Hospitalization Causes in Kidney Transplant Recipients: A Cross-Sectional Study from Isfahan, Iran

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Introduction. Kidney transplantation significantly improves survival and quality of life in End-Stage Kidney Disease (ESKD). However, kidney transplant recipients (KTRs) are prone to complications leading to hospitalization. Data on hospitalization etiologies among Iranian KTRs remain limited.

Methods. This cross-sectional study included all KTRs hospitalized in the two centers with kidney transplant department in Isfahan between March 2023 and March 2024. Demographic, clinical, and laboratory data were collected from medical records. Etiologies of admission were classified, and descriptive and analytical statistics were calculated using SPSS, version 22.

Results. A total of 408 patients (60.7% male, mean age 45.6 ± 15.2 years) were included. The most frequent comorbidities were diabetes mellitus (DM) (27.2%) and hypertension (HTN) (22.2%). Most patients (42.5%) had undergone transplantation for more than 10 years. The leading causes of admission were constitutional symptoms including fever, myalgia, and fatigue in 165 (40.4%), azotemia in 55 (13.5%), dysuria in 23 (5.6%) and limb edema in 21 (5.1%) patients. The main final diagnosis in hospitalized KTRs were infections (42.5%) and acute kidney injury (AKI)/AKI superimposed on chronic kidney disease (CKD) (15.6%). Laboratory findings revealed a mean serum creatinine of 2.58 ± 2.16 mg/dL, with 50% above 1.7 mg/dL. Anemia (Hb < 10 g/dL) was present in 43.7% of cases. Urinalysis showed hematuria in 50.3% and pyuria in 64.2% of patients. Graft failure requiring dialysis occurred in 9 (2.2%) patients. Eighteen (4.4%) patients died during hospitalization period.

Conclusion. Infections and acute kidney injury (AKI) were the predominant causes of hospitalization among Isfahan KTR population.

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INTRODUCTION

Kidney transplantation is considered as the preferred treatment of choice for ESKD, offering patients improved quality of life and extended survival compared to long-term dialysis. However, despite these significant benefits, kidney transplant recipients (KTRs) remain susceptible to various complications that often necessitate hospitalization.[1] Hospitalization among KTRs carries significant clinical and economic implications.

A transplanted kidney, while life-saving, is inherently predisposed to a unique set of insults beyond those affecting native kidneys, including acute kidney rejection, recurrence of the primary renal disease, medication toxicity (e.g., calcineurin inhibitors), and surgical complications.[2,3]

Furthermore, by virtue of having a solitary kidney, KTRs are more susceptible to AKI, including its more severe forms such as AKI requiring dialysis (AKI-D).[4] According to a multicenter observational cohort study that was published in 2025, rehospitalizations due to non-immunologic AKI following kidney transplantation were associated with worse long-term outcomes for both the allograft and the recipient.[5]

High readmission rates (81.1% within six months), primarily due to infection and graft rejection, are reported in a study on 53 patients in Pakistan.[6] Results of a study on 562 re-admissions of KTRs in Tehran, Iran, between 2000 and 2006 reported surgical complications, infection, and graft rejection as causes of early re-admission, and graft rejection and infection as causes of late readmission.[7] Other studies have identified older age, comorbidities, pre-transplant dialysis duration, calcineurin inhibitors (CNIs) nephrotoxicity, and graft rejection as risk factors for readmission.[7-9]

Understanding the epidemiology of hospitalizations in this vulnerable population is crucial for assessing the burden of disease, identifying modifiable risk factors, and ultimately improving patient outcomes. Despite this critical importance, comprehensive epidemiological studies focusing on hospitalization etiologies are scarce in Iran.

Hence, in this study we aimed to comprehensively evaluate specific etiologies of hospital admissions in KTRs.

MATERIALS AND METHODS

This cross-sectional study was conducted in Isfahan, Iran, based on the medical records of KTRs who were hospitalized between March 2023 and March 2024. Inclusion criteria were all kidney transplant recipients admitted to the two only centers with kidney transplant department in our Province (Al-Zahra (hospital1) and Khorshid (hospital2)) from March 2023 to March 2024 for any reason. Records with > 20% missing prespecified fields were excluded.

Patients' medical records were reviewed and demographic data including age, gender, past medical history, years since kidney transplant, and BMI, were recorded. Patient hospitalization etiology and laboratory findings, including urinalysis, complete blood count (CBC), serum creatinine (SCr), sodium (Na), potassium (K), and SARS-COV-19 Polymerase Chain Reaction (PCR) test results, were also recorded.

Data were analyzed using SPSS version 22 (IBM Corp., Armonk, NY, USA). Categorical variables were described using frequency tables, while quantitative variables were presented as mean and standard deviation (SD). Furthermore, t-test was applied to compare means between groups, and the Fisher's exact test was used to compare qualitative variables between groups. *P*-value < .05 considered as significant.

This study was approved by the Ethics Committee of the Isfahan University of Medical Sciences (IR.MUI.MED.REC.1402.373).

RESULTS

In this study, 408 patients transplanted between 1992 and 2022 were included, with 245 (60%) of them being male and 163 (40%) female. The mean age (± SD) of the patients was 45.6 (± 15.22) with a range of 16-87 years old. BMI was recoded in medical files of Al-Zahra hospital. Most of the patients had a functional graft for more than 10 years (42.5%). Patients had received a variety of immunosuppressive medications, the most common regimen was Tacrolimus, Mycophenolic acid, and prednisolone in 113 (27.7%), followed by tacrolimus and prednisolone in 57 (14%) patients. Overall, the most common comorbidity was DM in 103 (27.2%) and HTN in 84 (22.2%) of the patients (Table 1).

Out of 114 patients who took the SARS-COV-19 Polymerase Chain Reaction (PCR) test, 16 (4%) patients had a positive result. The most common presenting indications leading to hospitalization were constitutional symptoms including fever, myalgia, and fatigue in 165 (40.4%), azotemia in 55 (13.5%), dysuria in 23 (5.6%) and limb edema in 21 (5.1%) patients.

The most common final diagnosis in hospitalized KTRs were infections 166 (42.5%) (including wound infection, COVID-19, diabetic foot infection, parvovirus B19 infection, gastroenteritis, and pyelonephritis), and AKI 61 (15.6%) (Figure 1). The final diagnosis stratified by the two hospitals is presented in Table 2. Graft failure requiring dialysis initiation or adjustment occurred in 9 (2.2%) patients. Eighteen (4.4%) patients died during hospitalization.

Patients' laboratory findings at the time of

Table 1. Basic Characteristics of the Patients

	Hospital 1 n = 258 (63.5%)	Hospital 2 n = 149 (36.5%)	Total n = 408 (100%)
Age (year) Mean ± SD	44.56 (15.48)	47.57 (14.49)	45.64 (15.18)
Gender			
Female	102 (39.5%)	56 (38.9%)	158 (39.3%)
Male	156 (60.5%)	88 (61.1%)	244 (60.7%)
BMI (Kg/m^2) Mean ± SD	24.10 (4.35)	N/A	24.10 (4.35)
Past Medical History			
Diabetes Mellitus	63 (27.3)	40 (27.0)	103 (27.2)
Hypertension	65 (28.1)	19 (12.8)	84 (22.2)
Glomerulonephritis	13 (5.6)	2 (1.4)	15 (4.0)
ADPKD	2 (0.9)	7 (4.7)	9 (2.4)
Ischemic Heart Disease	4 (1.7)	2 (1.4)	6 (1.6)
Malignancy	5 (2.2)	0	5 (1.3)
Alport Syndrome	4 (1.7)	1 (0.7)	5 (1.3)
Graft Rejection	4 (1.7)	0	4 (1.1)
Heart failure	4 (1.7)	0	4 (1.1)
Nephrolithiasis	0	1 (0.7)	1 (0.3)
Other	24 (10.4)	16 (10.8)	40 (10.6)
None	43 (18.6)	60 (40.5)	103 (27.2)
Years since kidney transplant			
≤ 5 years	67 (29.9)	59 (45.0)	126 (35.5)
6-10 years	59 (26.3)	19 (14.5)	78 (22.0)
≥ 11 years	98 (43.8)	53 (40.5)	151 (42.5)
Transplant type			
Deceased	8 (18.6)	2 (15.4)	10 (17.9)
Living	35 (81.4)	11 (84.6)	46 (82.1)
Immunosuppressive therapy			
Monotherapy	46 (19.2)	18 (14.8)	64 (17.7)
Double Therapy	67 (27.9)	33 (27.0)	100 (27.6)
Triple Therapy	127 (52.9)	71 (58.2)	198 (54.7)

Data were reported as number (percent) unless otherwise stated.

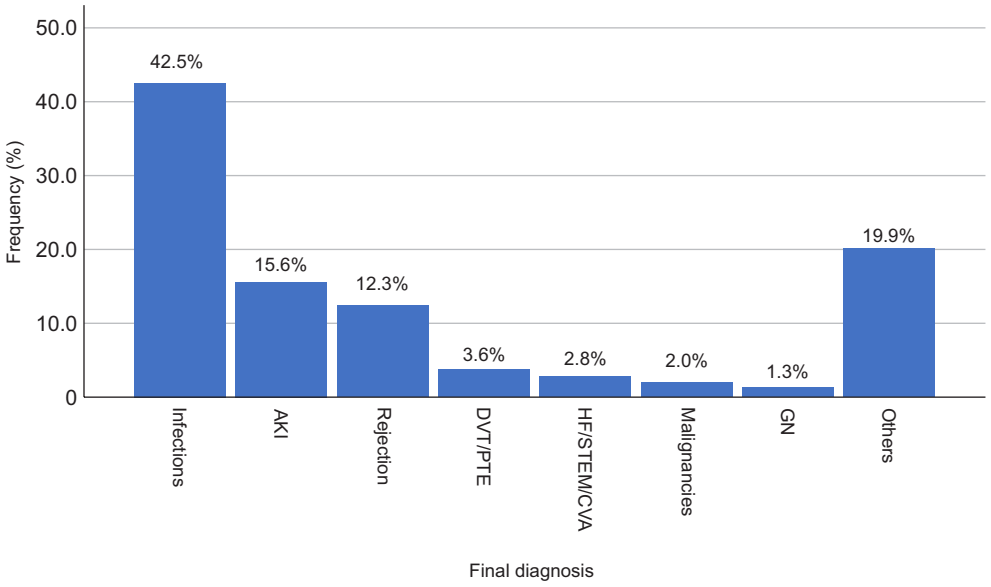

Figure 1. Frequency of final diagnosis in hospitalized KTRs.

Table 2. Frequency of final diagnosis in hospitalized KTRs

	Hospital 1 (n = 258)	Hospital 2 (n = 149)	Total (n = 408)
Infections	103 (39.9)	63 (47.4)	166 (42.5)
AKI/AKI on CKD	37 (14.3)	24 (18.0)	61 (15.6)
Graft rejection	42 (16.3)	6 (4.5)	48 (12.3)
Glomerulonephritis	13 (5.6)	2 (1.4)	15 (4.0)
DVT/PTE	13 (5.0)	1 (0.8)	14 (3.6)
Cardiovascular complications	9 (3.5)	2 (1.5)	11 (2.8)
Malignancy	5 (2.2)	0	5 (1.3)
Others	41 (15.9)	37 (27.8)	78 (19.9)

Data were reported as number (percent)

Table 3. Laboratory findings of the patients

	Hospital 1 (n= 258)	Hospital 2 (n=149)	Total (n=408)
FBS (mg/dL)	116.91 (48.75)	165.65 (146.84)	129.22 (87.18)
BUN (mg/dL)	36.62 (25.80)	29.72 (17.64)	34.51 (23.80)
Cr (mg/dL)	2.75 (2.36)	2.25 (1.64)	2.58 (2.16)
Alb (gr/dL)	3.68 (0.61)	3.87 (0.53)	3.71 (0.60)
Ca (mg/dL)	8.74 (0.95)	8.52 (0.91)	8.70 (0.95)
Ph (mg/dL)	3.72 (1.34)	4.05 (1.89)	3.75 (1.40)
Na (mEq/L)	138.25 (4.98)	135.91 (4.26)	137.52 (4.88)
K (mEq/L)	4.56 (0.88)	4.15 (0.80)	4.43 (0.88)
pH	7.36 (0.08)	7.38 (0.08)	7.37 (0.08)
HCO_3 (mmol/L)	17.64 (6.52)	18.57 (5.37)	17.85 (6.27)
AST (U/L)	31.15 (99.35)	33.90 (36.55)	31.6 (92.04)
ALT (U/L)	26.64 (60.19)	33.20 (26.01)	27.69 (56.16)
WBC	7707.88 (4018.26)	6288.40 (4338.99)	7353.01 (4139.33)
Neutrophils (%)	74.87 (11.49)	68.04 (17.40)	74.35 (12.12)
Lymphocytes (%)	16.26 (9.46)	21.46 (14.57)	16.61 (9.93)
Hb (gr/dL)	10.43 (2.46)	10.59 (2.42)	10.47 (2.45)
ESR (mm/h)	52.13 (37.183)	46.83 (34.06)	50.99 (36.53)
CRP (mg/L)	40.19 (44.56)	39.94 (44.32)	40.14 (44.43)

Data were reported as mean (SD)

admission were also recorded (Table 3). Patients on average had a fasting blood sugar (FBS) of 129 (± 87) mg/dL. Fifty percent of the patients had a serum creatinine of more than 1.7mg/dL, with an average of (2.58 ± 2.16) mg/dL. When checking for Hemoglobin (Hb), 43.7% of patients had a Hb level of lower than 10 g/dL, with an average of (10.47 ± 2.45) and a range of 3.3-18.3.

Urinalysis findings of the patients are represented on Table 4. Among all, 188 patients had urinalysis and urine culture in their records.

There was no association between the type of immunosuppressive therapy (mono-, double-, or triple therapy) and the final diagnosis.

Compared with alive patients, deceased patients had significantly higher levels of blood urea nitrogen (BUN), neutrophil count, and C-reactive protein (CRP), and significantly lower levels of albumin, lymphocytes, and hemoglobin. (Table 5)

Table 4. Urinalysis findings of the patients

	Positive (%)	Negative (%)	Total
Hematuria	65 (34.5)	123 (65.4)	188
Pyuria	51 (27.2)	137 (72.8)	188
Proteinuria	130 (69.2)	58 (30.8)	188
Glucosuria	31 (17)	157 (83)	188

Data were reported as number (percent)

As shown in Table 6, infections (bacterial, viral, fungal, and etc.) were the most prevalent final diagnosis cause of hospitalization in all periods (early, intermediate, and late) after kidney transplantation. Despite the higher prevalence of infections within the first five years after kidney transplantation, the difference was not statistically

Table 5. Association between mortality and lab findings

	Alive n= 390 (95.6%)	Death n=18 (4.4%)	*P*
FBS (mg/dL)	129.51 (88.67)	125.27 (67.44)	.87
BUN (mg/dL)	33.32 (22.52)	55.58 (34.77)	.019
Cr (mg/dL)	2.55 (2.16)	3.16 (1.98)	.27
Alb (gr/dL)	3.75 (0.58)	3.07 (0.60)	.000
Ca (mg/dL)	8.74 (0.93)	8.1 (1.13)	.019
Ph (mg/dL)	3.72 (1.36)	4.13 (1.90)	.289
Na (mEq/L)	137.48 (4.66)	138.17 (8.04)	.57
K (mEq/L)	4.44 (0.87)	4.32 (1.03)	.60
pH	7.37 (0.08)	7.33 (0.10)	.11
HCO_3 (mmol/L)	17.8 (6.06)	18.66 (9.22)	.72
AST (U/L)	25.24 (20.0)	139.79 (378.09)	.27
ALT (U/L)	24.42 (30.15)	82.93 (201.69)	.29
WBC	7269.97 (3974.2)	8806.25 (6388.68)	.35
Neutrophils (%)	73.89 (12.12)	82.46 (9.09)	.006
Lymphocytes (%)	17.06 (9.96)	8.77 (5.25)	.000
Hb (gr/dL)	10.54 (2.44)	9.45 (2.32)	.077
ESR (mm/h)	49.91 (35.73)	68.93 (45.69)	.148
CRP (mg/L)	38.15 (43.35)	70.66 (50.96)	.006

Data were reported as mean (SD)

Table 6. Final diagnosis based on years since transplant

	Years since kidney transplant		
	≤ 5 years	6-10 years	≥ 11 years
Infections	57 (48.7)	25 (33.3)	59 (39.9)
Cardiovascular complications	3 (2.6)	2 (2.7)	4 (2.7)
AKI/AKI on CKD	13 (11.1)	12 (16.0)	30 (20.3)
Graft rejection	16 (13.7)	11 (14.7)	17 (11.5)
DVT/PTE	2 (1.7)	4 (5.3)	6 (4.1)
Malignancies	1 (0.9)	2 (2.7)	5 (3.4)
Glomerulonephritis	0	3 (4.0)	2 (1.4)
Others	25 (21.4)	16 (21.3)	25 (16.9)

Data were reported as number (percent)

significant compared with patients beyond five years of transplantation.

The most common final diagnosis in KTRs who died during hospitalization were infections (44.4%), cardiovascular complications (16.7%), and acute kidney injury (AKI) (11.1%). The distribution of final diagnoses differed significantly between deceased and surviving patients (Table 7).

Table 7. Association between mortality and final diagnosis

	Alive	Death	*P**
Infections	159 (42.5)	8 (44.4)	.086
Cardiovascular complications	8 (2.1)	3 (16.7)	
AKI/AKI on CKD	59 (15.8)	2 (11.1)	
Graft rejection	48 (12.8)	0	
DVT/PTE	14 (3.7)	0	
Malignancies	8 (2.1)	0	
Glomerulonephritis	5 (1.3)	0	
Others	73 (19.5)	5 (27.8)	

Data were reported as number (percent)
*Fisher's exact test showed a non-significant overall association between diagnosis category and mortality ($P = 0.015$). Individual pairwise comparisons were not performed due to the small number of deaths (n = 18) and sparse data.

DISCUSSION

This cross-sectional study was conducted by enrolling 408 kidney transplant recipients hospitalized in two tertiary centers in our Province (Al-Zahra hospital and Khorshid hospital) during 2023–2024. We found that infections were the most frequent cause of admission (42.5%), followed by AKI not caused by graft rejection (15.6%). DM and HTN were the most prevalent comorbidities. In addition, 27.9% of patients underwent SARS-COV-19 testing, with a 4% positivity rate. Laboratory

data analysis revealed a mean serum creatinine of 2.58 ± 2.16 mg/dL, with half of the patients had values > 1.7 mg/dL. Anemia was common, with 43.7% having hemoglobin levels below 10 g/dL. These findings highlight that infection and graft dysfunction were key drivers of hospitalization in kidney transplant recipients in Isfahan province, consistent with global trends.

Previous studies have demonstrated that infection and graft rejection are leading causes of hospitalization among KTRs, with varying prevalence depending on population, follow-up time, and immunosuppressive regimens. In the United States, Garg *et al.* reported that hospitalization for primary diagnosis of acute kidney injury (AKI) in KTRs increased from 13.7 to 24.7 per 1,000 between 2004 and 2014, while secondary diagnosis of AKI admissions rose from 37.4 to 108.0 per 1,000 in the same period.[10] Similarly, Newman *et al.* found that patients on the transplantation waitlist were frequently hospitalized due to complications such as infections, hypertension, and sepsis, and that hospitalization was associated with lower transplant probability and poorer post-transplant outcomes.[1,11] Other U.S. data indicate that post-transplant infections, particularly bacterial pneumonia, significantly increase both short- and long-term mortality, contributing to increased healthcare costs.[12] Jawdeh and Govil further emphasized the role of calcineurin inhibitor toxicity, recurrence of the primary disease, and surgical complications as major contributors to graft dysfunction and hospitalization,[2] a phenomenon supported by mechanistic and histological studies on calcineurin inhibitor nephrotoxicity.[13]

Regional studies from the Middle East and Iran corroborate our findings. Lankarani *et al.* reported that early re-hospitalizations were most often due to surgical complications (84%), infections (51%), and graft rejection (45%), while intermediate and late (≥6 months after kidney transplantation) readmissions were more commonly linked to graft rejection and infection.[7] Tavakkoli *et al.* identified older age, comorbidities, and longer pre-transplant dialysis duration as independent predictors of readmission.[8] A cross-sectional study in Isfahan Province represented that the mortality rate in patients with COVID-19 was about 13%.[14] Sepehri *et al.*, during the COVID-19 pandemic, reported AKI rates of 60% and mortality of 30% among infected transplant recipients.[13] Additionally, Naylor *et al.* showed that 20.7% of Canadian KTRs were readmitted within the first year of transplantation, with infection and cardiovascular events as the leading causes.[15] These data suggest that, while infection and graft rejection remain universal issues, the exact etiological distribution may be shaped by local epidemiology, healthcare access, and post-transplant monitoring protocols. In our study, the leading cause of admission was infection and the prevalence of infection was higher within first five years after kidney transplantation. The higher observed rate of infections in kidney transplant recipients during this period (≤5 years after transplant) may be related to the higher doses of immunosuppressive therapy.

International literature further underscores the variability in post-transplant hospitalization patterns. Palmisano *et al.* noted that AKI in the early post-transplant period is often due to ischemia-reperfusion injury, graft rejection, and nephrotoxic medications, whereas late AKI may stem from chronic allograft nephropathy and systemic illnesses.[4] Eikmans *et al.* highlighted the importance of developing non-invasive biomarkers for early detection of rejection, which could potentially reduce hospitalization rates.[5] Lynch *et al.* demonstrated that frequent hospital admissions after waitlist placement predicted higher resource utilization and worse graft survival.[3] Infection risk remains a dominant concern in the post-transplant period, with Fishman reporting that up to 70% of KTRs experience at least one significant infection in the first year, most commonly bacterial, followed by viral and fungal infections.[16] In Pakistan, Dashti *et al.* found that 81.1% of recipients were readmitted within six months, predominantly for infections and rejection episodes.[6] Collectively, these studies reinforce that despite advances in immunosuppression and perioperative care, hospitalization burden in KTRs remains substantial and multifactorial.

This study has several limitations. First, its retrospective design relies on the accuracy and availability of complete medical records, which may have resulted in underreporting of certain variables. Second, the study population was limited to two tertiary referral centers in Isfahan, potentially leading to referral bias, as more complex cases may be overrepresented. Third, we did not assess

long-term outcomes following hospitalization, such as patient and graft survival, which would provide a more comprehensive view of the clinical impact. Finally, microbiological data for infectious etiologies were not systematically available, limiting pathogen-specific analysis.

CONCLUSION

In conclusion, infections and AKI are the leading causes of hospitalization among KTR patients in Isfahan province, mirroring patterns seen globally. Our findings emphasize the need for targeted infection prevention strategies such as vaccination optimization and early UTI screening, optimized immunosuppressive regimens, and early detection of graft dysfunction to reduce hospitalization rates and improve patient outcomes. Future multicenter, prospective studies incorporating detailed microbiological and long-term follow-up data are warranted to refine risk stratification and intervention strategies.

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