

MEDICATION USE PROFILE IN RENAL TRANSPLANT PATIENTS - IMPACTS ON LENGTH OF STAY

Izabell Maria Martins Teixeira¹, Natasha Maria Lima Pinheiro², Bruna Ribeiro Duque³
Mac Dionys Rodrigues da Costa⁴, Alene Barros de Oliveira⁵, Jan Hesron Ferreira Emiliano⁶
Maria Liliane Luciano Pereira⁷, Tiago Lima Sampaio⁸

Highlights: (1) The profile of medication use was related to polypharmacy. (2) Comorbidities and age are also associated with the amount of medication per patient. (3) Drug interactions with immunosuppressants have an impact on length of stay.

PRE-PROOF

(as accepted)

This is a preliminary, unedited version of a manuscript that was accepted for publication in Revista Contexto & Saúde. As a service to our readers, we are making this initial version of the manuscript available, as accepted. The article will still be reviewed, formatted and approved by the authors before being published in its final form.

<http://dx.doi.org/10.21527/2176-7114.2026.51.16759>

¹ Federal University of Ceará - Postgraduate in Pharmaceutical Sciences. Fortaleza/CE, Brazil.

<https://orcid.org/0000-0001-9396-659X>

² Federal University of Ceará - Postgraduate in Pharmaceutical Sciences. Fortaleza/CE, Brazil.

<https://orcid.org/0009-0008-3254-0729>

³ Federal University of Ceará - Postgraduate in Pharmaceutical Sciences. Fortaleza/CE, Brazil.

<https://orcid.org/0000-0002-2886-6450>

⁴ Federal University of Ceará - Postgraduate in Pharmaceutical Sciences. Fortaleza/CE, Brazil.

<https://orcid.org/0000-0002-3809-0377>

⁵ Federal University of Ceará - Postgraduate in Pharmaceutical Sciences. Fortaleza/CE, Brazil.

<https://orcid.org/0000-0002-4767-2256>

⁶ Federal University of Ceará - Postgraduate in Pharmaceutical Sciences. Fortaleza/CE, Brazil.

<https://orcid.org/0009-0002-0666-5639>

⁷ Federal University of Ceará - Postgraduate in Pharmaceutical Sciences. Fortaleza/CE, Brazil.

<https://orcid.org/0000-0002-4289-9603>

⁸ Federal University of Ceará - Postgraduate in Pharmaceutical Sciences. Fortaleza/CE, Brazil.

<https://orcid.org/0000-0002-3962-6508>

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

How to cite:

Teixeira IMM, Pinheiro NML, Duque BR, da Costa MDR, de Oliveira AB, Emiliano JHF. et al. Medication use profile in renal transplant patients - impacts on length of stay. Rev. Contexto & Saúde. 2026;26(51):e16759

ABSTRACT

Aim: to evaluate the impact of the medication use profile on the occurrence of complications in kidney transplant patients at a university hospital in Brazil. **Methodology:** retrospective study using data from renal transplant patients' medical records (n = 182). Interactions between immunosuppressants and other prescribed drugs were analyzed. **Results:** 68.7% of the patients were male. The average age was 48.15 years. The most frequent comorbidities were hypertension (62.6%) and diabetes (33.5%). The average hospital stay was 21.68 days. 104 drugs were used, 9.71 per patient. As an initial immunosuppressive regimen, 45.1% were prescribed tacrolimus + mycophenolate, 54.4% tacrolimus + sirolimus, and 0.5% mycophenolate + sirolimus. The drugs prescribed with probable interaction with tacrolimus were omeprazole (88.46%), amlodipine (48.90%), and isoniazid (37.91%); with sirolimus, they were amlodipine (29.67%) and isoniazid (20.33%), and with mycophenolate, omeprazole (39.01%). Prescribing a greater number of drugs increased hospitalization time by up to 8.5 days, while the use of calcium channel blockers predicted a reduction of approximately 5 days. **Conclusion:** The profile of medication use showed that drug prescriptions can have an impact on hospital stay.

Keywords: Drug therapy; Kidney transplantation; Length of stay; Immunosuppressive agents; Drug interactions.

INTRODUCTION

Kidney transplantation is a therapeutic alternative for patients with chronic kidney disease (CKD), providing longer survival and improved quality of life indicators, as well as being associated with a reduction in long-term healthcare costs^{1,2}. In 2023, kidney

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

transplantation was the main category of transplants carried out in Brazil in absolute numbers, with a total of 6047 procedures, followed by 4262 of bone marrow and 2365 liver³.

In this context, the use of immunosuppressive drugs is essential to prevent organ or tissue rejection and, consequently, graft dysfunction^{4,5}. Immunosuppressive pharmacotherapy, that transplant patients are submitted aims to reduce the body's immune response, can be divided into two phases: induction of immunosuppression and maintenance^{5,6}. Immunosuppression induction is used before, during, or in the post-transplant period to increase effectiveness and reduce the risk of organ rejection. Maintenance phase involves the long-term use of a combination of immunosuppressants drugs to prevent the rejection of the transplanted organ⁶.

Transplant patients are more susceptible to opportunistic pathogens that can cause serious diseases and increase the risk of mortality⁵. Underlying diseases are common and can lead to a worsening of the prognosis of CKD post-transplant patients. In this context, diabetes mellitus (DM) and systemic arterial hypertension (SAH) stand out as the main risk factors for the occurrence of CKD^{7,8}. This situation can lead to the use of five or more drugs simultaneously by the same patient, classified as polypharmacy⁹, a practice that can increase the occurrence of drug interactions and other drug-related problems (DRPs) in transplant patients, resulting in the increasing risk of adverse effects and can reduce the efficacy and effectiveness of the treatment, leading to morbidity and mortality, complications, and length of hospital stay, as well as graft dysfunction and rejection, in addition to increasing the risk of opportunistic infections¹⁰.

The literature considers 11 days to be the average hospital stay for kidney transplant patients. A hospital stay of more than 12 days post-transplant is considered prolonged¹¹. Thus, polypharmacy can be a determining factor in prolonging a patient's hospital stay, given the complexity of their condition¹².

Considering the limited number of qualitative studies in this segment and based on the assumption that a whole therapeutic arsenal is necessary to avoid organ rejection and guarantee the individual's quality of life in post-transplant therapy, this study aims to assess the prevalence

MEDICATION USE PROFILE IN RENAL TRANSPLANT PATIENTS - IMPACTS ON LENGTH OF STAY

and factors associated with the use of medication by analyzing the clinical and sociodemographic characteristics of kidney transplant patients at a university hospital.

METHODOLOGY

This is a retrospective observational study carried out at the kidney transplant service of the Walter Cantídio University Hospital (HUWC), part of the Federal University of Ceara Hospital Complex (CH-UFC), located in the city of Fortaleza - CE. This service is made up of two outpatient clinics, both with multi-professional teams, divided according to care into a pre-renal transplant clinic and a post-renal transplant clinic.

This study was approved by the HUWC Research Ethics Committee under n°. 67093523.2.0000.5045. The target audience for the study was post-transplant kidney patients at HUWC, from March 2019 to May 2022, who were on maintenance immunosuppression.

The following variables were analyzed: sociodemographic data (gender, age, schooling, length of stay in days, and comorbidities), initial immunosuppressive therapy consisting of the following regimens: tacrolimus and mycophenolate sodium (FK + MS), tacrolimus and sirolimus (FK + SRL), or sirolimus and mycophenolate sodium (SRL + MS). In addition, data was collected on the drugs used at hospital discharge.

The drugs prescribed to the patients in the study were listed according to the Anatomical Therapeutic Chemical (ATC) classification - 2nd level: therapeutic subgroup¹³. All possible interactions between the immunosuppressants and the other drugs prescribed for each patient were analyzed and recorded in accordance to the Clinical Protocol and Therapeutic Guidelines for Immunosuppression in Renal Transplantation⁶ and the Donation and Transplantation Manual¹³. Patients who were using five or more medications simultaneously were considered to have polypharmacy therapy⁹.

The information collected was compiled and stored in a Microsoft Office Excel® spreadsheet and analyzed using IBM-SPSS® version 22 statistical software. Numerical data is represented as mean ± standard deviation (SD); categorical data is presented as absolute and

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

relative frequencies (n(%)). A heat map was used to investigate whether patients who used more medication had longer hospital stays. Comparisons between continuous variables from up to two groups were analyzed using Student's t-test. A linear regression was also carried out using sociodemographic and clinical data, assessing the following categorical variables: interval of medication uses and use of ATC C08 class medications (predictor variables), predict patients' length of stay. A scatter plot was also generated to assess the categorical variables that predict length of stay. For all analyses, $p < 0.05$ was used.

RESULTS

The medical records of 182 post-renal transplant patients were analyzed, 125 of whom were male (68.7%) and had a mean age of 48.15 ± 13.691 years. There was no difference in age ($p = 0.114$) between female patients (47.77 ± 12.795 years) and male patients (49.23 ± 13.996 years). 64.2% ($n = 117$) of the patients collected had a low level of education, ranging from those who could not read and write to those who had only completed primary school (Table 1).

The most prevalent comorbidities were SAH (62.6%, $n = 114$) and DM (33.5%, $n = 61$), followed by dyslipidemia (7.7%, $n = 14$) and thyroid disorders (2.7%, $n = 5$). It is interesting to note that apart from hypertension and diabetes, the other comorbidities were very uncommon in the study. It is worth noting that 23.1% ($n = 42$) of the patients had no comorbidity. According to the analysis of the medical records, the patients' length of stay ranged from 6 to 110 days, with an average of $21,68 \pm 16,34$ days (Table 1).

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

Table 1 - Sociodemographic characteristics and comorbidities of the patients (n = 182).

Sociodemographic data		n = 182	
Gender		N	%
	Female	57	31.3%
	Male	125	68.7%
Age		Mean ± Standard deviation	P
	Female	47.77 ± 12.795	0.114 ^a
	Male	49.23 ± 13.996	
	Total	48.15 ± 13.691	
Age group		N	%
	< 18 years	1	0.5%
	18 to 30 years	18	9.9%
	31 to 59 years	121	66.5%
	> 59 years	42	23.1%
Education level		N	%
	Not being able to read or write	15	8.2%
	Elementary school	8	4.4%
	Incomplete middle school	37	20.3%
	Complete middle school	57	31.3%
	Incomplete high school	4	2.2%
	Complete high school	57	31.3%
	Incomplete college	1	0.5%
	Complete college	3	1.6%
Comorbidities		N	%
	System Arterial Hypertension	114	62.6%
	Diabetes Mellitus	61	33.5%
	Dyslipidemias	14	7.7%
	Thyroid disorders	5	2.7%
	Systemic Lupus Erythematosus	4	2.2%

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

Gout	3	1.6%
Heart diseases	3	1.6%
Hepatitis	2	1.1%
Breast cancer	1	0.5%
Epilepsy	1	0.5%
Hemophilia	1	0.5%
HIV	1	0.5%
ADHD	1	0.5%
Glaucoma	1	0.5%
Cirrhosis	1	0.5%
Generalized anxiety disorder	1	0.5%
Cognitive deficit	1	0.5%
No comorbidity	42	23.1%
<hr/>		
Length of stay	N	%
<hr/>		
<10 days	44	24.2%
10-19 days	53	29.1%
20-29 days	46	25.3%
30-39 days	19	10.4%
>40 days	20	11%
Average time: mean \pm SD	21,68 \pm 16,34	

^aUnpaired T-test; HIV – Human Immunodeficiency Virus; ADHD – Attention Deficit Hyperactivity Disorder. Source: the authors.

A total of 104 different drugs were used by the analyzed patients. The 21 most used drugs are described in Table 2. The others had a frequency of use of less than 9%, such as hydralazine 8.79%, doxazosin 6.04%, ranitidine 4.95% and simvastatin 4.4%. All the patients used more than 1 drug, with the majority using between 5 and 10 (Table 2). The average number of drugs used by the patients was 9.71 ± 2.458 . 99.5% of the analyzed patients were under use of polypharmacy (at least 5 drugs used). On the other hand, it was observed that there was a greater relationship between hospitalization time in the range of 11 to 15 drugs (27.84 ± 20.562 days) (Table 2).

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

Regarding the initial immunosuppression regimen prescribed, 45.1% of patients (n = 82) used the FK + MS regimen, 54.4% (n = 99) used FK + SRL, and only 1 patient used MS + SRL (Table 2). In addition, the heat map showed that a greater number of patients had fewer days in the hospital when they used a lower number of drugs (Figure 1).

Table 2 - Clinical data and distribution of the drugs most used by patients.

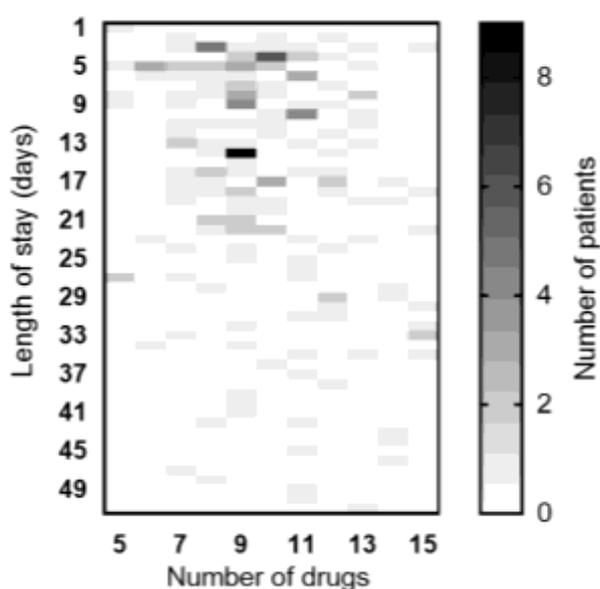
Clinical Data	%	
Initial therapy	n =182	
Tacrolimus + Sirolimus	99	54.4%
Tacrolimus + Mycophenolate sodium	82	45.1%
Mycophenolate sodium + Sirolimus	1	0.5%
Range of drugs used	n/mean of length of stay in days ± SD	
0 to 4 drugs	1 / 31 days	0.5%
5 to 10 drugs	116 / 18.11 ± 12.483 days	63.7%
11 to 15 drugs	63 / 27.84 ± 20.562 days	34.6%
over 15 drugs	2 / 29.5 ± 10.607days	1.1%
Mean number of drugs: mean ± SD	9.71 ± 2.458	
Drugs used	Number of patients in use	
Tacrolimus (FK)	181	99.45%
Nystatin	171	93.96%
Sulfamethoxazole + Trimethoprim	169	92.86%
Omeprazole	162	89.01%
Sirolimus (SRL)	102	56.04%
Amlodipine	90	49.45%
Erythropoietin	80	43.96%
Mycophenolate sodium (MS)	80	43.96%
Isoniazid	70	38.46%
Pyridoxine (vitamin B6)	68	37.36%
Clonidine	51	28.02%
Furosemide	45	24.73%
Prednisone	45	24.73%
NPH insulin	42	23.08%
Atenolol	37	20.33%

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

Sodium bicarbonate	36	19.78%
Regular insulin	30	16.48%
Carvedilol	24	13.19%
Calcium polystyrene sulfonate	21	11.54%
Acetylsalicylic acid	18	9.89%
Ferrous sulfate	17	9.34%

SD – Standard deviation. Source: the authors.

Figure 1 - Heat map illustrating the number of drugs and length of stay.



Source: the authors.

The drugs prescribed at discharge were classified according to ATC (Table 3). The classes most used by patients (apart from immunosuppressants) were topical antifungals (93.96%, $n = 171$), antibiotics (92.86%, $n = 169$), drugs for acid-related disorders (87.36%, $n = 159$) and selective calcium channel blockers (51.10%, $n = 93$).

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

Table 3 - Distribution of drugs used among patients according to Anatomical Therapeutic Chemical (ATC) classification (second level: therapeutic subgroup).

ATC	N	%
L04 – IMMUNOSUPPRESSANTS	182	100%
D01 – ANTIFUNGALS FOR DERMATOLOGICAL USE	171	93.96%
J01 – ANTIBACTERIALS FOR SYSTEMIC USE	169	92.86%
A02 – DRUGS FOR ACID RELATED DISORDERS	159	87.36%
C08 – CALCIUM CHANNEL BLOCKERS	93	51.10%
B03 – ANTIANEMIC PREPARATIONS	90	49.45%
C07 – BETA BLOCKING AGENTS	72	39.56%
J04 – ANTIMYCOBACTERIALS	70	38.46%
A11 – VITAMINS	68	37.36%
A12 – MINERAL SUPPLEMENTS	46	25.27%
C03 – DIURETICS	46	25.27%
A10A – INSULINS AND ANALOGUES	45	24.73%
H02 – CORTICOSTEROIDS FOR SYSTEMIC USE	45	24.73%
M01 – ANTIINFLAMMATORY AND ANTIRHEUMATIC PRODUCTS	18	9.89%
C02 – ANTIHYPERTENSIVES	16	8.79%
C10 – LIPID MODIFYING AGENTS	15	8.24%
C01 – CARDIAC THERAPY	13	7.14%
N03 – ANTIEPILEPTICS	11	6.04%
G04 – UROLOGICALS	10	5.49%
J05 – ANTIVIRALS FOR SYSTEMIC USE	8	4.40%
N05 – PSYCHOLEPTICS	8	4.40%
B01 – ANTITHROMBOTIC AGENTS	7	3.85%
A06 – DRUGS FOR CONSTIPATION	5	2.75%
H03 – THYROID THERAPY	5	2.75%
N06 – PSYCHOANALEPTICS	5	2.75%
N02 – ANALGETICS	4	2.20%
A10B – BLOOD GLUCOSE LOWERING DRUGS, EXCLUDING INSULINS	3	1.65%
J02 – ANTIMYCOTICS FOR SYSTEMIC USE	3	1.65%
M04 – ANTIGOUT PREPARATIONS	3	1.65%
P01 – ANTIPROTOZOALS	3	1.65%
R06 – ANTIHISTAMINES FOR SYSTEMIC USE	3	1.65%
A05 – BILE AND LIVER THERAPY	1	0.55%
A07 – ANTIDIARRHEALS, INTESTINAL ANTIINFLAMMATORY/ANTIINFECTIVE AGENTS	1	0.55%
C05 – VASOPROTECTIVES	1	0.55%
H05 – CALCIUM HOMEOSTASIS	1	0.55%
N04 – ANTI-PARKINSON DRUGS	1	0.55%
R05 – COUGH AND COLD PREPARATIONS	1	0.55%
V03 – ALL OTHER THERAPEUTIC PRODUCTS	1	0.55%

Source: the authors.

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

When studying the interactions that can occur between immunosuppressants and other drugs taken by the patient, it could be seen that amlodipine, omeprazole, isoniazid, and prednisone are the most frequent drugs. Thus, we list the patients who are susceptible to each of these interactions below.

The probable interactions between immunosuppressants and drugs in relation to tacrolimus include: omeprazole (88.46%, n = 161), amlodipine (48.90%, n = 89), isoniazid (37.91%, n = 69), prednisone (23.63%, n = 43), fluconazole (1.65%, n = 3), diltiazem (0.55%, n = 1), phenytoin (0.55%, n = 1), and carbamazepine (0.55%, n = 1). About sirolimus, probable interactions can occur with amlodipine (29.67%, n = 54), isoniazid (20.33%, n = 37), clonazepam (1.65%, n = 3), levamlodipine (1.1%, n = 2), nifedipine (0.55%, n = 1), gabapentin (0.55%, n = 1), and fluconazole (0.55%, n = 1).

Regarding MS, interaction can occur only with omeprazole (39.01%, n = 71). The linear regression model was used to see if there was a relationship between polypharmacy and length of stay. This analysis showed a significant model [$X^2(1, N = 181) = 14.072; P < 0.001; R^2 = 0.073$], which reveals that the greater the number of drugs used, the longer the hospital stay, increasing by up to around 8.5 days (Table 4).

Linear regression was also carried out to see if it is possible to predict the length of hospital stay based on the drugs used by the patient. It was found that only drugs belonging to the ATC C08 class (calcium channel blockers) showed a significant model [$X^2(1, N = 181) = 4.513; P = 0.035; R^2 = 0.024$], in which the use of these drugs predicts a reduction in the length of hospital stay of approximately 5 days (Table 4). Scatter plots were generated from linear regression statistics with the range of drug use (A) and the use of ATC C08 class drugs (B), both predicting length of stay (Figure 2).

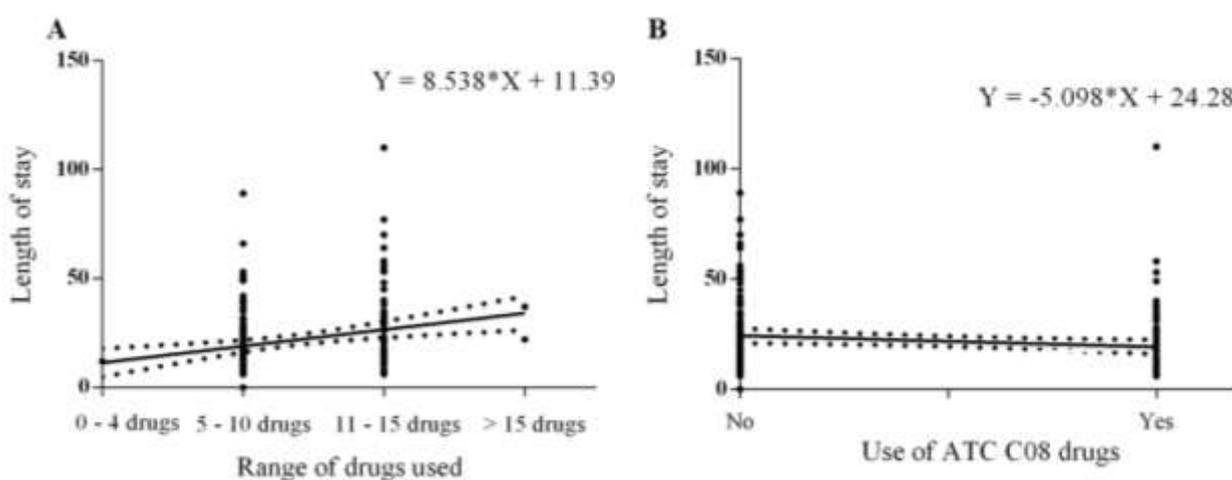
**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

Table 4 - Analysis of the use of medication in relation to the patient's length of stay and the influence of the use of calcium channel blockers on the patient's length of stay.

Predictor variable	B	Standard error	p	IC 95%
Range of drug use	8,538	2,276	<0,001	4,047 a 13,029
ATC C08	-5,098	2,4	0,035	-9,833 a -0,383

Source: the authors.

Figure 2 - Scatter plots of linear regression statistics with the range of drug use (A) and drugs belonging to the ATC C08 class (B) predicting length of stay.



Source: the authors.

DISCUSSION

The results of this study showed that the medication use profile of kidney transplant patients corresponds to polypharmacy, and a significant presence of medications that may interact with the initial immunosuppressive regimens, directly influencing the length of hospital stay. These results are important because data in the literature suggest that a longer hospital stay is associated with a greater graft dysfunction¹¹, and drug interaction can lead to the failure of immunosuppressive therapy, affecting renal function and reducing patients' quality of life¹⁰.

In this study, males were the most frequent, a finding corroborated by previous studies¹⁴. The prevalence of transplantation in males can be explained by the fact that end-stage CKD is more prevalent in males¹⁵. However, data from the National Health Survey in 2013 and 2019 showed a higher prevalence of females with CKD¹⁶.

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

Data from the literature suggests that the occurrence of CKD and the need for kidney transplantation are more prevalent in older patients. This can be explained by the possible physiological changes associated to the aging process^{17,18}. In addition, other factors can interfere with the success of kidney transplantation. According to previous studies, schooling has a direct influence on the success of renal replacement therapy, mainly due to satisfactory health literacy, which has an association with patient adherence to pharmacotherapy^{19,20}. However, this study identified a low level of education among many of the patients, which has a negative impact on treatment and transplant success.

According to the results presented in this study, the presence of polypharmacy was identified among the patients analyzed in the post-transplant period, with most of them using between 5 and 10 drugs concomitantly. The drugs most commonly used by these patients were tacrolimus, nystatin, sulfamethoxazole + trimethoprim, omeprazole, and sirolimus. Data from the literature shows that the pharmacotherapy of transplant patients is complex, having an impact on indicators associated with the success of immunosuppression, adherence to treatment, and the number of drugs administered²⁰. A previous study of kidney transplant patients showed that the average number of medications taken regularly was 9.4, ranging from 3 to 22. A total of 43% of patients were classified in the polypharmacy criteria²¹.

In this sense, polypharmacy may be associated with the high rate of comorbidities found in this study. The prevalence of comorbidities such as SAH, DM, and dyslipidemia found in this study is similar to the findings in the literature²¹, which may have started before the kidney transplant and increased after the use of immunosuppressants, given the potential of these drugs to worsen these comorbidities²². It should also be noted that patients with SAH and hyperlipidemia are more likely to develop diabetes after kidney transplantation, thus showing the importance of continuous monitoring of comorbidities in transplant patients²³.

The results of this study also demonstrated that polypharmacy has a direct impact on the length of hospital stay. A similar association was observed in relation to hospital readmission, in which intensive care unit patients who underwent multiple pharmacotherapy regimens had higher rates of hospital readmission, considering the complexity of the cases¹². In this context, greater exposure to polypharmacy is associated with increased risks of adverse

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

drug reactions, drug interactions, undesirable clinical outcomes, and higher healthcare service utilization ²⁴.

The maintenance immunosuppressive protocols most used in solid organ transplants are based on a combination of corticosteroids such as prednisone, calcineurin inhibitors (CNIs) such as FK, and antiproliferative agents such as mycophenolic acid ⁶. FK is one of the calcineurin inhibitor drugs that has been increasingly adopted due to its greater efficacy in reducing the incidence of acute rejection ²⁵.

SRL, an inhibitor of the target of rapamycin (mTORi), can be used in patients with chronic rejection or CNI toxicity ⁶. Therapeutic regimens containing SRL are associated with greater preservation of kidney function, improving graft and patient survival in the long term ²⁶. In cases where FK cannot be used, the SRL + MS combination can be used, but only for patients at low immunological risk due to adverse effects and a higher risk of graft rejection ⁶.

Using the linear regression model, it was found that the length of stay was predicted by the number of drugs used, with an increase of eight days in the length of stay. On the other hand, the use of calcium channel blockers (CCBs), ATC C08, predicted a decrease in hospitalization time of five days.

Studies have shown that the renal protective effect is related to the use of CCB class antihypertensives in kidney transplant recipients ^{27,28}. Among the possible mechanisms for this nephroprotection, in addition to the pressure control promoted by these antihypertensive drugs, are the vasodilation of the pre-glomerular and post-glomerular arterioles, resulting in beneficial effects on renal hemodynamics ²⁸. In addition, non-dihydropyridine CCBs can help to reduce proteinuria by altering glomerular capillary permeability ²⁹. This corroborates the findings of the present study, which reveals that the use of these drugs is a predictor of shorter hospital stays in post-kidney transplant patients due to their nephroprotective effect.

A longer hospital stay may be related to higher rates of acute rejection, since immunosuppression should be at its highest-level during induction therapy in the transoperative period, being reduced over time. As a result, this scenario increases the occurrence of opportunistic infections in the post-surgical period, highlighting the need to use antimicrobials

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

¹¹. Thus, the need for antimicrobials contributes to polypharmacy and, consequently, to an increase in the number of days spent in hospital. An extended length of hospitalization has been observed in patients who used more than five drugs, probably due to the presence of adverse events caused by the use of multiple drug regimens ³⁰.

In this sense, the study by Kossoku *et al.*, 2022, showed a positive correlation between polypharmacy and frailty in kidney transplant patients, classified according to the Kihon Checklist (KVL), corroborating the results of the present study ²¹. This relationship is far too complex, given that the number of medications is related to the number of comorbidities, which can lead to this situation of patient fragility ²⁷.

Therefore, although this study has some limitations, such as the need for prospective follow-up of patients and other factors that may influence the variables, the results support the importance of implementing strategies to ensure therapeutic success in preventing graft rejection among kidney transplant recipients. In this situation, our results can help justify the role of clinical pharmacists, especially in monitoring patients taking multiple medications, to improve their treatment and reduce issues related to medications.

CONCLUSION

This study showed that the profile of medication used by CKD patients was related to polypharmacy, with an average of 9.71 ± 2.458 medications per patient, which may be a consequence of factors such as comorbidities and age. In this sense, according to the results obtained by linear regression, we can observe an influence of the drugs, as well as their interactions with immunosuppressants, on the patient's length of stay, making them more susceptible to opportunistic infections, increasing the risk of morbidity and mortality and multiple drug regimens. In this sense, the use of drugs such as those in ATC C08 can help reduce hospitalization time and improve the patient's quality of life. Therefore, this study provides an overview of the profile of drugs used by kidney transplant patients, enabling a better understanding of the pharmacological regimens and interactions to which they are subjected.

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

ACKNOWLEDGMENT

The authors would like to thank CNPq (Conselho Nacional de Pesquisa e Desenvolvimento) and CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) for the financing granted to perform this work. Laboratório de Análises Clínicas e Toxicológicas—Prof. PhD. Eurico Litton Pinheiro de Freitas-LACT for their support during the experiments. We are also grateful to Analytic Center – UFC/CT – Infra/Pro and Capes Equipment.

REFERENCES

1. Galato D, Simões IG, Soares LS da S. Avaliação do Índice de Complexidade da Farmacoterapia em Pacientes de um Ambulatório de Transplante Renal. *Brazilian Journal of Transplantation*. 2022 Jun 23;25(2). DOI: https://doi.org/10.53855/bjt.v25i2.448_pt
2. Medeiros LKA de, Borba AK de OT, Sette GCS, Maciel C de G, Quirino AP de S, Pereira MPL, et al. FATORES ASSOCIADOS À ADESÃO A TERAPIA IMUNOSSUPRESSORA EM INDIVÍDUOS TRANSPLANTADOS RENAIIS. *Enfermagem em Foco*. 2022 Dec 23;13. DOI: <https://doi.org/10.21675/2357-707x.2022.v13.e-202244>
3. Associação Brasileira de Transplante de Órgãos. Dimensionamento dos Transplantes no Brasil e em cada estado (2016-2023) [Internet]. 2023. <https://doi.org/10.000>
4. Szumilas K, Wilk A, Wiśniewski P, Gimpel A, Dziedziejko V, Kipp M, et al. Current Status Regarding Immunosuppressive Treatment in Patients after Renal Transplantation. *Int J Mol Sci*. 2023 Jun 1; 24(12). DOI: <https://doi.org/10.3390/IJMS241210301>
5. Cardoso Martins BC, Fernandes da Costa IH, Chaves EF, Firmino PYM, Castelo Branco Camurca Fernandes PF, Fonteles MM de F. Medication Regimen Complexity Index After Kidney Transplant in Fortaleza, Brazil. *Journal of Young Pharmacists*. 2023 Apr 17;15(2):338–44. DOI: <https://doi.org/10.5530/jyp.2023.15.45>
6. Ministério da Saúde. PROTOCOLO CLÍNICO E DIRETRIZES TERAPÊUTICAS-IMUNOSSUPRESSÃO EM TRANSPLANTE RENAL. 2011.
7. Batista Marquito A, Sanders Pinheiro H, Maria da Silva Fernandes N, Baumgratz de Paula R. Avaliação da farmacoterapia na doença renal crônica: validação do instrumento PAIR para uso no Brasil. *Brazilian Journal of Nephrology* [Internet]. 2020; DOI: <https://doi.org/10.1590/2175-8239>

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

8. Crews DC, Bello AK, Saadi G. Editorial do Dia Mundial do Rim 2019 – impacto, acesso e disparidades na doença renal. *Brazilian Journal of Nephrology*. 2019 Mar 1;41(1):1–9. DOI: <https://doi.org/10.1590/2175-8239-JBN-2018-0224>
9. Oosting IJ, Colombijn JMT, Kaasenbrood L, Liabeuf S, Laville SM, Hooft L, et al. Polypharmacy in Patients with CKD: A Systematic Review and Meta-Analysis. *Kidney360*. 2024 Jun 1;5(6):841–50. DOI: <https://doi.org/10.34067/KID.0000000000000447>
10. Moradi O, Karimzadeh I, Davani-Davari D, Shafiekhani M, Sagheb MM, Raees-Jalali GA. Drug-Drug Interactions among Kidney Transplant Recipients in The Outpatient Setting. *Int J Organ Transplant Med*. 2020;
11. Moura Fraga J, Rodrigues da Silva A, Souza de Oliveira AR, Soares Barbosa A, Melo Girão C, Borges Studart RM. Fatores que influenciam o tempo de internação no transplante renal. *Saúde Coletiva (Barueri)*. 2021 Oct 13;11(68):7617–28. DOI: <https://doi.org/10.36489/saudecoletiva.2021v11i68p7617-7628>
12. Turnbull AJ, Donaghy E, Salisbury L, Ramsay P, Rattray J, Walsh T, et al. Polypharmacy and emergency readmission to hospital after critical illness: a population-level cohort study. *BJA: British Journal of Anaesthesia*. 2020 Feb 1;126(2):415. DOI: <https://doi.org/10.1016/J.BJA.2020.09.035>
13. Garcia CD, Garcia VD, Pereira JD. *Manual de Doação e Transplantes*. 2017.
14. Gomes RM, Barbosa WB, De Assis Acurcio F, Guerra Júnior AA. Dezesesseis anos de transplante renal: uma coorte aberta no sistema único de saúde no Brasil. *JORNAL DE ASSISTÊNCIA FARMACÊUTICA E FARMACOECONOMIA*. 2024 Feb 21;9(1). DOI: <https://doi.org/10.22563/2525-7323.2024.v9.n.1.p.5-17>
15. Katz-Greenberg G, Shah S. Sex and Gender Differences in Kidney Transplantation. Vol. 42, *Seminars in Nephrology*. W.B. Saunders; 2022. p. 219–29. DOI: <https://doi.org/10.1016/j.semnephrol.2022.04.011>
16. Gouvêa E de CDP, Szwarcwald CL, Damacena GN, de Moura L. Self-report of medical diagnosis of chronic kidney disease: prevalence and characteristics in the Brazilian adult population, National Health Survey 2013 and 2019. *Epidemiologia e Serviços de Saúde*. 2022;31(Spe1). DOI: <https://doi.org/10.1590/SS2237-9622202200017>
17. Charles C, Ferris AH. Chronic Kidney Disease. *Primary Care: Clinics in Office Practice*. 2020 Dec 1;47(4):585–95. DOI: <https://doi.org/10.1016/J.POP.2020.08.001>
18. Sistema de Dados Renais dos Estados Unidos - USRDS - NIDDK <https://www.niddk.nih.gov/about-niddk/strategic-plans-reports/usrds>
19. da Rocha KT, Figueiredo AE, da Rocha KT, Figueiredo AE. Letramento em Saúde: avaliação de pacientes em terapia renal substitutiva. *Enfermería Nefrológica*. 2019;22(4):388–97. DOI: <https://doi.org/10.4321/S2254-28842019000400005>

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

20. Melilli E, Díaz MI, Gomis-Pastor M, González E, Gutierrez-Dalmau A, Nuño EI, et al. Predictors of Treatment Adherence in Kidney Transplant Patients: A Systematic Review of the Literature. *J Clin Med*. 2025 Mar 1;14(5). DOI: <https://doi.org/10.3390/JCM14051622>
21. Kosoku A, Iwai T, Kabei K, Nishide S, Maeda K, Kumada N, et al. Hyperpolypharmacy and Frailty in Kidney Transplant Recipients. *Transplant Proc*. 2022 Mar 1;54(2):367–73. DOI: <https://doi.org/10.1016/j.transproceed.2021.11.026>
22. Rostaing L, Jouve T, Terrec F, Malvezzi P, Noble J. Adverse Drug Events after Kidney Transplantation. *Journal of Personalized Medicine* 2023, Vol 13, Page 1706 [Internet]. 2023 Dec 14;13(12):1706. DOI: <https://doi.org/10.3390/JPM13121706>
23. Cheng CY, Feng YT, Wang HY. Incidence and relative risk factors in posttransplant diabetes mellitus patients: a retrospective cohort study. *Korean Journal of Transplantation*. 2020 Dec 12;34(4):213. DOI: <https://doi.org/10.4285/KJT.20.0026>
24. Kardas P, Lichwierowicz A, Urbański F, Chudzyńska E, Czech M, Kardas G. Prevalence of Chronic Polypharmacy in Community-Dwelling Elderly People in Poland: Analysis of National Real-World Database Helps to Identify High Risk Group. *Front Pharmacol*. 2021 Nov 18;12. DOI: <https://doi.org/10.3389/FPHAR.2021.739740>
25. Passos MMB dos, Barbosa GS, Costa MR da. Análises das autorizações de procedimentos de alta complexidade de medicamentos para pacientes transplantados renais do Estado do Rio de Janeiro. *Research, Society and Development*. 2021 May 17;10(5):e3110514522. DOI: <https://doi.org/10.33448/rsd-v10i5.14522>
26. Tedesco-Silva H, del Carmen Rial M, Cruz Santiago J, Mazzali M, Pacheco-Silva A, Torres R. Optimizing the clinical utility of sirolimus-based immunosuppression for kidney transplantation. *Clin Transplant* [Internet]. 2019 Feb 1; 33(2). DOI: <https://doi.org/10.1111/CTR.13464>
27. Loutradis C, Sarafidis P, Marinaki S, Berry M, Borrows R, Sharif A, et al. Role of hypertension in kidney transplant recipients. Vol. 35, *Journal of Human Hypertension*. Springer Nature; 2021. p. 958–69. DOI: <https://doi.org/10.1038/s41371-021-00540-5>
28. Seeman T, Feber J. Should ACE inhibitors or calcium channel blockers be used for post-transplant hypertension? *Pediatric Nephrology*. 2021 Mar 1;36(3):539–49. DOI: <https://doi.org/10.1007/S00467-020-04485-8>
29. Moore KH, Clemmer JS. Questioning the renoprotective role of L-type calcium channel blockers in chronic kidney disease using physiological modeling. *Am J Physiol Renal Physiol*. 2021 Oct 1;321(4):F548–57. DOI: <https://doi.org/10.1152/AJPRENAL.00233.2021>
30. Fukuba N, Nishida M, Hayashi M, Furukawa N, Ishitobi H, Nagaoka M, et al. The Relationship Between Polypharmacy and Hospital-stay Duration: A Retrospective Study. *Cureus*. 2020 Mar 14;12(3). DOI: <https://doi.org/10.7759/CUREUS.7267>

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

Submitted: November 26, 2024

Accepted: October 9, 2025

Published: March 2, 2026

Author Contributions

Izabell Maria Martins Teixeira: Data curation, Formal analysis, Investigation, Methodology, Supervision, Visualization, Writing – original draft.

Natasha Maria Lima Pinheiro: Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft.

Bruna Ribeiro Duque: Investigation, Methodology.

Mac Dionys Rodrigues da Costa: Data curation, Formal analysis, Investigation, Methodology.

Alene Barros de Oliveira: Investigation, Methodology, Writing – original draft.

Jan Hesron Ferreira Emiliano: Investigation, Methodology.

Maria Liliane Luciano Pereira: Investigation, Methodology.

Tiago Lima Sampaio: Conceptualization, Funding acquisition, Project administration, Resources, Supervision, Validation, Writing – review & editing.

All authors approved the final version of the manuscript.

Conflict of Interest: There is no conflict of interest.

Funding: CNPq (Conselho Nacional de Pesquisa e Desenvolvimento)
CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior)

Corresponding Author: Tiago Lima Sampaio
Federal University of Ceará
Rua Pastor Samuel Munguba, 1210 – Rodolfo Teófilo.
Fortaleza/CE, Brazil.- zip code: 60430-372
tiagosampaio@ufc.br

**MEDICATION USE PROFILE IN RENAL TRANSPLANT
PATIENTS - IMPACTS ON LENGTH OF STAY**

Editor-in-Chief: Adriane Cristina Bernat Kolankiewicz. PhD

Editor: Christiane de Fátima Colet. PhD

This is an open access article distributed under the terms of the Creative Commons license.



PRE-PROOF