Characteristics and Outcomes of Kidney Transplant Recipients Requiring High-Acuity Care After Transplant Surgery: A 10-Year Single-Center Study

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Abstract

Objective: To study the characteristics and outcomes of a cohort of kidney transplant recipients who required high-acuity care after transplant surgery.

Patients and Methods: All adult (aged ≥18 years) solitary kidney transplant recipients from January 1, 2007, through December 31, 2016, were screened and those who required high-acuity care within the same hospitalization were enrolled. Patient demographic and clinical data were collected from the departmental database and electronic DataMart.

Results: Of 1525 patients, 266 (17.4%) required high-acuity care after the kidney transplant operation: 166 (62.4%) directly from the operating room and 100 (37.6%) after an interval during the same hospitalization. Overall, 2 main indications were hypotension (n=87; 32.7%) and cardiac rhythm disturbances (n=83; 31.2%). Recipients in the direct admission group had higher medium body mass index (31.0 [interquartile range, 26.6-36.0] vs 28.0 [interquartile range, 24.3-32.4] kg/m^2; $P<.001$) and were more likely to have undergone a concomitant procedure with the transplant surgery. Overall, in-hospital mortality was 1.9% (n=5).

Conclusion: In contemporary practice, patients with higher body mass index are more likely to require high-acuity care immediately after kidney transplant surgery. The most common reasons are hypotension and cardiac rhythm disorders. The overall intensive care unit mortality rate of these patients is low. However, these patients are at risk for graft loss and death in the long term compared with patients who do not require intensive care unit care after transplant surgery.

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Kidney transplant is the treatment of choice for patients with end-stage renal disease (ESRD).[1] In comparison to patients maintained on dialysis, expectancy and quality of life are significantly better among transplant recipients.[1,2] However, the relative risk for dying within the first month after transplant is approximately 3 times higher compared with dialysis patients.[1] Patients with ESRD are at least American Society of Anesthesiologist (ASA) class III as per the ASA physical status classification system,[3,4] which is associated with higher postsurgical morbidity compared with ASA class I surgical patients.[4,5] In contemporary practice, most patients have an uncomplicated course after transplant surgery. However, a few of these patients may require high-acuity care in the intensive care unit (ICU) after transplant surgery.

Transplant trends have changed in the past 2 decades.[6,7] Due to the increasing incidence of ESRD and limited supply of organs, the number of waitlisted candidates continues to increase.[6] At the same time, listing criteria have expanded significantly during the same period. For example, the percentage of elderly patients (aged >64 years) on the United Network for Organ Sharing waiting list increased from 15.3% in 2006 to 22.5% in 2016, and diabetes as a cause of ESRD increased from 39.4% to 46%.[6] Following the same trend, the number of patients waiting for more than 5 years

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increased from nearly 11% to 16%.[6] Despite these factors predicting poor outcomes, there has been an improvement in patient and graft survival.[2,6]

There are very limited data for the characteristics and outcomes of kidney transplant recipients requiring high-acuity care after transplant surgery. In an earlier study, ICU admission and mortality rates were 41.6% and 11%, respectively.[8] To our knowledge, there is no other published report from North America evaluating ICU outcomes of kidney transplant recipients. Studies from the other parts of the world included multiorgan transplant recipients and ICU admissions long after kidney transplant.[9-15] The ICU mortality rate varies from 12.8% to as high as 42.6% in these studies.[9,10,12-15] The risk profile of multiorgan recipients is different from that of solitary kidney transplant recipients. Similarly, delayed ICU admissions after kidney transplant are mainly due to respiratory failure or sepsis.[11] This does not represent the risk due to kidney transplant surgery in this population. Therefore, there is a need to re-examine the characteristics and outcomes of kidney transplant recipients requiring ICU admission. Earlier, we studied factors predicting the admission of solitary kidney transplant recipients to the ICU after kidney transplant surgery.[16] The current study focuses on the characteristics and outcomes of these patients.

PATIENTS AND METHODS

The study was carried out at a tertiary-care teaching hospital and was approved by the Institution Review Board. All adult patients (aged ≥18 years) who received a kidney transplant between January 1, 2007, and December 31, 2016, were selected for the study. Children (aged <18 years at the time of transplant), patients who did not give prior research authorization to review their medical charts, and patients who received combined organ transplants (liver, lungs, heart, or pancreas with kidney) were excluded from the study. In our practice, patients who require invasive monitoring or parenteral drugs for hemodynamic support are kept in the ICU because of the lack of a step-down monitoring unit. Therefore, our ICU cohort includes patients who were admitted for high-acuity monitoring. For the purpose of this study, early ICU admissions were defined as ICU transfer during transplant surgery—related hospital admission and before discharge from the hospital. Patients with ICU admission in a separate hospitalization than transplant hospitalization were excluded from the study (Figure). To characterize the indications for and outcomes of patients requiring early ICU admission after kidney transplant in more detail, next we compared those who were admitted directly from the operating room (OR) or postanesthesia care unit to the ICU (ie, direct admission) with patients who were admitted to a general floor after successful recovery from anesthesia but were later transferred to the ICU (ie, interval admission).

Data for patient-related (demographic characteristics: age, sex, and body mass index [BMI; calculated as the weight in kilograms divided by the height in meters squared], comorbid conditions, dialysis before transplant, and previous solid-organ transplant) and donor-related (age, deceased vs living, sex, warm ischemia time [WIT], and total ischemia time) variables were abstracted from the Mayo Clinic Transplant Center database. We abstracted comorbid conditions based on a validated algorithm.[17] We defined WIT as the time between removal of the kidney allograft out of cold preservation solution and reperfusion. The ICU-related data were collected from the previously validated electronic DataMart.[15] On ICU admission, the reason for the admission was recorded. The Acute Physiology and Chronic Health Evaluation III (APACHE III) score at 24 hours of ICU admission and Sequential Organ Failure Assessment (SOFA) scores on day 1 were used for the severity of the disease process. Severity outcome parameters studied included requirement of ventilation, type of ventilation (noninvasive mechanical [NIMV] or invasive mechanical ventilation [IMV]), duration of ventilation, inotrope requirement, dialysis requirement, blood product transfusion in ICU, ICU length of stay (LOS), hospital LOS, ICU mortality, and hospital mortality. The long-term patient- and graft-related outcome variables (graft loss in the first year; mortality in 30 days, 1 year, and long term; time from transplant to death; and death with a functioning allograft) were also studied.

Statistical analyses were performed using JMP, version 14 (SAS Institute Inc; 1989-2019). Data were descriptively summarized using frequency and percentage for categorical variables (sex of recipient, comorbid conditions, dialysis before transplant, previous solid-organ transplant, type of donor, combined procedure with a transplant, ICU admission indications, and ICU resource use) and median and interquartile range (IQR) for continuous variables (age of recipient, Charlson score, BMI, donor age, WIT, total ischemia time, SOFA and APACHE III scores, vitals in ICU, LOS, and mortality). Data distributions across direct ICU admission were compared using Wilcoxon rank sum test. $P<.05$ was considered significant.

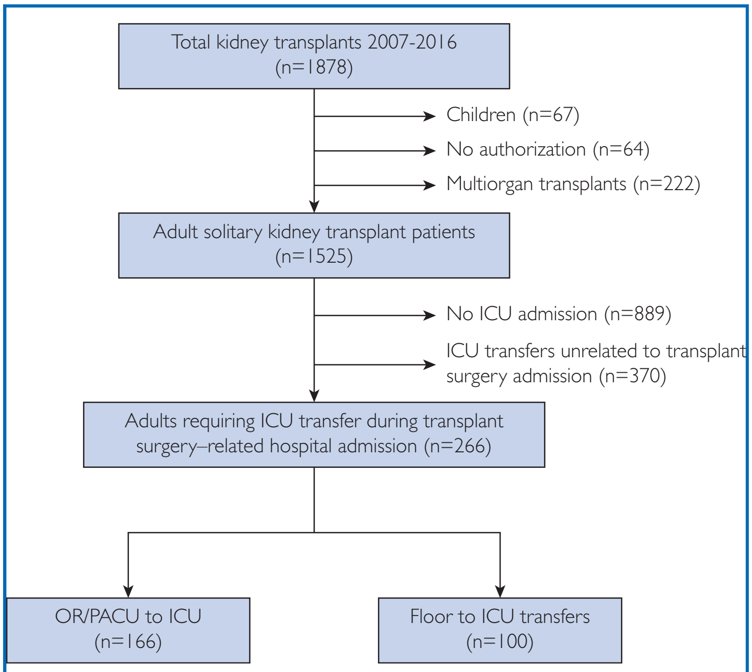

FIGURE. Study flow diagram. ICU = intensive care unit; OR = operating room; PACU = postanesthesia care unit.

RESULTS

Patient Demographic Characteristics

A total of 1878 kidney transplants were performed during the study period. After excluding combined-organ transplants (n=222), patients without research authorization (n=64), and pediatric transplants (n= 67), 266 (266 of 1525; 17.4%) adult recipients were found to have required early ICU admission (ie, during the hospitalization related to the kidney transplant). Characteristics of patients in the ICU cohort are shown in Table 1. The median age of patients was 55.7 (IQR, 45.6-65.5) years and most were men (n=155; 58.3%). Diabetes mellitus (n=96; 36.0%), congestive heart failure (n=27; 10.2%), and previous myocardial ischemia (n=29; 10.9%) were major comorbid conditions. Most patients were receiving dialysis (n=173; 65.0%) and received a kidney from a living donor (n=183; 68.8%). Importantly, 14.3% (n=38) of recipients underwent an additional procedure simultaneously with kidney implantation under the same anesthesia. Laparoscopic bilateral native nephrectomy for polycystic kidneys (n=11; 4.1%), allograft nephrectomy (n=6; 2.3%), and bilateral ureteral ligation (n=6; 2.3%) were the most common procedures performed with the transplant. Other combined procedures were splenectomy (n=1), iliofemoral arterial bypass graft (n=3), and repair of bowel injury (n=1).

Characteristics of Direct vs Interval Early ICU Admission After Kidney Transplant

Of the 266 patients who required early ICU admission, 166 (62.4%) had direct admission while 100 (37.6%) had interval admission. Recipients in both groups were similar with respect to age (median, 54.8 [IQR, 45.0-63.6] vs 57.8 [IQR, 49.7-67.0] years; $P=.11$), sex (male, 59.6% [99 of 166] vs 56.0% [56 of 100]; $P=.56$), requirement of dialysis before transplant (66.9% [111 of 166] vs 62.0% [62 of 100]; $P=.42$), Charlson score (median, 5 [IQR, 3.0-7.0] vs 6 [IQR, 3.3-8.0]; $P=.22$), and history of previous solid-organ transplant (26.0% [43 of 166] vs 19.0% [19 of 100]; $P=.19$; Table 1). Similarly, there was no difference in donor age (median, 44.5 [IQR, 35.0-55.0] vs 47.0 [IQR, 33.5-54.8] years; $P=.99$), donor type (70.0% [116 of 166] vs 67.0% [67 of 100] living donors; $P=.62$), donor sex (male, 51.8% [86 of 166] vs 44.0% [44 of 100]; $P=.22$), and ischemia times. Those who required direct ICU admission had higher BMI (median, 31 [IQR, 26.6-36.0] vs 28 [IQR, 24.3-32.4] kg/m^2; $P<.001$) and were more likely to have undergone a concomitant operation (20.0% [33 of 166] vs 5.0% [5 of 100]; $P<.001$; Table 1).

ICU Resource Use and Outcomes of Direct vs Interval Early ICU Admission

The ICU resource use and outcomes of the 2 groups are shown in Table 2. The most

TABLE 1. Characteristics of Study Cohort, Direct Admission, and Interval Admission Groups[a]

		All Patients (n=266)	Direct Admission (n=166)	Interval Admission (n=100)	*P*
Patient-related characteristics	Age (y), median (IQR)	55.7 (45.6-65.5)	54.8 (45.0-63.6)	57.8 (49.7-67.0)	.11
	Male sex, no. (%)	155 (58.3)	99 (59.6)	56 (56.0)	.56
	Body mass index (kg/m^2), median (IQR)	30.1 (25.6-34.5)	31.0 (26.6-36.0)	28.0 (24.3-32.4)	<.001[b]
	Charlson score, median (IQR)	5 (3-7)	5 (3.0-7.0)	6 (3.3-8.0)	.22
	Comorbid conditions, no. (%)				
	History of diabetes mellitus	96 (36.0)	63 (37.9)	33 (33.0)	.42
	History of congestive heart failure	27 (10.2)	14 (8.4)	13 (13.0)	.24
	History of myocardial infaction	29 (10.9)	20 (12.0)	9 (9.0)	.43
	History of cerebrovascular accident	23 (8.7)	12 (7.2)	11 (11.0)	.30
	Dialysis before Tx, no. (%)	173 (65.0)	111 (66.9)	62 (62.0)	.42
	Previous solid-organ Tx, no. (%)	62 (23.3)	43 (26.0)	19 (19.0)	.19
	Liver	5	2	3	
	Kidney	50	36	14	
	Pancreas	9	7	2	
	Heart	6	5	1	
	Lungs	2	1	1	
Donor-related characteristics	Age (y), median (IQR)	46 (35.0-55.0)	44.5 (35.0-55.0)	47 (33.5-54.8)	.99
	Living donor, no. (%)	183 (68.8)	116 (70.0)	67 (67.0)	.62
	Ischemia time, median (IQR)				
	Warm (min)	43.0 (36.0-51.3)	44.0 (36.0-53.0)	42.0 (36.2-49.8)	.52
	Cold (h)	1.7 (0.7-11.6)	1.4 (0.6-11.4)	2.1 (0.7-11.7)	.48
	Total (h)	2.4 (1.4-12.2)	2.4 (1.4-12.1)	2.7 (1.4-12.9)	.62
	Male sex, no. (%)	130 (48.8)	86 (51.8)	44 (44.0)	.22
Surgery-related characteristics	Combined procedure with Tx (yes), no. (%)	38 (14.3)	33 (20.0)	5 (5.0)	<.001[b]
	Bilateral native nephrectomy (ADPKD)	11 (4.1)	8 (4.8)	3 (3.0)	
	Hernia repair	4 (1.5)	3 (1.8)	1 (1.0)	
	Thrombectomy	2 (0.8)	2 (1.2)	0 (0.0)	
	Native ureter ligation	6 (2.3)	5 (3.0)	1 (1.0)	
	Allograft nephrectomy	6 (2.3)	6 (3.6)	0 (0.0)	
	Other	9 (3.4)	9 (5.4)	0 (0.0)	

[a]ADPKD = autosomal dominant polycystic kidney disease; IQR = interquartile range; Tx = transplant.
[b]Statistically significant.

common admission indications in both groups were cardiac arrhythmias (34.3% [57 of 166] vs 26.0% [26 of 100]) and low blood pressure (34.3% [57 of 166] vs 30.0% [30 of 100]). Among the former, new-onset postoperative atrial fibrillation was the most common arrhythmia in both groups. Cardiac ischemia was a more common indication for interval admission to the ICU (16.0% [16 of 100] vs 2.4% [4 of 166]; $P<.001$). Day 1 APACHE III (median, 48.0 [IQR, 41.0-58.0] vs 44.5 [IQR, 35.0-55.0]; $P<.01$) and SOFA scores (median, 6.0 [IQR, 4.3-7.5] vs 4.0 [IQR, 2.0-6.0]; $P<.001$) were significantly high in the direct admission group. Requirement of NIMV (20 of 166 [12.0%] vs 13 of 100 [13.0%]; $P=.82$), median heart rate (79 [73.0-87.0] vs 79 [73.0-86.8] beats/min; $P=.95$), median mean arterial pressure (81 [IQR, 76.0-89.0] vs 83 [IQR, 76.3-91.0] mm Hg; $P=.30$), dialysis requirement (19 of 166 [11.4%] vs 11 of 100 [11.0%]; $P=.91$),

TABLE 2. Comparison of ICU Resource Use and Outcome Between Direct Admission and Interval Admission Groups[a]

	Direct Admission (n=166)	Interval Admission (n=100)	P
ICU admission indication, no. (%)			
Respiratory	23 (13.8)	13 (13.0)	.84
Hypotension	57 (34.3)	30 (30.0)	.46
Hypertension	12 (7.2)	6 (6.0)	.70
Electrolyte imbalance	4 (2.4)	4 (4.0)	.47
Altered consciousness	1 (0.6)	0 (0.0)	.33
Cerebral hemorrhage	0 (0.0)	1 (1.0)	.16
Cardiac rhythm disturbance	57 (34.3)	26 (26.0)	.15
Non–ST-elevation myocardial infarction/myocardial infarction	4 (2.4)	16 (16.0)	<.001[b]
Acid-base imbalance	8 (4.8)	0 (0.0)	<.01[b]
Trimethoprim/sulfamethoxazole desensitization	0 (0.0)	4 (4.0)	<.01[b]
SOFA score day 1, median (IQR)	6.0 (4.3-7.5)	4.0 (2.0-6.0)	<.001[b]
APACHE III score at 24 h, median (IQR)	48.0 (41.0-58.0)	44.5 (35.0-55.0)	<.01[b]
Ventilation in ICU			
Required NIMV, no. (%)	20 (12.0)	13 (13.0)	.82
Required IMV, no. (%)	32 (19.3)	7 (7.0)	<.01[b]
Duration of ventilation (d), median (IQR)[c]	0.3 (0.1-1.2)	1.4 (0.2-2.6)	<.01[b]
Vital signs in ICU			
Mean arterial pressure (mm Hg), median (IQR)	81 (76.0-89.0)	83 (76.3-91.0)	.30
Heart rate (beats/min), median (IQR)	79 (73.0-87.0)	79 (73.0-86.8)	.95
Respiratory rate (breaths/min), median (IQR)	14.5 (13.0-16.0)	16 (14.0-18.0)	<.01[b]
Dialysis required, no. (%)	19 (11.4)	11 (11.0)	.91
Hemodialysis	17	7	
Continuous renal replacement therapy	2	4	
Pressor support required, no. (%)	63 (38.0)	29 (29.0)	.13
Blood product transfusion, no. (%)	55 (33.1)	36 (36.0)	.63
Fresh frozen plasma, no. (%)	7 (4.2)	6 (6.0)	
Volume (mL), median (IQR)	840.0 (558.0-1871)	1129.0 (535.0-3301.0)	
Cryoprecipitate, no. (%)	2 (1.2)	2 (2.0)	
Volume (mL), median (IQR)	302.5 (189.0-415.9)	530.0 (398.0-662.0)	
Platelets, no. (%)	6 (3.6)	5 (5.0)	
Volume (mL), median (IQR)	374.5 (308.5-877.0)	348.0 (256.5-702.0)	
Red blood cells, no. (%)	55 (33.1)	35 (35.0)	
Volume (mL), median (IQR)	660.0 (330.0-1320.0)	660.0 (330.0-1149.8)	.52
ICU length of stay (d), median (IQR)	1.1 (0.7-1.9)	1.2 (0.6-2.1)	.60
ICU mortality	1	4	.050
Hospital length of stay (d), median (IQR)	5.7 (4.5-8.2)	6.3 (4.6-8.8)	.95
Hospital mortality	1	4	.050

[a]APACHE = Acute Physiology and Chronic Health Evaluation; ICU = intensive care unit; IQR = interquartile range; IMV = invasive mechanical ventilation; NIMV = noninvasive mechanical ventilation; SOFA = Sequential Organ Failure Assessment.
[b]Statistically significant.
[c]Median duration of ventilation (IMV and NIMV) in those who required ventilatory support.

vasopressor requirement (38.0% [63 of 166] vs 29.0% [29 of 100]; *P*=.13), blood product transfusion (33.1% [55 of 166] vs 36.0% [36 of 100]; *P*=.63), ICU LOS (median 1.1 [IQR, 0.7-1.9] vs 1.2 [IQR, 0.6-2.1] days; *P*=.60), and hospital LOS (median, 5.7 [IQR, 4.5-8.2] vs 6.3 [IQR, 4.6-8.8] days; *P*=.95) were similar in both groups. A higher percentage of patients with direct ICU admission required IMV (19.3% [32 of 166] vs 7.0% [7 of 100]; *P*<.01), although duration of ventilation was longer in those who required ventilator support after interval admission (median, 0.3 [IQR, 0.1-1.2] vs 1.4 [IQR, 0.2-2.6] days;

TABLE 3. Long-term Outcomes Data

	Controls (1259)	Cases (n=266)	*P*	Direct Admissions (n=166)	Interval Admissions (n=100)	*P*
Follow-up (y), mean ± SD	5.6±2.8	5.2±3.0	.02[a]	5.5±3.1	4.6±2.8	.02[a]
Nonsurvivors, no. (%)	128 (10.2)	55 (20.7)	<.001[a]	32 (19.3)	23 (23.0)	.50
Death with functioning graft, no. (%)	107 (83.6)	42 (76.4)	.14	24 (75.0)	18 (78.3)	.78
Time to death from transplant (y), mean ± SD	5.0±2.9	4.0±2.8	.02	4.0±2.7	4.0±3.1	.93
Death within 30 d, no.	0	5		1	4	
Death within first y, no. (%)	9 (0.7)	9 (3.4)		3 (1.8)	6 (6.0)	
Graft loss within first y, no. (%)	15 (1.2)	16 (6.0)	<.001[a]	7 (4.2)	9 (9.0)	.12

[a]Statistically significant.

P<.01). The incidence of requiring dialysis was 11.4% (19 of 166) and 11% (11 of 100), respectively (*P*=.91).

In-Hospital Mortality

Overall, in-hospital mortality was 1.9% (n=5). All were men, and none of the recipients had combined procedures along with kidney transplant. Most did not have a previous solid-organ transplant. Four of the 5 in-hospital deaths occurred in patients who required early interval ICU admission. Due to the low overall mortality rate, we have not compared posttransplant survival with a survival model framework.

Long-term Outcomes

Overall, long-term mortality was significantly higher for patients who required high-acuity care before discharge from transplant-related hospitalization (55 of 266 [20.7%] vs 128 of 1259 controls [10.2%]; *P*<.001; Table 3). Most of these patients died with a functioning allograft (76.4% [42 of 55] vs 83.6% [107 of 128]). Importantly, mortality within the first year was low in both groups (3.4% [9 of 266] vs 0.7% [9 of 1259]), and time to death from transplant was shorter in patients requiring ICU care (4.0 vs 5.0 years; *P*=.02; Table 3). Similarly, allograft loss within the first year of transplant was more common in these patients (6.0% [16 of 266] vs 1.2% [15 of 1259]; *P*<.001). The differences in long-term patient and graft survival in the direct and interval admission groups were not statistically significant (Table 3).

DISCUSSION

Patients with ESRD are at higher surgical and anesthesia risk compared with ASA class 1 patients[4] and may require high-acuity care immediately after kidney transplant. Despite this, there is a paucity of literature on the characteristics and outcomes of patients requiring early high-acuity care after kidney transplant in contemporary practice in North America. The current study provides insights into the characteristics and outcomes of this cohort of patients.

Our results demonstrate that the overall early ICU admission rate after kidney transplant surgery was 17.4% (266 of 1525). This rate is higher than those reported previously,[12,13,15] likely due to the standardized interval ICU admission criteria used in our center during the length of the study, which differs from criteria used in previous studies, and lack of a stepdown unit for monitoring in our practice. The standardized ICU admission criteria used in our center include: (1) systolic blood pressure less than 90 mm Hg in 2 consecutive measurements that does not respond to fluid resuscitation, (2) a posttransplant reduction in systolic blood pressure greater than 20% compared with the pretransplant measurement, and (3) new-onset cardiac arrhythmia associated with hemodynamic instability. However, it should be noted that the current study differs from the previously reported results because it represents a more homogeneous and contemporary kidney transplant recipient cohort that includes all patients requiring high-acuity care. Moreover, although previous studies included ICU admissions at any time from the transplant surgery, we focused only on early ICU admissions. Therefore, hypotension, cardiopulmonary monitoring, and cardiac rhythm disorders were the main indications in our cohort compared with sepsis, acute respiratory failure, and malignancy in other studies.[11,13,15,16] The characteristics and outcomes of transplant recipients who are admitted due to sepsis, acute respiratory failure, or other indications months or years after transplant surgery are inherently different from the immediate postsurgery patients. Therefore, our results cannot be directly compared with previously published reports. Our cohort represents the true risk associated with kidney transplant surgery in patients with ESRD.

The selection of candidates for kidney transplant has evolved during the past 2 decades, parallel to the changes in population demographics.[6,7,18] Our analysis shows that increased recipient BMI is associated with increased risk for direct ICU admission. As the deceased donor wait times continue to grow, so does the risk for recipients to develop cardiac comorbid conditions.[19] The latter in turn appeared to be directly related to increased risk for interval ICU admission after transplant surgery and was the major cause of mortality in our cohort.

In the current cohort, most early ICU admissions were directly from the OR or postanesthesia care unit. Recipients with higher BMI and those who had combined surgery were more likely to require direct ICU admission. Although surgeon input is an important factor in the decision-making process for these patients and may account for the relatively high rates, objective parameters such as relative hypotension and cardiac arrhythmias were the most common reasons for ICU admission. These patients had higher acuity of care reflected by higher SOFA scores and the requirement of IMV. However, these patients were also more likely to recover quickly. This trend might be due to the transfer of intubated patients from the OR and elective extubation in the ICU. In contrast, recipients who required interval ICU admission had a higher incidence of cardiac ischemia (non—ST-elevation myocardial infarction or myocardial infarction) and required mechanical ventilation for a longer duration. Most of the deaths occurred in this group. Although the overall mortality rate was lower than that reported previously,[8,12-15] the kidney recipient population remains a high-risk group for cardiovascular complications in the immediate posttransplant period.

The incidence of delayed graft function in our ICU cohort was 11.3% (30 of 266). Most of these patients were receiving dialysis before transplant and received the allograft from a deceased donor. Other studies reported the incidence of renal replacement therapy during th ICU stay from 35% to 63%.[13,15] The higher rate in these studies may be due to ICU admissions months after transplant that are mainly due to sepsis or acute respiratory failure. Our ICU dialysis rate is close to that reported by Marques et al[14] for their ICU immediate postoperative recipients. Higher preemptive living donor transplant rates at our center may be another important factor for less delayed graft function in the ICU.

This study has several limitations inherent to retrospective analyses and represents the outcomes of a single center. These findings may lack generalizability due to the unique study cohort comprising mainly living donor recipients and different institutional practices. However, this is the first study that has studied the risk associated with kidney transplant surgery itself in adult solitary kidney transplant recipients. To our knowledge, this is also the first attempt to study early ICU admissions after kidney transplant with granular data. The protocolized standard patient selection, immunosuppression, and ICU management provide a homogenous cohort with reduced bias. We have not studied the causes of allograft loss and mortality after discharge from the transplant-related hospitalization because this was not the objective of the study.

CONCLUSION

Our results demonstrate that in contemporary practice, kidney transplant recipients generally do not require high-acuity care after transplant surgery. Among those who require high-acuity care, patients with higher BMI are more likely to be admitted immediately after surgery, particularly when transplant surgery is combined with another procedure. Overall, hypotension and cardiac rhythm disorders are the most common indications for high-acuity care. Mortality is higher for patients who deteriorate on the regular surgical ward. The ICU mortality rate is less than 2% (5 of 266). However, these patients have a greater risk for graft loss within the first year and worse long-term survival.

Abbreviations and Acronyms: **ADPKD** = autosomal dominant polycystic kidney disease; **APACHE** = Acute Physiology and Chronic Health Evaluation; **ASA** = American Society of Anesthesiologists; **BMI** = body mass index; **ESRD** = end-stage renal disease; **ICU** = intensive care unit; **IQR** = interquartile range; **IMV** = invasive mechanical ventilation; **LOS** = length of stay; **NIMV** = noninvasive mechanical ventilation; **OR** = operating room; **PACU** = postanesthesia care unit; **SOFA** = Sequential Organ Failure Assessment; **Tx** = transplant; **WIT** = warm ischemia time

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