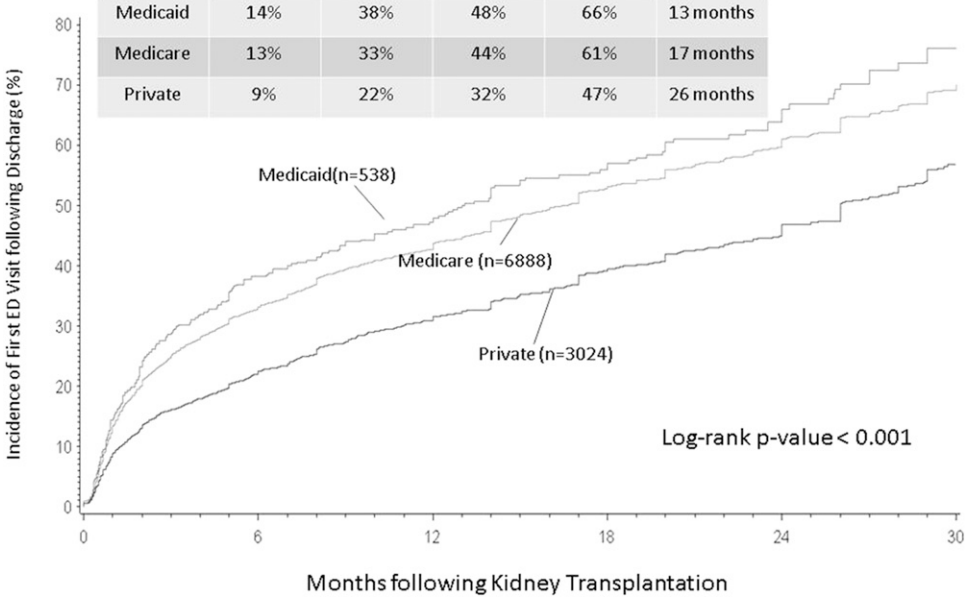


Figure 1. | (Continued)

The cumulative incidences of first ED visit after discharge at 1, 6, 12, and 24 months were 12%, 30%, 40%, and 57%, respectively. Median time to ED visit was 19 months (95% CI, 18.0 to 20.0; 25th percentile =5 months; 75th percentile =33 months). Figure 1 displays cumulative incidence plots of first ED visit for select characteristics. Women had a higher incidence rate ($P<0.001$), with 16 months median time to ED visit compared with 22 months for men (Figure 1A). The cumulative incidence was higher for black and Hispanic recipients compared with whites, and the median time to first ED visit by race/ethnic group was 14 months for blacks, 15 months for Hispanics, 22 months for whites, and 26 months for Asian/Pacific Islander recipients (Figure 1B). Time to ED visit was shorter for patients with Medicaid (median =13 months) and Medicare (median =17 months) as primary insurance

Table 3. Most common primary clinical classification diagnoses codes for emergency department visits requiring and not requiring hospital admission among kidney transplant recipients postdischarge

Diagnosis Description (CCS Code)[a]	Frequency, %
ED visits requiring hospital admission	
Complication of device; implant or graft (237)	17.2
Essential hypertension (99)	6.5
Diabetes mellitus with complications (50)	5.6
Septicemia (2)	5.2
Fluid and electrolyte disorders (55)	4.2
Acute and unspecified renal failure (157)	3.9
Congestive heart failure; nonhypertensive (108)	3.8
Pneumonia (122)	3.6
Urinary tract infections (159)	3.6
Complications of surgical procedures or medical care (238)	3.3
Nonspecific chest pain (102)	2.1
Intestinal infection (135)	1.7
Cardiac dysrhythmias (106)	1.5
Deficiency and other anemia (59)	1.5
Skin and subcutaneous tissue infections (197)	1.3
ED visits not requiring hospital admission	
Abdominal pain (251)	7.8
Urinary tract infections (159)	4.9
Fluid and electrolyte disorders (55)	3.8
Nonspecific chest pain (102)	3.1
Genitourinary symptoms and ill-defined conditions (163)	3.1
Nausea and vomiting (250)	2.9
Fever of unknown origin (246)	2.8
Diabetes mellitus with complications (50)	2.7
Other gastrointestinal disorders (155)	2.7
Superficial injury; contusion (239)	2.6
Other connective tissue disease (211)	2.5
Headache; including migraine (84)	2.5
Complication of device; implant or graft (237)	2.4
Sprains and strains (232)	2.4
Skin and subcutaneous tissue infections (197)	2.2

CCS, Clinical Classifications Software; ED, emergency department.

[a]These codes describe 65% of the cumulative diagnosis classifications for the study population in ED visits requiring hospital admission and 48% of the cumulative diagnosis classifications for the study population in ED visits not requiring hospital admission.

relative to private pay recipients (median =26 months). Time to first ED visit was shorter for patients who used the ED the year before transplantation (median =13 months) compared with that in patients who did not use the ED before transplantation (median =26 months) (Figure 1D).

The primary diagnoses of ED visits requiring hospitalization were complication of the graft followed by essential hypertension, diabetes, and septicemia (Table 3). ED visits that did not require hospitalization were most commonly classified by abdominal pain, urinary tract infections, fluid and electrolyte disorders, and chest pain (Table 3). Supplemental Table 2 displays CPT codes indicating the documented level of complexity of ED visits that did not require a hospital admission. Over one-half of ED visits were classified as high severity/urgent or critical care/injury related. The distribution of visit severity did not vary substantially by patient characteristics.

There were 49 individual hospitals, and the median number of transplants performed during the study period was 109 (25th percentile =46; 75th percentile =298). Among 41 centers with ≥10 transplants, the median rate of ED visits was 124.6/100 patient-years (25th percentile =98.5/100 patient-years; 75th percentile =166.9/100 patient-years) (Figure 2). There was no significant correlation between center transplant volume and rate of ED visits (Spearman correlation =−0.02; P=0.87).

Discussion

There are several principal findings of the study. First, ED visits after kidney transplantation are relatively common after discharge (12% at 1 month) and continue steadily, with median time to first ED visit of 19 months. Almost one-half of recipient ED visits lead to a hospital admission. The rate of ED visits varies dramatically by patient characteristics, and recipients who are younger, are women, are minority race/ethnicity, are publicly insured, have select comorbidities, have longer length of initial hospital stay, and have ED use in the year before transplant have significantly higher post–transplant ED rates. Rates of ED visits also vary substantially by individual transplant center, which may reflect diverse patient– and systems–level factors. Cumulatively, results indicate that transplant recipients have extensive interaction with EDs after discharge. ED providers need to be knowledgeable of clinical issues salient to this population. In addition, transplant centers must consider coordination of care with EDs as efficiently as possible, with particular consideration for recipients with characteristics associated with common use.

Higher rates among select patient characteristics, in part, likely reflect higher acuity levels or complexity with the initial procedure, such as comorbid conditions, longer initial length of stay, and discharge to a site other than home. Other factors, such as insurance status and prior use of the ED, likely partially reflect access to care and behavioral patterns of obtaining care. Interestingly, after accounting for other factors, household median income, assessed at the zip code level, was not associated with ED rates, suggesting that this aggregate proxy for socioeconomic status may not be independently associated with ED use. Women have higher rates of ED care in the general

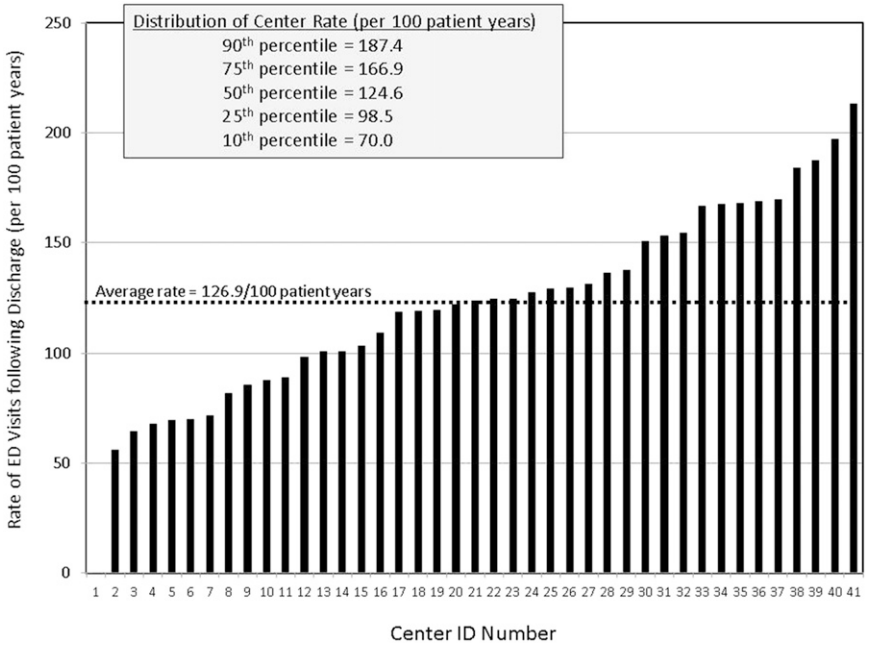


Figure 2. | **Rates of emergency department (ED) visits by transplant center.** ID, identification.

population, partially explained by pregnancy-related care, and this association was consistent in the kidney transplant population (1). Finally, younger recipients were more likely to seek care through the ED, particularly visits that did not require hospitalizations. These higher rates may reflect a combination of access to care, socioeconomic status, and higher rates of injuries.

Study findings indicate that recipients have an ED rate of 127/100 patient-years, and approximately 12% and 40% of recipients had an ED visit within 1 and 12 months of discharge, respectively. Notably, the 1-month rates are significantly less than previous studies indicating a 30% 30-day hospital readmission rate. To some degree, this suggests that the ED is not the initial point of care in the immediate discharge period for the majority of transplant recipients but does continue to be a source of care over time and notably, includes common admissions to hospitals other than the transplant hospital with extended time after discharge. To place findings in perspective in other settings, Tang *et al.* (26) showed that rates of ED use in the general population increased from 35 to 39 visits per 100 patient-years between 1997 and 2007, with increased rates among underserved Medicaid patients. A national study of Medicare patients receiving surgery (including percutaneous coronary intervention, hip fracture repair, and coronary artery bypass grafting) reported a 30-day ED visit rate of 17% (14). A 2013 study using the SIDs found that 40% of 30-day acute care encounters after hospital discharge were to an ED (10). Vashi *et al.* (10) suggested that, given the high proportion of treat and release ED visits, discharge and transition planning should focus more attention toward this common modality of care rather than hospital readmissions alone. This sentiment is likely salient for the transplant population, in which ED visits are common but relatively understudied and evaluated as an intervention for quality improvement.

Findings of this study indicated that there is wide variation in rates of ED visits by individual center. This variation may reflect differences in the acuity of the respective populations, care coordination, complication rates, and availability of alternative sources of care and other processes of care. Future studies should detail the sources of this variation and whether certain interventions could reduce rates and health care expenditures. It is notable that approximately one-half of ED visits that were treat and release (did not lead to an admission) were also coded as moderate or low complexity, suggesting that a proportion of these visits could be coordinated directly with the transplant center or other primary care providers. A question that the study finding raises is whether ED rates could be considered a quality metric for transplant centers. The data used for this study do not include long–term graft and patient survival or transplant center quality evaluations, and as such, it is unclear whether there is a strong relationship between ED visits and long–term patient outcomes. However, caution must also be exercised in directly assuming that ED visits are an indicator of poor quality given the many potential sources of variation in the reasons for ED visits and the structure of health care systems in different regions of the country as well as the underlying characteristics of patients between transplant centers.

The findings of this study do suggest that the frequency of ED visits by patients with transplants necessitates a high level of acumen about the issues salient to this population among ED providers. In 2004, Venkat and Venkat (27) published a summary of care protocols for patients with transplants in the ED. This type of consolidated information may be important to disseminate to ED providers to ensure that the nuances of care for transplant recipients are well understood. Other interventions may also be effective

to prevent ED use or direct care to primary providers and the transplant center. Coleman and colleagues (5,28,29) have published several studies characterizing ED usage in a chronically ill population. In a randomized, controlled trial, this group illustrated that more routine multidisciplinary interaction with patients after discharge led to attenuated ED use relative to standard of care (30). This type of enhanced management of patients with transplants considered at high risk for ED visits may have potential to reduce expenditures and improve quality of care.

There are several limitations to consider with the interpretation of study findings. Findings may not be entirely generalizable to the United States population, because the patients in the respective states used for this study may be unique and may not represent states with more rural populations, different provisions for underserved populations, or variation in access to health care. Compared with the national recipient population, the study population had similar age and sex distributions but higher prevalence of publicly insured and minority groups. Therefore, estimated incidence rates found in this study may be higher than the United States population. Another limitation of the study is that these data are not directly linked to national death indices or Medicare files, and as such, the relationship between ED visits and longer-term outcomes is not clear. In a similar fashion, the available data do not capture events that occur in states other than the residential state at the time of transplant. As such, it is unclear the degree to which patient mobility may affect outcomes or vary between groups. Finally, compared with transplant-specific databases, these data do not contain certain risk factors that may also affect ED visits (*e.g.*, HLA matching, panel reactive antibody levels, donor characteristics, *etc.*). However, it is worth noting that transplant registries similarly do not capture numerous recipient comorbidities included in this study (*e.g.*, congestive heart disease, depression, and hypothyroidism) that were associated with ED visits.

In summary, this study provides an evaluation of the incidence and risk factors for a broad population of kidney transplant recipients. Results quantify the rate of ED visits after initial discharge (approximately 1.3 visits per patient-year) and indicate wide variability in the risks for ED visits on the basis of patient characteristics, processes of care, and prior use of the ED. Additional understanding of sources of variation between patients and centers requires prospective research. Given the frequent use of the ED among kidney transplant recipients, efforts to coordinate care after discharge and evaluate the quality of care and transplant-specific acumen among ED providers are needed.

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The interpretation and reporting of these data are the responsibility of the authors and in no way should be seen as an official policy of or interpretation by the SRTR or the US Government.

Disclosures

None.

References

1. Skinner HG, Blanchard J, Elixhauser A: Trends in emergency department visits, 2006-2011: HCUP statistical brief #179. Rockville, MD, Agency for Healthcare Research and Quality, 2014
2. Burke RE, Juarez-Colunga E, Levy C, Prochazka AV, Coleman EA, Ginde AA: Patient and hospitalization characteristics associated with increased postacute care facility discharges from US hospitals. *Med Care* 53: 492–500, 2015
3. Owens P, Elixhauser A: Hospital admissions that began in the emergency department, 2003: Statistical brief #1. Rockville, MD, Agency for Healthcare Research and Quality, 2006
4. Weiss AJ, Wier LM, Stocks C, et al: Overview of emergency department visits in the United States, 2011: Statistical brief #174. Rockville, MD, Agency for Healthcare Research and Quality, 2014
5. Baier RR, Gardner RL, Coleman EA, Jencks SF, Mor V, Gravenstein S: Shifting the dialogue from hospital readmissions to unplanned care. *Am J Manag Care* 19: 450–453, 2013
6. Burke RE, Juarez-Colunga E, Levy C, Prochazka AV, Coleman EA, Ginde AA: Rise of post-acute care facilities as a discharge destination of US hospitalizations. *JAMA Intern Med* 175: 295–296, 2015
7. Joynt KE, Jha AK: Thirty-day readmissions–truth and consequences. *N Engl J Med* 366: 1366–1369, 2012
8. Gerhardt G, Yemane A, Hickman P, Oelschlaeger A, Rollins E, Brennan N: Medicare readmission rates showed meaningful decline in 2012. *Medicare Medicaid Res Rev* 3: mmrr.003.02.b01, 2013
9. Joynt KE, Orav EJ, Jha AK: Thirty-day readmission rates for Medicare beneficiaries by race and site of care. *JAMA* 305: 675–681, 2011
10. Vashi AA, Fox JP, Carr BG, D'Onofrio G, Pines JM, Ross JS, Gross CP: Use of hospital-based acute care among patients recently discharged from the hospital. *JAMA* 309: 364–371, 2013
11. Gilstrap LG, Joynt KE: Understanding the relationship between readmission and quality of hospital care in heart failure. *Curr Heart Fail Rep* 11: 347–353, 2014
12. Keyhani S, Cheng E, Arling G, Li X, Myers L, Ofner S, Williams LS, Phipps M, Ordin D, Bravata DM: Does the inclusion of stroke severity in a 30-day mortality model change standardized mortality rates at Veterans Affairs hospitals? *Circ Cardiovasc Qual Outcomes* 5: 508–513, 2012
13. Martin RC, Brown R, Puffer L, Block S, Callender G, Quillo A, Scoggins CR, McMasters KM: Readmission rates after abdominal surgery: The role of surgeon, primary caregiver, home health, and subacute rehab. *Ann Surg* 254: 591–597, 2011
14. Kocher KE, Nallamothu BK, Birkmeyer JD, Dimick JB: Emergency department visits after surgery are common for Medicare patients, suggesting opportunities to improve care. *Health Aff (Millwood)* 32: 1600–1607, 2013
15. Trzeciak S, Rivers EP: Emergency department overcrowding in the United States: An emerging threat to patient safety and public health. *Emerg Med J* 20: 402–405, 2003
16. McAdams-Demarco MA, Grams ME, Hall EC, Coresh J, Segev DL: Early hospital readmission after kidney transplantation: Patient and center-level associations. *Am J Transplant* 12: 3283–3288, 2012
17. Harhay M, Lin E, Pai A, Harhay MO, Huverserian A, Mussell A, Abt P, Levine M, Bloom R, Shea JA, Troxel AB, Reese PP: Early rehospitalization after kidney transplantation: Assessing preventability and prognosis. *Am J Transplant* 13: 3164–3172, 2013
18. Luan FL, Barrantes F, Roth RS, Samaniego M: Early hospital readmissions post-kidney transplantation are associated with inferior clinical outcomes. *Clin Transplant* 28: 487–493, 2014
19. McAdams-Demarco MA, Grams ME, King E, Desai NM, Segev DL: Sequelae of early hospital readmission after kidney transplantation. *Am J Transplant* 14: 397–403, 2014
20. Taber DJ, McGillicuddy JW, Bratton CF, Lin A, Chavin KD, Baliga PK: The concept of a composite perioperative quality index in kidney transplantation. *J Am Coll Surg* 218: 588–597, 2014
21. Unterman S, Zimmerman M, Tyo C, Sterk E, Gehm L, Edison M, Benedetti E, Orsay E: A descriptive analysis of 1251 solid organ transplant visits to the emergency department. *West J Emerg Med* 10: 48–54, 2009

22. Hollisaaz MT, Noorbala MH, Irani N, Bahaeloo-Horeh S, Assari S, Saadat SH, Araghizadeh H, Rezaie Y: Severity of chronic pain affects health care utilization after kidney transplantation. *Transplant Proc* 39: 1122–1125, 2007
23. Trzeciak S, Sharer R, Piper D, Chan T, Kessler C, Dellinger RP, Pursell KJ: Infections and severe sepsis in solid-organ transplant patients admitted from a university-based ED. *Am J Emerg Med* 22: 530–533, 2004
24. Steiner C, Elixhauser A, Schnaier J: The healthcare cost and utilization project: An overview. *Eff Clin Pract* 5: 143–151, 2002
25. Levine GN, McCullough KP, Rodgers AM, Dickinson DM, Ashby VB, Schaubel DE: Analytical methods and database design: Implications for transplant researchers, 2005. *Am J Transplant* 6: 1228–1242, 2006
26. Tang N, Stein J, Hsia RY, Maselli JH, Gonzales R: Trends and characteristics of US emergency department visits, 1997-2007. *JAMA* 304: 664–670, 2010
27. Venkat KK, Venkat A: Care of the renal transplant recipient in the emergency department. *Ann Emerg Med* 44: 330–341, 2004
28. Coleman EA, Eilertsen TB, Magid DJ, Conner DA, Beck A, Kramer AM: The association between care co-ordination and emergency department use in older managed care enrollees. *Int J Integr Care* 2: e03, 2002
29. Coleman EA, Mahoney E, Parry C: Assessing the quality of preparation for posthospital care from the patient's perspective: The care transitions measure. *Med Care* 43: 246–255, 2005
30. Coleman EA, Eilertsen TB, Kramer AM, Magid DJ, Beck A, Conner D: Reducing emergency visits in older adults with chronic illness. A randomized, controlled trial of group visits. *Eff Clin Pract* 4: 49–57, 2001

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