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[Jonathan Muamba Mutombo](#) , Joelle Claudeon , [Arriel Makembi Bunkete](#) ^{*} , Jimmy Batcho , Gerard Dalvius , Jean-Robert Makulo , [Christian Kisoka Lusunsi](#) , Yannick Nlandu Mayamba , [Ernest Sumaili Kiswaya](#) , Nazaire Nseka Mangani , Befu Notokadokaza

Posted Date: 16 October 2025

doi: 10.20944/preprints202510.1274.v1

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Article

Kidney Transplants Before and During the COVID-19 Pandemic at the University Hospital of Guadeloupe

Jonathan Muamba Mutombo ^{1,3}, Joelle Claudeon ¹, Arriel Makembi Bunkete ^{2,3,*}, Jimmy Batcho ¹, Gerard Dalvius ¹, Jean-Robert Makulo ³, Christian Kisoka Lusunsi ³, Yannick Nlandu Mayamba ³, Ernest Sumaili Kiswaya ³, Nazaire Nseka Mangani ³ and Befu Notokadoukaza ¹

¹ Department of Nephrology, Dialysis and Transplantation, University Hospital Center of Guadeloupe, Guadeloupe, France

² Department of Nephrology and Dialysis, University Clinics of Guyane, Saint-Laurent-du-Maroni Site, French Guiana, France

³ Department of Nephrology, Internal Medicine Division, University Clinics of Kinshasa, Kinshasa University, Kinshasa, Democratic Republic of Congo

* Correspondence: docteur.makarriel2017@gmail.com

Abstract

Kidney transplantation activity at the University Hospital of Guadeloupe was briefly interrupted at the onset of the COVID-19 pandemic. This study assessed patient and graft survival in 335 recipients transplanted between 2013 and 2023, comparing those transplanted before 2020 and after the resumption of activity. Most patients (70%) received transplants before 2020, with 30% afterward. ABO compatibility was observed in 98.2% of grafts from brain-dead donors. Peak transplant activity occurred in 2018, followed by a decline until 2021 and recovery from 2022. After 2020, recipients were more likely to be elderly (≥ 70 years), immunized, obese, have heterozygous sickle cell disease, or polycystic kidney disease ($p < 0.05$). Mean cold ischemia time decreased ($p = 0.009$), while warm ischemia time increased ($p < 0.001$). Graft survival remained stable, with 97.5% at 6 months and 89.8% at 4 years for transplants before 2020, versus 100% and 96.9%, respectively, after 2020 ($p = 0.160$). Patient survival did not differ between periods ($p = 0.199$). Independent factors associated with mortality included recipient age ≥ 60 years, diabetes, graft failure, transplantation before 2020, cold ischemia time ≥ 1200 minutes, and graft pyelonephritis. Despite an increased proportion of transplants with expanded criteria after 2020, graft and patient survival were not adversely affected.

Keywords: kidney transplant; survival; death; risk factors; Guadeloupe

1. Introduction

Chronic kidney disease (CKD) has emerged as a major global public health issue. According to the World Health Organization, nearly 850 million people are currently affected by CKD [1]. Furthermore, CKD was ranked as the 27th leading cause of death worldwide in 1990, increasing to the 11th by 2016 [2]; projections suggest it could become the 5th leading cause of death by 2040 [3]. In Europe, approximately 100 million individuals are estimated to be living with CKD [4]. In France, around 6 million people are affected, with over 90,000 receiving treatment for end-stage renal disease (ESRD) [5]. The incidence rate of treated ESRD stands at 169 per million population, with rates 2.2 times higher in the overseas departments compared to mainland France [6].

The rising global prevalence of diabetes, obesity, and hypertension over recent decades has contributed significantly to the surge in CKD reported in numerous epidemiological studies. This increase has led to a higher number of patients requiring dialysis and a growing demand for kidney transplantation (KT) worldwide [7–9].

In Guadeloupe, KT has been performed since June 2004 [10], with steady expansion until the end of 2019. However, the onset of the COVID-19 pandemic in 2020 disrupted healthcare systems worldwide [11]. In France, a 25% decrease in organ transplants was observed compared to 2019, which was largely due to reduced organ procurement and the saturation of intensive care units [12]. Guadeloupe was no exception: the partial suspension of transplant activities significantly impacted the care pathways of patients with kidney failure, exposing them to increased morbidity and mortality.

The last decade also coincides with an expansion of access criteria for kidney transplantation. Indeed, in recent years, studies conducted in the West and North America have reported a greater proportion of transplants with expanded criteria, or even ABO-incompatible transplants [13,14]. This paradigm shift responds to the need to address the graft shortage and the aging of the population. To date, in Guadeloupe, no study has compared the profile of transplant recipients and their survival according to these two periods. The cessation of transplant activity and its resumption at the University Hospital of Guadeloupe provided the opportunity to conduct this work. The objective of this study was to characterize the clinical profiles and survival outcomes of KT recipients at the University Hospital of Guadeloupe, comparing the periods before and after the onset of the COVID-19 pandemic.

2. Materials and Methods

2.1. Nature, Scope, and Study Period

The present study is a historical cohort of KT patients at the University Hospital of Guadeloupe, spanning from 2013 to 2023.

2.2. Patient Selection

We collected data from CRISTAL software, hospital software Easily, which is dedicated to the follow-up of KT patients. Patients who underwent KT outside Guadeloupe and those who were also transplanted with another organ were excluded from the study.

2.3. Parameters of Interest

Renal transplant donors were screened for sex, age, circumstances of graft retrieval (living-related donor (LRD), deceased brain-dead donor (DBD), or deceased cardiac arrest donor (DCAD), blood group, and human leukocyte antigen (HLA) group.

Pre- and intra-operative information included the date of KT, graft harvesting technique, type of preservation bath, cold ischemia time (CIT), warm ischemia time (WIT), ABO Rhesus compatibility, and the actual crossmatch between donor serum and graft antigens.

In the recipient, we assessed the sex, age, background CKD, comorbidities, immunizing events prior to transplantation (transfusion, pregnancy), preformed antibodies (anti-HLA class I and anti-HLA class II), donor-specific antibodies (DSAs) at M3 and M12, induction of immunosuppressive treatment, maintenance immunosuppressive treatment, intra-or postoperative complications, graft biopsy results, graft failure and time of onset, return to hemodialysis (HD), death and date of onset, and the immediate cause of death reported in the file.

2.4. Operational Definitions and Concepts

Deceased brain-dead donor (DBD): irreversible loss of encephalic functions, in particular, those of the brainstem [10];

Deceased cardiac arrest donor (DCAD): absence of spontaneous cardiac recovery beyond a minimum of 30 min of specialized resuscitation [10];

Living-related donor (LRD): any responsible adult, including family members or any person who can provide proof of at least 2 years' cohabitation with the recipient or of a close and stable

affective relationship for at least 2 years with the recipient [10];Compatible KT: transplantation carried out with ABO [10];

CIT: corresponds to the time the graft is stored between removal and transplantation [10];

WIT: corresponds to the time elapsed between removal of the kidney from cold storage and reperfusion with warm blood (venous or arterial), including the surgical anastomosis time [10];

Delayed recovery of graft function: need for dialysis during the first week after transplantation [10];

Renal graft failure (RGF): defined by a glomerular filtration rate <15 ml/min or return of the transplant patient to dialysis [10];

CIT was deemed high if it was ≥1200 min;

WIT was deemed high if it was ≥60 min;

Non-immunized patient: absence of anti-HLA Ac detection [10];

Immunized patient: anti-HLA Ac detection (MFI score 4) [10]

Crossmatch negative: absence of cytotoxic antibodies directed against donor antigens

Crossmatch positive: denotes the presence of graft-directed Ac [10].

2.5. Ethical Considerations

The research protocol had been approved by the ethics committee of the CHU de Guadeloupe. The study was conducted in strict confidentiality. Patients were not exposed to any particular risk or additional care during the study.

2.6. Statistics

Data were entered in Excel, and statistical analyses were performed using SPSS 21 software. Patients were classified into two groups: those transplanted between 2013 and 2019 and those transplanted between 2020 and 2023. Group comparisons were made using the Pearson Chi-square test, Fisher’s exact test, or the student t-test, as appropriate. The survival of grafts and grafted patients was studied using the Kaplan–Meier method, and log-rank tests were used to compare the groups. Independent factors associated with graft failure and death were investigated using a stepwise, top-down logistic regression analysis. The odds ratio (OR) with a 95% confidence interval (CI) was used to assess risk. The threshold of statistical significance was $p < 0.05$.

3. Results

During the study period (2013–2023), 335 kidney transplants were performed at the University Hospital of Guadeloupe. Peak activity was observed in 2018, with 55 patients undergoing transplantation, representing 16.4% of the total. Between 2018 and 2021, the number of procedures fell steadily before rising again from 2022 onwards (Figure 1).

3.1. Kidney Transplant Recipients

At the time of transplantation, patients had an average age of 52.5 ± 11.9 years (range: 22–81 years). Men outnumbered women (63.9% vs. 36.1%). Blood group O was the majority (49.9%) followed by groups A (31.9%) and B (16.1%). Other general patient characteristics according to the time of transplantation are shown in Table 1. The proportion of women (32.6% vs. 44.4%), recipients aged ≥70 years (2.1% vs. 8.1%), and patients that were obese (14.4% vs. 25.3%), heterozygous sickle cell (0.8% vs. 6.1%), and polycystic (6.4% vs. 14.1%) had increased significantly from 2020 onwards.

During the COVID-19 pandemic, all transplant patients received the COVID-19 vaccine; this was also the case for all kidney transplant candidates from 2021.

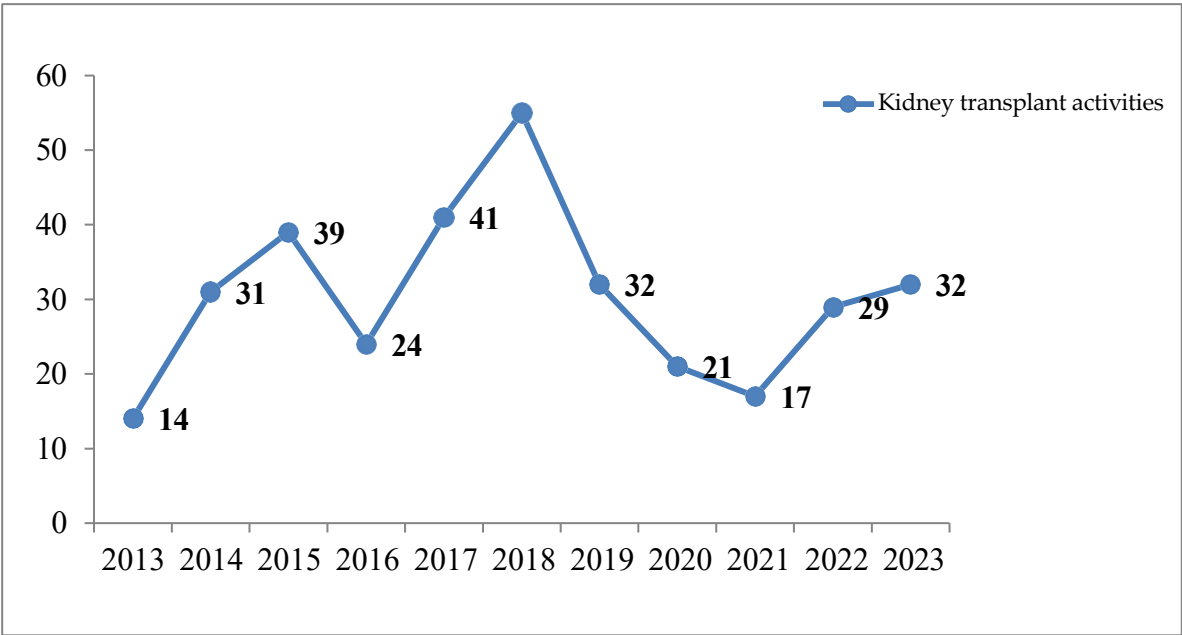


Figure 1. Evolution of the number of kidney transplant patients between 2013 and 2023. This figure shows the annual number of kidney transplants performed at the University Hospital of Guadeloupe during this period. A total of 335 transplants were carried out. Peak activity occurred in 2018, with 55 transplants (16.4% of the total). The number of procedures declined steadily between 2018 and 2021 before rising again from 2022 onwards.

Table 1. Clinical profile of kidney transplant recipients according to period.

Variables	All n=335	2013-2019 n=236	2020-2023 n=99	P
Age, years	52.5 ±11.9	52.3±11.6	53.2±12.7	0.553
Age ≥ 70 years	13 (3.9)	5 (2.1)	8 (8.1)	0.024
Gender				0.040
Men	214 (63.9)	159 (67.4)	55 (55.6)	
Women	121(36.1)	77(32.6)	44 (44.4)	
Blood types				0.381
O	167 (49.9)	115(48.7)	52(52.5)	
A	107 (31.9)	74(31.4)	33(33.3)	
B	54 (16.1)	43(18.1)	11(11.1)	
AB	7(2.1)	4(1.7)	3(3.0)	
HBP	327 (97.6)	232 (98.3)	95 (96.0)	0.242
Diabetes mellitus	85 (25.4)	63 (26.7)	22 (22.2)	0.391
Obesity	59 (17.6)	34 (14.4)	25 (25.3)	0.017
Heterozygous sickle cell disease	8 (2.4)	2 (0.8)	6 (6.1)	0.010
SLE	13 (3,9)	9 (3,8)	4 (4,0)	1.000
ADPKD	29 (8,7)	15 (6,4)	14 (14,1)	0.021
Ab HLA I positive	145 (43,3)	92 (39,0)	53 (53,5)	0.014
Ab HLA II positive	105 (31,3)	61(25,8)	44 (44,4)	<0.001
Positive historical DSA	88 (26,3)	57 (24,2)	31(31,3)	0.174
Pre-transplant transfusion	114 (34,0)	69 (29,2)	45 (45,5)	0.004

Results are expressed as mean ± standard deviation or frequency (%). Abbreviations: HBP: high blood pressure; SLE: systemic lupus erythematosus; ADPKD: autosomal dominant polycystic kidney disease. Ab HLA: antibodies against human leukocyte antigens; DSA: Donor-specific antibodies.

3.2. Kidney Transplant Donors

The average age of kidney transplant donors was 51.5 ± 16.1 years (range: 13–87 years). The majority were male (78.5%), and almost all were Deceased brain-dead donor (DBD; 98.2%). (Table 2) shows that the average age of the donors was higher during the period from 2020 to 2023 (53.5 ± 14.4 years vs. 50.6 ± 16.7 years, p=0.007). The proportion of female donors increased between 2020 and 2023 (14.8% to 37.3%). Furthermore, the proportion of O donors increased insignificantly between 2020 and 2023 (48.7% vs. 52.5%, p=0.236). There were no group AB donors.

Table 2. Clinical profile of donors according to study period.

Variables	All n=335	2013-2019 n=236	2020-2023 n=99	P
Average age, years	51.5 ±16,1	50.6±16,7	53.5±14.4	0.007
Gender				0.001
Men	263(78.5)	201 (85.2)	62(62.6)	
Women	72(21.5)	35 (14,8)	37(37.3)	
Type of donor				0.109
DBD	329(98.2)	230(97.5)	99(100.0)	
LRD	6(1.8)	6(2.5)	0(0.0)	
Blood types				0.236
O	163(48.7)	114(48.3)	49(49.5)	
A	100(29.9)	65(27.5)	35(35.4)	
B	56(16.7)	45(19.1)	11(11,1)	
AB	16(4.8)	12(5.1)	4 (4.0)	

Results are expressed as mean ± standard deviation or frequency (%). Abbreviations: DBD: Deceased Brain-dead donors; LRD: Living related donors.

3.3. Modalities of Renal Transplantation

The average hospital stay was 21.6 ± 8.8 days (range: 1–63 days). Between 2013 and 2019, the average was 21.1 ± 8.9 days, compared to 22.8 ± 8.5 days between 2020 and 2023 (p = 0.113). All transplanted patients received a kidney transplant with a compatible donor. All virtual and real crossmatch tests were negative. In 95.2% of cases, grafts were harvested from deceased donors with marginal/extended criteria (DBM). All grafts were preserved with an IGL-1® solution. The mean CIT decreased significantly between 2020 and 2023, while the mean WIT increased (Table 3).

Table 3. Cold and warm ischemia durations during renal transplantation.

Variables	All n=335	2013-2019 n=236	2020-2023 n=99	p
CIT, min	1090±389.7	1126.6±392.3	1002.9±402.5	0.009
CIT >1200 min	136 (40.6)	101(42.8)	35 (35.4)	0.206
WIT, min	60.4±19.4	57.7±17.8	66.9±21.5	<0.001
WIT > 60 min	149 (44.5)	92 (39,0)	57 (57.6)	0.002
Cardiac arrest	319 (95.2)	222 (94.1)	97 (98.0)	

Results are expressed as mean ± standard deviation or frequency (%). Abbreviations: TIF: cold ischemia time; WIT: warm ischemia time.

3.4. Anti-Rejection Immunosuppressive Therapy

Induction therapy consisted of anti-thymocyte globulin (ATG), mycophenolate mofetil (MMF), and Solumedrol in all patients. (Figure 2) shows that maintenance immunosuppressive therapy was predominantly tacrolimus + MMF + Cortancyl (90.4%). This regimen became exclusive in the group transplanted between 2020 and 2023 (p < 0.001).

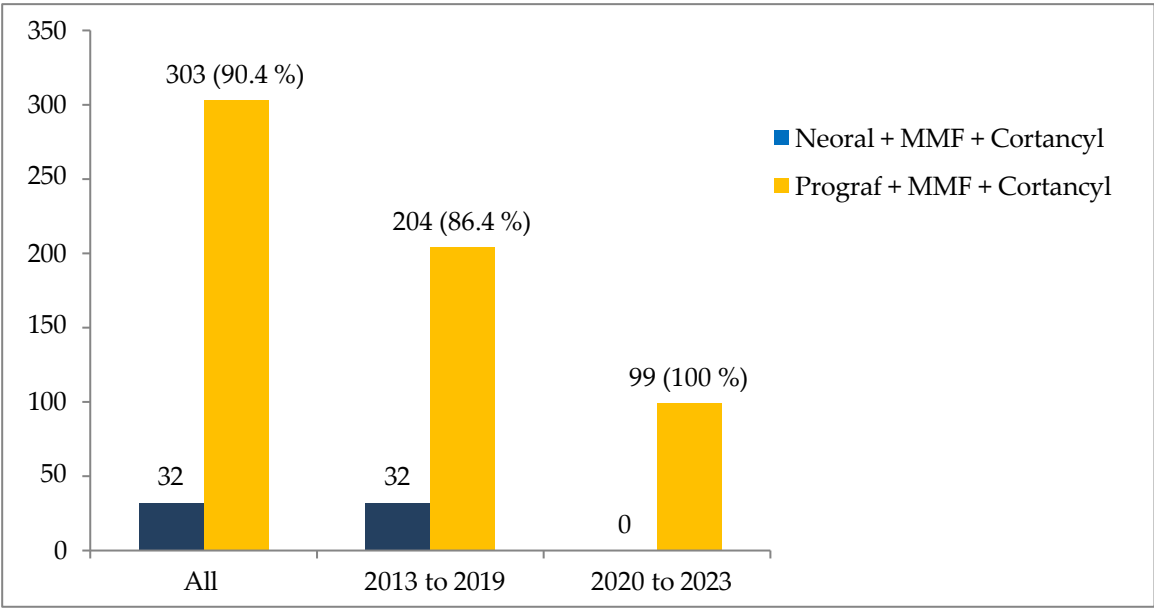


Figure 2. Immunosuppressive treatment regimen according to patient group. Induction therapy consisted of anti-thymocyte globulin (ATG), mycophenolate mofetil (MMF), and Solumedrol in all patients. The figure shows that maintenance immunosuppressive therapy was predominantly tacrolimus + MMF + Cortancyl (90.4%). This regimen became exclusive in patients transplanted between 2020 and 2023 ($p < 0.001$).

3.5. Post-Transplant Complications

The most frequent post-renal transplant complications were interstitial fibrosis, RGF, and acute graft pyelonephritis, followed by allograft nephropathy, recurrence of baseline nephropathy, BK virus infection, and hyperacute rejection (Table 4).

Table 4. Post-kidney transplant complications.

Complications	All n=335	2013-2019 n=236	2020-2023 n=99	P
Delayed recovery of graft function	4(1.2)	4(1.7)	0	0.193
Acute tubular necrosis	1(0.3)	1(0.4)	0	0.517
Active humoral rejection M3	9(2.7)	8(3.4)	1(1.0)	0.219
Chronic humoral rejection M12	2(0.6)	2(0.8)	0	0.358
Acute cellular rejection M3	8(2.4)	8(3.4)	0	0.064
Chronic cell rejection M12	2(0.6)	2(0.8)	0	0.358
Post-operative cardiac arrest	2(0.6)	2(0.8)	0	0.358
Graft artery thrombosis	1(0.3)	1(0.4)	0	0.517
Urological complications				
Acute urinary retention	1(0.3)	1(0.4)	0	0.517
Graft artery stenosis	1(0.3)	1(0.4)	0	0.517
External iliac artery stenosis	2(0.6)	2(0.8)	0	0.358
Plicature of the graft artery	1(0.3)	1(0.4)	0	0.517
Ureterotomy	1(0.3)	1(0.4)	0	0.517
Ureteral breach	1(0.3)	0	1(1.0)	0.517
Surgical complications				
Transplantectomy	1(0.3)	1(0.4)	0	0.517
Section of the inferior polar artery	2(0.6)	2(0.8)	0	0.358
Infectious complications				
COVID-19	9(2.7)	8(3.4)	1(1.0)	0.219
BK virus infection	13(3.9)	10(4.2)	3(3.3)	0.602
Graft preservation fluid infection	3(0.9)	2(0.8)	1(1.0)	0.885

Acute graft pyelonephritis	23(6.9)	15(6.4)	8(8.1)	0.569
Other complications				
Cortisonic diabetes	3(0.9)	3(1.3)	0	0.260
Native nephropaty disease	12(3.6)	9(3.8)	3(3.0)	0.725
Chronic allograft nephropathy	21(6.3)	17(7.2)	4(4.0)	0.276
IFTA grade 1 M3	26(7.8)	9(3.8)	17(17.2)	< 0.001
IFTA grade 2 M3	22(6.6)	8(3.4)	14(14.1)	<0.001
IFTA grade 3 M3	9(2.7)	4(1.7)	5(5.1)	0.083
IFTA grade 1 M12	9(2.7)	7(3.0)	2(2.0)	0.625
IFTA grade 2 M12	3(0.9)	3(1.3)	0(0.0)	0.260
IFTA grade 3 M12	4(1.2)	3(1.3)	1(1.0)	0.841
Arteriolar hyalinosis M12	21(6.3)	12(5.1)	9(9.1)	0.168
Graft failure	48(14.3)	44 (18.6)	4(4.0)	<0.001

Results are expressed as frequency (%). Abbreviations: M: month; IFTA: interstitial fibrosis and tubular atrophy.

3.6. Graft Survival and Factors Associated with RGF

Table 5 reports on graft survival, which was 97.3% at 6 months post-transplant, compared with 85.1% at 5 years and 73.1% at 10 years in the whole group. Comparing patients according to the period in which their kidney transplant was performed, it appears that during the first 4 years post-transplant, graft survival was better in the group of patients transplanted between 2020 and 2023; however, this finding was not statistically significant.

Table 5. Graft survival according to transplant year groups.

Time	All	2013-2019	2020-2023	p
	n=335	n=236	n=99	
6 months	97.3	97.5	100	0.160
1 year	97.0	94.9	98.5	
4 years	90.9	89.8	96.9	
5 years	85.1	84.2	-	
10 years	73.1	72.2	-	

This table shows graft survival rates after kidney transplantation, comparing two transplant periods (2013–2019 vs. 2020–2023). At 6 months, graft survival was slightly higher in the 2020–2023 group (100%) than in the 2013–2019 group (97.5%), with no statistically significant difference (p = 0.160). Results are expressed as percentages.

Univariate analysis showed that RGF was associated with the time of transplantation (years 2013–2019), male donor sex, intraoperative incident, postoperative cardiac arrest, interstitial fibrosis and tubular atrophy (IFTA) grade 1 score at 3 months post-transplant, allograft nephropathy, and the presence of anti-HLA class I Ac prior to transplantation. A history of blood transfusion, the presence of anti-HLA class II Ac, and a positive historical DSA result prior to renal transplantation were not associated with RGF. In the Multivariate analysis revealed that time of transplantation (years 2013–2019) and allograft nephropathy were the only factors independently associated with RGF (Table 6).

Table 6. Risk factors for graft failure.

Risk factors	Univariate analysis			Multivariate analysis		
	OR	95% CI	P	ORa	95% CI	p
Transplantation 2013-2019 vs 2020-2023	7.53	2.28-24.88	<0.001	6.24	1.84 – 21.14	0.003
Male vs. female donors	3.42	1.18-9.85	0.014	-	-	-
Surgical complications vs no	4.56	1.41-15.31	0.018	6.01	1.61-22.40	0.080
Ab HLA1+	2.04	1.05-3.96	0.033	-	-	-

Postoperative cardiac arrest vs no	7.24	5.52-9.43	0.020	-	-	-
IFTA grade 1 M3 vs no	1.18	1.12-1.24	0.035	-	-	-
Allograft nephropathy vs. no	3.33	1.26-8.77	0.019	3.21	1.14-9.00	0.027

Abbreviations: Ab HLA1+: Positive antibody human Leukocyte Antigen (HLA) Class I antibodies; IFTA: interstitial fibrosis and tubular atrophy.

3.7. Patient Survival and Factors Associated with Death

Survival rates at 6 months, 5 years, and 10 years for all transplanted patients were 97.3%, 83.2%, and 72.3%, respectively (Table 7).

Table 7. Patient survival according to transplant year groups.

Time	All	2013-2019	2020-2023	p
	n=335	n=236	n=99	
6 months	97.3	96.6	98.9	0.199
1 year	95.3	94.5	97.6	
4 years	87.5	87.3	95.9	
5 years	83.2	83.0	-	
10 years	72.3	72.0	-	

This table shows patient survival rates after kidney transplantation, comparing two transplant periods (2013–2019 vs. 2020–2023). No statistically significant difference was observed at 6 months (p = 0.199).

The Kaplan–Meier curve showed that during the first 4 years post-transplant, survival appeared to be better when transplantation was performed between the years 2020 and 2023; however, this finding was not statistically significant (Figures 3 and 4).

The univariate analysis identified recipient age ≥ 60 years, RGF, transplantation between 2013 and 2019, diabetes mellitus, CIT ≥ 1200 min, postoperative cardiac arrest, graft pyelonephritis (GPN), as being associated with death. After adjustment, recipient age ≥ 60 years, RGF, transplantation between 2013 and 2019, diabetes mellitus, CIT ≥ 1200 min, and GPN emerged as factors independently associated with death (Table 8).

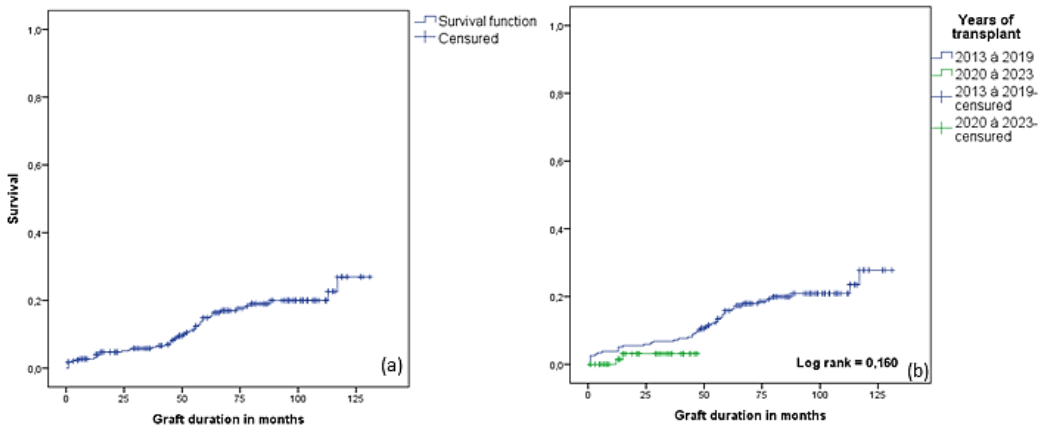


Figure 3. Kaplan–Meier survival analysis of kidney grafts. (a) Incidence of graft failure in the overall cohort. (b) Comparison of graft survival according to years of transplantation (2013–2019 vs. 2020–2023). The Kaplan–Meier curve suggests improved survival in patients transplanted between 2020 and 2023, although this difference did not reach statistical significance (log-rank = 0.160).

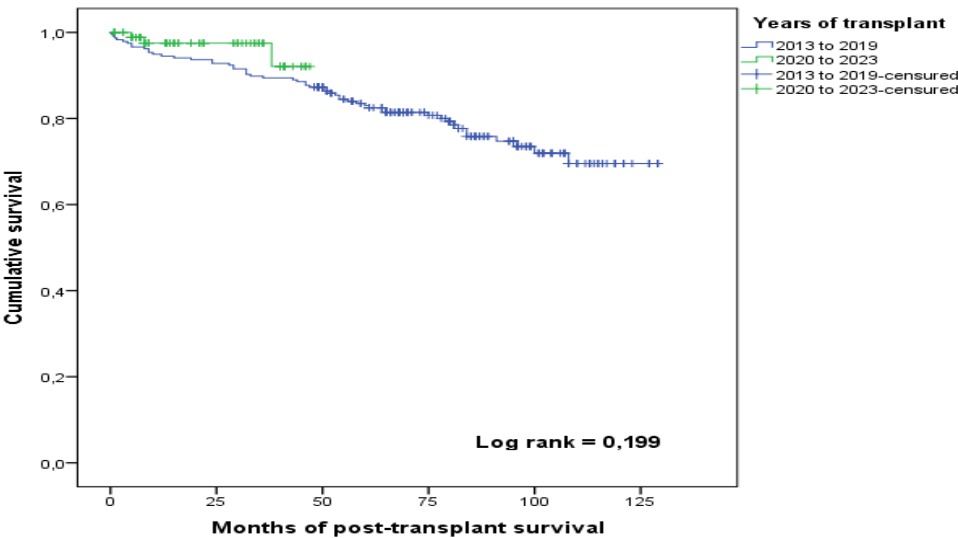


Figure 4. Kaplan–Meier survival curves comparing post-transplant survival of kidney transplant recipients based on the period of transplantation. (a) The blue curve represents patients transplanted between 2013 and 2019, while (b) the green curve represents those transplanted between 2020 and 2023. Censored data are indicated by tick marks. The log-rank test did not show a statistically significant difference between the two groups (Log rank = 0.199). The x-axis represents the number of months post-transplant, and the y-axis represents cumulative survival.

Table 8. Risk factors associated with death in transplant patients.

Risk factors	Univariate analysis			Multivariate analysis		
	OR	95% CI	p	Ora	95% CI	P
Age ≥ 60 years vs. no	2.87	1.60-24.88	<0.001	2,96	1.39–5.62	0.004
Graft failure vs no	2.87	1,60-5.13	<0.001	10.31	4.76–22.22	<0.001
Transplantation 2013 - 2019 vs 2020-2023	5.43	2.11-14.08	0.001	4.48	1.52–13.33	0.007
Diabetes mellitus vs no	2.50	1.38-4.53	0.004	3.26	1.57-6.75	0.002
CIT ≥1200 min vs no	1.88	1.06-3.32	0.039	2.28	1.15-4.54	0.019
Post-operative cardiac arrest	5.95	4.67-7.58	0.030	-	-	-
Graft pyelonephritis vs no	2.80	1.13-6.94	0.040	3.51	1.17-10.49	0.025

Risk factors independently associated with mortality in kidney transplant patients. Significant variables included age ≥ 60 years, graft failure, diabetes, longer CIT, transplant period (2013–2019), and graft pyelonephritis. OR: odds ratio; CI: confidence interval.

Of the patients with GRF (n = 48), 27 (56.3%) had resumed HD. The proportion of deaths was 6/27 (22.2%) in the group who had resumed HD, compared with 21/21 (100%) in those who had not resumed HD (p < 0.001).

3.8. Causes of Death

The different causes of death are shown in Table 9. Death at home and multi-visceral failure predominated over sepsis (Table 9)

Table 9. Causes of death by study period.

Variables	All n=335	2013-2019 n=236	2020-2023 n=99	P
Death at home	17(5,1)	16(6,8)	1(1,0)	0,028
Multivisceral failure due to sepsis	18(5,4)	17(7,2)	1(1,0)	0,022
COVID-19	9(2,7)	8(3,4)	1(1,0)	0,219
Hemorrhagic shock	2(0,6)	2(0,8)	0(0,0)	0,358
Hemorrhagic stroke	3(0,9)	3(0,9)	0(0,0)	0,260
Cranioencephalic trauma	1(0,3)	1(0,4)	0(0,0)	0,517
Clostridial colitis	1(0,3)	1(0,4)	0(0,0)	0,517
Suicide	1(0,3)	1(0,4)	0(0,0)	0,122
Cancer	3 (0,9)	2 (0,8)	1(1,0)	0,925
Unknown	1(0,3)	1(0,4)	0(0,0)	0,517

Causes of death in kidney transplant patients by study period (2013–2019 vs. 2020–2023). Death at home and multivisceral failure due to sepsis were significantly more frequent in the earlier period. Data are presented as n (%).

4. Discussion

A total of 335 patients received KT during the study period. While KT activity gradually increased until 2018, it decreased again between 2019 and 2021. This observation was confirmed in France by the Agence de la Biomédecine (ABM) in its 2020 transplant activity report [11]. The decrease in KT activity is primarily attributed to the COVID-19 pandemic, during which hospitals focused their efforts on patients with severe forms of the disease [12].

In the present study, the average age of KT donors was 51.5 ± 16.1 years. This observation is consistent with data from metropolitan France [11]. However, due to the shortage of grafts, the use of elderly donors is becoming increasingly frequent [11].

Almost all the donors were DBD, i.e., 98.2%. This corresponds to only 1.8% of voluntary LRDs. This proportion of LRDs is lower than the general average for transplant centers in France and in several other countries [11]. Despite the first successful kidney transplant in Guadeloupe in 2004, many challenges remain. Very few people agree to donate a kidney; the rate of opposition to kidney donation is estimated at 50% in the Guadeloupean population, compared with 33% in France [11]. To address this issue, the transplant coordination team at the CHU de Guadeloupe regularly organizes awareness-raising days to highlight the importance of live organ donation in saving lives.

There are sex differences in KT donation. A multicenter study overseen by the European Committee on Organ Transplantation reported that men were the main source of DBMs, with proportions ranging from 63.3% to 71.9% in over 60 countries [15]. In contrast, women represented the main source of kidneys from LRDs, accounting for 61.1%.

In line with data from the general population, the three most common blood groups among KT donors were O, A, and B. The proportion of group O donors rose from 48.7% between 2013 and 2019 to 52.5% between 2020 and 2023. This has little impact, as the Rhesus group is not involved in organ transplantation.

The average age of patients was 52.5 ± 11.9 years (range: 22–81 years). The proportion of patients over 70 had risen from 2.1% over the period 2013 to 2019 to 8.1% from 2020 to 2023. Advanced age may be a limitation to renal transplantation; however, older patients with fewer comorbidities and fewer vascular complications may be eligible for renal transplantation. The average age of patients at the time of KT is comparable to the average reported in France [11].

In many countries, the majority of harvested organs are transplanted into men rather than women [16]. In our study, approximately two-thirds of transplant patients were male. This proportion had fallen over the period 2020 to 2023 compared with 2013 to 2019 (55.6% versus 67.4%), possibly reflecting easier access to healthcare services for women.

In terms of comorbidities, hypertension was preeminent, followed by diabetes mellitus and obesity, with proportions of 97.6%, 25.4%, and 17.6%, respectively. This result reflects the importance of these pathologies in the epidemiology of CKD. Indeed, hypertension, diabetes, and obesity are the top three cardiovascular risk factors for CKD, both in Guadeloupe and worldwide [1–3].

Between 2020 and 2023, the proportion of transplant patients that were obese, heterozygous sickle cell, polycystic, had a history of blood transfusion, and were class I and II anti-HLA Ac had increased significantly. Access to renal transplantation has become easier despite these comorbidities, thanks to the implementation of close and effective follow-up programs. For example, obese patients can benefit from bariatric surgery, gastric banding, or gastric bypass to reduce their weight and facilitate renal transplant surgery [17].

For immunized patients, renal transplantation is no longer an absolute contraindication, as desensitization protocols and more effective immunosuppressive treatments with fewer adverse effects are now available [18].

The terms of the transplant included several conditions that donors and recipients had to comply with. In the present study, all transplanted patients benefited from a KT with a compatible donor. All virtual and real crossmatch tests were negative. To date, ABO incompatible kidney transplants are not performed in Guadeloupe. This modality could help reduce waiting times for KTs, particularly for candidates from minority blood groups.

In France, the average waiting time for KTs with DBD is 17.2 months; however, in Guadeloupe, it is two to three times longer than in some regions of mainland France [11].

According to the renal transplant activity report published by the ABM [11], the average CIT has fallen from 15.4 h in 2013 to 12.4 h in 2023 throughout France.

For locally allocated transplants in Guadeloupe and Reunion, CIT had decreased from 17.1 h to 14.3 h for DBD [11,19]. Our results also show that CIT decreased significantly between the two study periods (1126.6 ± 392.3 min vs. 1002.9 ± 402.5 min). Longer CIT is known to be associated with delayed recovery of renal function and is a risk factor for graft failure [20]. Strengthening logistical capacities and technical skills, as well as the introduction of an hourly tracking sheet for KTs, certainly helped to achieve the reduction in CIT during the second part of our study. It is possible that there were fewer transplants from mainland France between 2020 and 2023; however, this aspect was not specifically examined in our study. Cold ischemia, a cornerstone of graft preservation, is associated with significant biochemical changes, including reduced adenosine triphosphate (ATP) production. The persistence of anaerobic glycolysis produces lactate, which generates acidosis with a mediocre and inadequate energy production yield [20,21]. Although obligatory, organ cooling has deleterious consequences for tissues, as several metabolic pathways are affected. For example, inhibition of the Na⁺/K⁺ ATPase pump leads to cellular and interstitial edema, as well as disturbances in calcium homeostasis, which activates proteases and promotes proteolytic lesions [21].

All the grafts in our study were preserved with IGL-1® solution, a new-generation preservation solution. Its colloid is a 35,000-dalton polyethylene glycol [22]. Multicenter clinical results in KT patients showed that this solution resulted in better recovery of graft function and graft survival compared to grafts preserved with Belzer's solution (UW), which has been recognized as the reference preservation solution in organ procurement for many years [23].

Paradoxically, instead of decreasing, WIT actually increased during the second part of the present study (57.7 ± 17.8 min vs. 66.9 ± 21.5 min). Warm ischemia is also an important parameter of ischemia-reperfusion in transplantation, as it integrates the time taken to make graft anastomoses at the recipient's body temperature. The prolonged duration of WIT induces cellular disorders responsible for kidney graft dysfunction [20,21].

Reasons that may explain our results include the introduction of new surgeons to the renal transplant unit, as well as a higher proportion of recipients aged 70 years or older, those who are obese, heterozygous sickle cell patients, and polycystic patients between 2020 and 2023. Comorbidities can promote atherosclerotic lesions, which may contribute to longer vascular anastomosis times.

In general, very few post-renal transplant complications were reported, both in 2013–2019 and 2020–2023. This low complication rate can be attributed to the fact that renal transplant practice at the CHU de Guadeloupe dates back to 2004, and the teams are better trained and have acquired experience [5].

RGF remains one of the most dreaded complications following KT. Our study showed that 14.3% of KT patients developed RGF, with the majority of these cases occurring among patients transplanted before 2020. Graft survival was 97.3% at 6 months, 85.1% at 5 years, and 73.1% at 10 years. Our results are in line with the literature [24–26]. According to a study from 1993 to 2016 [27], of 59,162 patients who received a KT, overall graft survival was 91.4% at 1 year, 79.4% at 5 years, and 62.4% at 10 years. Graft survival is known to vary according to the timing and modalities of renal transplantation. In recent years, there has been an increasing use of donors with extended criteria and recipients with multiple comorbidities. In addition, several teams now perform ABO-incompatible transplants. For example, the ABM report estimates 3-year post-renal transplant survival at 82.4% for the period 2018 to 2022, compared with 85.3% for the period 2012 to 2014 [11].

During 2013 to 2019, intraoperative events and allograft nephropathy were independently associated with RGF. It is known that after transplantation, the renal graft can be the site of allograft nephropathy, which is responsible for a progressive deterioration in renal function. Several studies show that this complication represents a major prognostic factor in long-term graft loss [24,28]. Most cases are attributable to causes such as calcineurin inhibitor intoxication, diabetic or hypertensive nephropathy, or viral infection, notably BK virus nephritis and cytomegalovirus (CMV) infection.

Pre-formed positive anti-HLA class I antibodies, a grade 1 IFTA score at 3 months post-transplant, and male donors were associated with RGF in the univariate analysis. It has been established that patients immunized prior to transplantation are at risk of graft dysfunction, and anti-HLA class I antibodies may appear following immunizing events, including blood transfusion (presence of platelets and granulocytes) as well as pregnancy and previous transplantation [18]. Despite the presence of preformed anti-HLA class II Ac and positive DSA results in some patients, these factors were not associated with RGF. This may be explained by the fact that not all anti-HLA antibodies have the same clinical significance and do not necessarily expose patients to rejection [25]. Furthermore, the quantification of DSA enables us to better assess its correlation with the risk of organ rejection [26].

The association between the IFTA score and RGF corroborates data in the literature [29]. Interstitial fibrosis and tubular atrophy correspond to an abnormal accumulation of connective tissue in the kidneys, resulting in structural damage and impaired kidney function [29].

The role of the male donor in justifying RGF in the univariate analysis in our study has no obvious explanation. This link was not retained in the multivariate analysis. To date, few studies have investigated the role of male donors in graft survival. However, for other grafts, notably skin, the role of the sex-linked HY system has been reported [30]. This histocompatibility gene, located on the Y chromosome and therefore absent in women, can lead to rejection of a male skin graft transplanted to a female of the same lineage.

Patient survival at 6 months post-transplant was 97.3%, compared to 83.2% at 5 years and 72.3% at 10 years. Our results align with the existing literature [11]. Patient survival was better in the absence of RGF, in younger recipients (age <60 years), in the absence of a history of diabetes mellitus, when KT was performed in more recent years (2020 to 2023 vs. 2013 to 2019), and for a shorter CIT (≤ 1200 min vs. >1200 min). These results corroborate data in the literature [11,31,32]. Some patients with RGF died before being dialyzed. These are generally patients who did not present metabolic complications indicating emergency dialysis but who presented pathologies leading to death within a very short time.

Death at home, multi-visceral failure due to sepsis, and COVID-19 infection were the three main causes of patient death, regardless of the group (patients transplanted between 2013 and 2019 vs. patients transplanted between 2020 and 2023). These results are in line with the literature, which reports that infectious and cardiovascular complications are the main causes of death after KT [31,32].

This study has some limitations. These include the retrospective nature of the study, the duration of observation, which was limited to 4 years in the second group of patients (between the years 2020 and 2023), the monocentric nature limiting observations to the University Hospital of Guadeloupe, the absence of certain data, such as mean fluorescence intensity (MFI) quantification, and de novo DSA results. However, our study also has its strengths. It is the first to compare transplant activity before and after the outbreak of the COVID-19 pandemic in Guadeloupe. Despite a higher proportion of immunized patients and patients with comorbidities among transplant patients in recent years, our results showed that overall survival was not impacted. It should also be noted that this study reported on practices carried out within the renal transplant team at the University Hospital of Guadeloupe, enabling us to consider strategies for further improving patient management.

5. Conclusions

Our study revealed a decline in renal transplant activity at the University Hospital of Guadeloupe following the COVID-19 outbreak in 2020; however, this trend began to increase again from 2022 onwards. Almost all KT's were taken from DBDs. All transplants were ABO-compatible and performed using conventional surgical techniques. Compared with the period prior to COVID-19, recent years have been marked by a greater proportion of older, more immunized KT recipients with several comorbidities. However, these conditions did not affect graft and transplant patient survival, which improved between 2020 and 2023.

Author Contributions: Conceptualization: Jonathan Muamba Mutombo, Jean-Robert Makulo ,Arriel Makembi Bunkete, Befa Notokadokaza; Methodology: Jonathan Muamba Mutombo, Jean-Robert Makulo Joelle Claudeon, Batcho Jimmy, Christian Kisoka Lusunsi; Data Collection: Jonathan Muamba Mutombo, Joelle Claudeon, Gerard Dalvius; Data Curation and Validation: Jean-Robert Makulo ,Arriel Makembi Bunkete, Yannick Nlandu Mayamba; Formal Analysis: Jonathan Muamba Mutombo, Arriel Makembi Bunkete, Ernest Sumaili Kiswaya; Investigation: Jonathan Muamba Mutombo, Joelle Claudeon, Gerard Dalvius; Resources: Befa Notokadokaza, Nazaire Nseka Mangani; Writing – Original Draft: Jonathan Muamba Mutombo, Arriel Makembi Bunkete; Writing – Review & Editing: Jean-Robert Makulo ,Arriel Makembi Bunkete, Ernest Sumaili Kiswaya; Supervision: Befa Notokadokaza, Nazaire Nseka Mangani, Ernest Sumaili Kiswaya; Project Administration: Arriel Makembi Bunkete, Befa Notokadokaza. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the University Hospital of Guadeloupe.

Informed Consent Statement: Informed consent was waived due to the retrospective nature of the study and the use of anonymized data, in accordance with institutional and national guidelines. Written informed consent for publication was not required, as no identifiable personal data are presented in this article.

Data Availability Statement: Data supporting the findings of this study are available from the corresponding author upon reasonable request. Due to ethical and privacy restrictions, the data are not publicly available, as they contain sensitive patient information.

Acknowledgments: The authors would like to acknowledge the administrative and technical support provided by the staff of the Nephrology, Dialysis, and Transplantation Department at the University Hospital of Guadeloupe. No additional support or donations in kind were received for this study.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Abbreviations

ATG	anti-thymocyte globulin
ATP	adenosine triphosphate
CHU	centre hospitalier universitaire
CI	confidence interval
CIT	cold ischemia time
CKD	chronic kidney disease
COVID-19	coronavirus disease 2019
DBD	deceased brain-dead donor
DCAD	deceased cardiac arrest donor
DSA	donor specific antidodies
ESRD	end stage renal disease
GPN	graft pyeloniphritis
HLA	human leukocyte antigen
IFTA	interstitial fibrosis and tubular atrophy
KT	kidney transplant
LVD	living-related donor
MFI	mean fluorescence intensity
MMF	mycophenolate mofetil
OR	odds ratio
RGF	renal graft failure
SCD	standard criteria donor
WIT	warm ischemia time

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