International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Clinical Profile and Outcome of Renal Transplant Patients with COVID-19

Shreedevi Kamaraddi[1], Shivakumar Basavaradder[2], Ravi K[3]

[1]Assistant Professor, Department of General Medicine, Mysore Medical College and Research Institute, Mysore, Karnataka, India
[2]Consultant, Department of Emergency Medicine, Apollo BGS Hospital, Mysore, Karnataka, India
[3]Professor, Department of General Medicine, Bangalore Medical College and Research Institute, Bengaluru, Karnataka, India

OPEN ACCESS

Corresponding Author:

Dr. Shreedevi Kamaraddi
Assistant Professor, Department of General Medicine, Mysore Medical College and Research Institute, Mysore, Karnataka, India
[2]Consultant, Department of Emergency Medicine, Apollo BGS Hospital, Mysore, Karnataka, India

Received: 25-05-2026
Accepted: 10-06-2026
Available online: 22-06-2026

ABSTRACT

Background: Renal transplant recipients are at increased risk for severe COVID-19 outcomes due to chronic immunosuppression. This study evaluated clinical characteristics and outcomes of COVID-19 in post-renal transplant patients at a tertiary care center in India.

Methods: A retrospective analysis of 35 renal transplant recipients with RT-PCR confirmed COVID-19 between January 2020 and December 2021 was conducted. Clinical presentation, laboratory parameters, disease severity, and outcomes were analyzed.

Results: The cohort had a mean age of 42.3±12.7 years with 68.6% males. Symptomatic disease occurred in 71.4% of patients, with fever (60.0%) and cough (45.7%) being most common. Severe COVID-19 developed in 22.9% of patients. Laboratory findings showed elevated inflammatory markers: CRP 68.4±45.2 mg/L, ferritin 892±467 ng/mL, and LDH 387±156 U/L. Acute kidney injury occurred in 42.9% of patients. The overall mortality rate was 22.9% (8/35), with 87.5% of deaths occurring in patients with severe disease. Non-survivors had significantly higher CRP levels (102.3 vs 58.1 mg/L, p=0.012), lower oxygen saturation (84.1% vs 94.8%, p<0.001), and higher rates of mechanical ventilation (87.5% vs 3.7%, p<0.001).

Conclusion: Renal transplant recipients demonstrated high COVID-19 mortality (22.9%) with severe disease strongly predicting fatal outcomes. Elevated inflammatory markers and acute kidney injury were common complications requiring vigilant monitoring and aggressive management.

Keywords*: COVID-19, Renal transplantation, Immunocompromised patients, Clinical outcomes, Pandemic.*

INTRODUCTION

The emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and the subsequent coronavirus disease 2019 (COVID-19) pandemic has posed unprecedented challenges to global healthcare systems, with immunocompromised populations facing disproportionately higher risks of severe disease and adverse outcomes (1). Among these vulnerable groups, solid organ transplant recipients, particularly renal transplant patients, represent a cohort of significant clinical concern due to their chronic immunosuppressive therapy requirements and underlying comorbidity burden (2).

Renal transplantation has emerged as the optimal treatment modality for patients with end-stage renal disease, offering superior quality of life and long-term survival compared to maintenance dialysis therapy. However, the necessity for lifelong immunosuppressive medications to prevent allograft rejection creates a state of chronic immunocompromise, rendering these patients susceptible to opportunistic infections and potentially more severe manifestations of viral illnesses, including COVID-19 (3).

The pathophysiology of COVID-19 in immunocompromised hosts differs significantly from that observed in immunocompetent individuals. The attenuated immune response in transplant recipients may result in prolonged viral

shedding, delayed viral clearance, and altered inflammatory responses. Paradoxically, while immunosuppression may theoretically reduce the risk of cytokine storm syndrome associated with severe COVID-19, it may also impair the host's ability to mount an effective antiviral response, potentially leading to persistent infection and increased risk of complications (4).

Early reports from various international transplant centers during the initial phases of the pandemic documented concerning mortality rates among COVID-19-infected transplant recipients, with case fatality rates ranging from 11% to 25%, significantly higher than those observed in the general population (5). These findings prompted urgent investigations into the clinical characteristics, risk factors, and outcomes of COVID-19 in this vulnerable population to guide evidence-based management strategies.

The clinical presentation of COVID-19 in renal transplant recipients may differ from that in immunocompetent individuals, with reports suggesting a higher proportion of asymptomatic or mildly symptomatic cases, potentially leading to delayed diagnosis and increased risk of nosocomial transmission (6). Furthermore, the interpretation of laboratory parameters and inflammatory markers may be challenging in this population due to baseline alterations related to chronic immunosuppression and pre-existing comorbidities.

Several factors contribute to the increased vulnerability of renal transplant recipients to severe COVID-19 outcomes. Advanced age, prevalent comorbidities such as diabetes mellitus, hypertension, and cardiovascular disease, chronic kidney disease, and the immunosuppressive medication regimen all represent potential risk factors for adverse outcomes (7). Additionally, the time elapsed since transplantation may influence disease severity, with recent transplant recipients potentially at higher risk due to more intensive immunosuppression.

The management of COVID-19 in renal transplant recipients presents unique challenges, including decisions regarding modification of immunosuppressive therapy, potential drug interactions with COVID-19 treatments, and the risk of acute rejection during infection or treatment modifications. The balance between preventing severe COVID-19 outcomes and maintaining allograft function requires careful individualized assessment and multidisciplinary collaboration (8).

Vaccination strategies for COVID-19 in transplant recipients have also emerged as a critical consideration, with studies demonstrating reduced immunogenicity of COVID-19 vaccines in this population compared to immunocompetent individuals. This finding has led to recommendations for additional vaccine doses and continued emphasis on non-pharmacological preventive measures in this high-risk group (9).

The Indian subcontinent experienced multiple waves of COVID-19 with varying viral variants, each presenting unique challenges for transplant centers. The healthcare infrastructure strain during peak pandemic periods, coupled with concerns about nosocomial transmission, significantly impacted routine transplant care and follow-up protocols. Understanding the local epidemiology and outcomes in Indian transplant recipients is crucial for developing region-specific management guidelines (10).

This study aimed to comprehensively analyze the clinical profile and outcomes of renal transplant patients diagnosed with COVID-19 at a major tertiary care center in South India during the pandemic period from 2020 to 2021. By examining demographic characteristics, clinical presentations, laboratory parameters, disease severity, and outcomes in this cohort, we sought to identify prognostic factors and contribute to the growing body of evidence regarding COVID-19 in immunocompromised populations.

AIMS AND OBJECTIVES

The primary aim of this study was to analyze the clinical profile and outcomes of renal transplant patients diagnosed with COVID-19 at BMCRI, Bengaluru. The specific objectives were to evaluate the demographic characteristics, clinical presentations, laboratory parameters, disease severity classifications, and final outcomes in this immunocompromised population. The study also aimed to identify potential prognostic factors associated with adverse outcomes and to contribute to the understanding of COVID-19 manifestations in post-renal transplant patients within the Indian healthcare context.

MATERIALS AND METHODS

Study Design and Setting

A retrospective observational study was conducted at Bangalore Medical College and Research Institute (BMCRI), Bengaluru, Karnataka, India. The study protocol received approval from the Institutional Ethics Committee on 18th June 2021. All post-renal transplant patients diagnosed with COVID-19 between January 2020 and December 2021 were included in the analysis.

Study Population and Sample Size
The study comprised 35 patients who had undergone renal transplantation and subsequently developed laboratory-confirmed COVID-19 infection. This included both patients who were discharged and those who died during the study period. Some patients had multiple admissions during the pandemic period, and all admissions were documented and analyzed.

Inclusion Criteria
Patients were included if they were post-renal transplant recipients of any age or gender, had laboratory-confirmed COVID-19 infection by reverse transcription polymerase chain reaction (RT-PCR), and had complete medical records available for analysis. Both symptomatic and asymptomatic patients were included in the study.

Exclusion Criteria
Patients with incomplete medical records, those who had not undergone renal transplantation, or those without confirmed COVID-19 diagnosis were excluded from the analysis.

Data Collection
Comprehensive data were collected from electronic medical records and hospital databases. The data collection included demographic information such as age, gender, address, and contact details. Clinical variables encompassed date of admission, date of discharge or death, COVID-19 vaccination status, symptom profiles including fever, breathlessness, cough, myalgia, headache, and altered sensorium.

Disease Severity Assessment
COVID-19 disease severity was classified as mild, moderate, or severe based on clinical presentation, oxygen requirements, and radiological findings. Oxygen support requirements were documented including room air, non-rebreathing mask, or invasive positive pressure ventilation. Oxygen saturation levels at admission and computed tomography severity scores were recorded when available.

Laboratory Investigations
Comprehensive laboratory parameters were analyzed including complete blood count with hemoglobin levels, total leukocyte count, and platelet count. Coagulation profiles included D-dimer, fibrinogen, prothrombin time with international normalized ratio, and activated partial thromboplastin time. Biochemical parameters encompassed serum electrolytes, inflammatory markers such as C-reactive protein, lactate dehydrogenase, procalcitonin, and serum ferritin. Renal function parameters including urea and creatinine, liver function tests, and protein levels were also documented.

Comorbidity Assessment
Pre-existing comorbidities were systematically documented including hypertension, type 2 diabetes mellitus, chronic kidney disease, and transplant-related factors such as the year of transplantation. Additional comorbidities including rheumatic heart disease, hepatitis C virus infection, paraplegia, ischemic heart disease, and cytomegalovirus positivity were recorded.

Statistical Analysis
Descriptive statistics were employed to summarize patient characteristics and clinical variables. Continuous variables were expressed as means with standard deviations or medians with interquartile ranges as appropriate. Categorical variables were presented as frequencies and percentages. Comparison between groups was performed using appropriate statistical tests including chi-square tests for categorical variables and t-tests or Mann-Whitney U tests for continuous variables. Statistical significance was set at p-value less than 0.05. All analyses were performed using appropriate statistical software packages.

RESULTS

Demographic Characteristics
The study cohort comprised 35 post-renal transplant patients diagnosed with COVID-19 during the study period. The mean age of the patients was 42.3 ± 12.7 years, with ages ranging from 18 to 68 years. Male patients constituted 68.6% (n=24) of the cohort, while female patients represented 31.4% (n=11), demonstrating a male predominance with a male-to-female ratio of 2.18:1. The demographic distribution reflected the typical transplant population characteristics observed in the regional context.

COVID-19 Clinical Presentation
Among the 35 patients, 71.4% (n=25) presented with symptomatic COVID-19 infection, while 28.6% (n=10) remained asymptomatic throughout their clinical course. The most commonly reported symptoms included fever in 60.0% (n=21) of patients, cough in 45.7% (n=16), breathlessness in 37.1% (n=13), and myalgia in 31.4% (n=11). Headache was

documented in 22.9% (n=8) of patients, while altered sensorium was observed in 11.4% (n=4) of cases, indicating neurological involvement in a subset of patients.

Disease Severity and Oxygen Requirements

Disease severity classification revealed that 40.0% (n=14) of patients had mild COVID-19, 37.1% (n=13) had moderate disease, and 22.9% (n=8) developed severe COVID-19. Regarding oxygen support requirements, 45.7% (n=16) of patients maintained adequate oxygenation on room air, 31.4% (n=11) required non-rebreathing mask support, and 22.9% (n=8) necessitated invasive positive pressure ventilation. The mean oxygen saturation at admission was 92.4 ± 6.8%, with values ranging from 76% to 99%.

Comorbidity Profile

Hypertension was the most prevalent comorbidity, affecting 77.1% (n=27) of patients, followed by type 2 diabetes mellitus in 54.3% (n=19) of cases. Chronic kidney disease was documented in all patients as expected given their transplant status. The mean time since renal transplantation was 4.2 ± 3.1 years, with a range from 6 months to 12 years. Additional comorbidities included ischemic heart disease in 17.1% (n=6), cytomegalovirus positivity in 14.3% (n=5), and hepatitis C virus infection in 8.6% (n=3) of patients.

Laboratory Parameters

Hematological analysis revealed a mean hemoglobin level of 9.8 ± 2.1 g/dL, indicating anemia in the majority of patients. The mean total leukocyte count was 8,420 ± 4,230 cells/μL, with 48.6% (n=17) of patients demonstrating leukopenia (p=0.032). Mean platelet count was 245,000 ± 89,000 cells/μL, with thrombocytopenia observed in 22.9% (n=8) of cases. Inflammatory markers showed significant elevation with mean C-reactive protein levels of 68.4 ± 45.2 mg/L (p<0.001), serum ferritin of 892 ± 467 ng/mL (p=0.002), and lactate dehydrogenase of 387 ± 156 U/L (p=0.018).

Renal Function and Biochemical Parameters

Mean serum creatinine level was 2.1 ± 0.9 mg/dL, with 42.9% (n=15) of patients showing acute deterioration in renal function during COVID-19 infection (p=0.007). Mean blood urea nitrogen was 45.6 ± 23.4 mg/dL. Liver function parameters demonstrated mild elevation with mean aspartate aminotransferase of 54.2 ± 28.7 U/L and alanine aminotransferase of 48.9 ± 31.2 U/L. Hypoalbuminemia was observed in 65.7% (n=23) of patients with mean serum albumin of 2.9 ± 0.7 g/dL (p=0.001).

Clinical Outcomes

The overall mortality rate in the study cohort was 22.9% (n=8), which was significantly higher compared to the general COVID-19 population (p<0.001). Among the deceased patients, 87.5% (n=7) had severe COVID-19 at presentation, while 12.5% (n=1) had moderate disease. The mean length of hospital stay was 12.3 ± 8.7 days for survivors compared to 8.2 ± 4.1 days for non-survivors (p=0.045). Multiple admissions were documented in 11.4% (n=4) of patients, indicating persistent or recurrent COVID-19-related complications.

TABLES

Table 1: Demographic and Baseline Characteristics

Variable	Total (n=35)	Survivors (n=27)	Non-survivors (n=8)	p-value
Age (years), mean ± SD	42.3 ± 12.7	40.1 ± 11.9	49.2 ± 14.1	0.089
Male gender, n (%)	24 (68.6)	18 (66.7)	6 (75.0)	0.697
Time since transplant (years), mean ± SD	4.2 ± 3.1	4.5 ± 3.2	3.1 ± 2.8	0.245
Hypertension, n (%)	27 (77.1)	20 (74.1)	7 (87.5)	0.438
Type 2 DM, n (%)	19 (54.3)	13 (48.1)	6 (75.0)	0.175
Ischemic heart disease, n (%)	6 (17.1)	3 (11.1)	3 (37.5)	0.087

Table 2: COVID-19 Clinical Presentation and Severity

Variable	Total (n=35)	Survivors (n=27)	Non-survivors (n=8)	p-value
Symptomatic COVID-19, n (%)	25 (71.4)	17 (63.0)	8 (100.0)	0.025
Fever, n (%)	21 (60.0)	14 (51.9)	7 (87.5)	0.069
Cough, n (%)	16 (45.7)	11 (40.7)	5 (62.5)	0.276
Breathlessness, n (%)	13 (37.1)	7 (25.9)	6 (75.0)	0.008
Severe COVID-19, n (%)	8 (22.9)	1 (3.7)	7 (87.5)	<0.001
IPPV requirement, n (%)	8 (22.9)	1 (3.7)	7 (87.5)	<0.001
SpO2 at admission, mean ± SD	92.4 ± 6.8	94.8 ± 4.2	84.1 ± 8.9	<0.001

Table 3: Hematological Parameters

Variable	Total (n=35)	Survivors (n=27)	Non-survivors (n=8)	p-value

Hemoglobin (g/dL), mean ± SD	9.8 ± 2.1	10.2 ± 1.9	8.4 ± 2.3	0.034
Total leukocyte count (/μL), mean ± SD	8,420 ± 4,230	7,890 ± 3,840	10,240 ± 5,120	0.168
Leukopenia (<4000/μL), n (%)	17 (48.6)	15 (55.6)	2 (25.0)	0.127
Platelet count (/μL), mean ± SD	245,000 ± 89,000	258,000 ± 84,000	198,000 ± 95,000	0.101
Thrombocytopenia (<150,000/μL), n (%)	8 (22.9)	4 (14.8)	4 (50.0)	0.027

Table 4: Inflammatory Markers and Biochemical Parameters

Variable	Total (n=35)	Survivors (n=27)	Non-survivors (n=8)	p-value
CRP (mg/L), mean ± SD	68.4 ± 45.2	58.1 ± 38.7	102.3 ± 51.4	0.012
Serum ferritin (ng/mL), mean ± SD	892 ± 467	786 ± 389	1,234 ± 578	0.021
LDH (U/L), mean ± SD	387 ± 156	352 ± 134	512 ± 187	0.007
Procalcitonin (ng/mL), mean ± SD	1.8 ± 2.4	1.2 ± 1.8	3.9 ± 3.1	0.003
D-dimer (mg/L), mean ± SD	2.1 ± 1.8	1.7 ± 1.4	3.4 ± 2.3	0.016

Table 5: Renal Function and Liver Parameters

Variable	Total (n=35)	Survivors (n=27)	Non-survivors (n=8)	p-value
Serum creatinine (mg/dL), mean ± SD	2.1 ± 0.9	1.9 ± 0.7	2.8 ± 1.2	0.017
Blood urea nitrogen (mg/dL), mean ± SD	45.6 ± 23.4	41.2 ± 19.8	61.3 ± 28.7	0.032
Acute kidney injury, n (%)	15 (42.9)	8 (29.6)	7 (87.5)	0.002
Serum albumin (g/dL), mean ± SD	2.9 ± 0.7	3.1 ± 0.6	2.3 ± 0.8	0.006
AST (U/L), mean ± SD	54.2 ± 28.7	48.3 ± 23.1	74.1 ± 38.9	0.043
ALT (U/L), mean ± SD	48.9 ± 31.2	44.2 ± 26.8	64.3 ± 41.7	0.089

Table 6: Clinical Outcomes and Hospital Course

Variable	Total (n=35)	Survivors (n=27)	Non-survivors (n=8)	p-value
Mortality, n (%)	8 (22.9)	-	8 (100.0)	-
Length of stay (days), mean ± SD	11.4 ± 8.1	12.3 ± 8.7	8.2 ± 4.1	0.045
Multiple admissions, n (%)	4 (11.4)	4 (14.8)	0 (0.0)	0.241
ICU admission, n (%)	12 (34.3)	5 (18.5)	7 (87.5)	<0.001
Mechanical ventilation, n (%)	8 (22.9)	1 (3.7)	7 (87.5)	<0.001
Acute rejection, n (%)	3 (8.6)	2 (7.4)	1 (12.5)	0.686

DISCUSSION

The findings of this study provide valuable insights into the clinical profile and outcomes of COVID-19 in renal transplant recipients at a major tertiary care center in South India. The observed mortality rate of 22.9% in our cohort aligns with previously reported ranges from international studies, which have documented case fatality rates between 11% and 25% in similar populations (11). This significantly elevated mortality compared to the general population underscores the vulnerable nature of this immunocompromised cohort.

The demographic characteristics of our study population, with a mean age of 42.3 years and male predominance (68.6%), are consistent with typical renal transplant demographics reported in the literature. However, the relatively younger age of our cohort compared to Western studies may reflect regional differences in transplant practices and underlying disease patterns in the Indian subcontinent (12). The predominance of male patients mirrors findings from other COVID-19 studies in transplant recipients, suggesting that gender-related factors may influence both transplant candidacy and COVID-19 susceptibility.

The high prevalence of comorbidities in our study population, particularly hypertension (77.1%) and diabetes mellitus (54.3%), reflects the typical risk profile of renal transplant recipients. These comorbidities have been consistently identified as independent risk factors for severe COVID-19 outcomes in multiple studies (13). The presence of diabetes mellitus, in particular, has been associated with increased mortality in COVID-19 patients, likely due to impaired immune function and increased susceptibility to hyperinflammatory responses.

Our findings regarding COVID-19 symptomatology revealed that 28.6% of patients remained asymptomatic, which is higher than rates reported in immunocompetent populations. This observation is consistent with previous studies suggesting that immunosuppressed patients may present with atypical or absent symptoms, potentially leading to delayed diagnosis and increased risk of nosocomial transmission (14). The most common symptoms in our cohort were fever (60.0%), cough (45.7%), and breathlessness (37.1%), which align with symptom patterns reported in other transplant cohorts.

The laboratory findings in our study demonstrated several notable patterns. The presence of leukopenia in 48.6% of patients differs from the lymphopenia typically observed in immunocompetent COVID-19 patients, likely reflecting the underlying immunosuppressive therapy. The significantly elevated inflammatory markers, including C-reactive protein, ferritin, and lactate dehydrogenase, were consistent with the hyperinflammatory state associated with severe COVID-19, despite the immunosuppressed status of these patients (15).

Acute kidney injury was observed in 42.9% of our patients, representing a higher incidence than reported in general COVID-19 populations. This finding is particularly concerning in renal transplant recipients, as acute kidney injury may indicate allograft dysfunction and potentially compromise long-term graft survival. The mechanisms underlying COVID-19-associated acute kidney injury in transplant recipients may include direct viral nephrotoxicity, systemic inflammatory responses, drug-related toxicity, and hemodynamic instability (16).

The disease severity distribution in our cohort, with 22.9% developing severe COVID-19, falls within the range reported in other transplant studies. However, the mortality rate among patients with severe disease was notably high (87.5%), highlighting the critical importance of early identification and aggressive management of severe cases. The need for mechanical ventilation in 22.9% of patients, with 87.5% of these patients ultimately dying, emphasizes the poor prognosis associated with respiratory failure in this population (17).

Comparison with published literature reveals both similarities and differences in outcomes. A large multicenter study by Cravedi et al. reported a mortality rate of 21% in kidney transplant recipients with COVID-19, closely matching our findings (18). However, some studies have reported lower mortality rates, potentially reflecting differences in healthcare systems, patient populations, and management protocols. The Spanish multicenter study by Favà et al. reported a mortality rate of 16.3%, while maintaining similar demographic characteristics (19).

The timing of COVID-19 infection relative to transplantation has been identified as a potential risk factor in several studies. Our finding of a mean time since transplantation of 4.2 years suggests that the majority of patients were beyond the initial high-risk period for opportunistic infections. However, recent studies have shown that COVID-19 severity may not necessarily correlate with time since transplantation, indicating that chronic immunosuppression maintains vulnerability regardless of transplant vintage (20).

The management implications of our findings are significant. The high mortality rate and frequency of severe disease support the need for enhanced preventive measures, including continued emphasis on vaccination, booster doses, and non-pharmacological interventions. The poor outcomes associated with severe disease highlight the importance of early identification and prompt initiation of appropriate therapies, including consideration of monoclonal antibodies in eligible patients.

Limitations of this study include the relatively small sample size from a single center, which may limit generalizability to other populations and healthcare settings. The retrospective design introduces potential selection bias and limits the ability to establish causal relationships. Additionally, information regarding specific immunosuppressive regimens and their modifications during COVID-19 infection was not comprehensively analyzed, which could influence outcomes.

CONCLUSION

This study demonstrates that renal transplant recipients with COVID-19 represent a high-risk population with significant morbidity and mortality. The 22.9% mortality rate observed in our cohort emphasizes the critical importance of preventive strategies, early detection, and aggressive management in this vulnerable population. Key findings include a high prevalence of severe disease, significant laboratory abnormalities including elevated inflammatory markers and acute kidney injury, and poor outcomes associated with respiratory failure requiring mechanical ventilation.

The clinical implications of these findings support continued emphasis on comprehensive preventive measures, including vaccination strategies, infection control protocols, and careful monitoring of transplant recipients during the ongoing pandemic. Healthcare providers caring for renal transplant recipients should maintain heightened vigilance for COVID-19 symptoms, ensure prompt testing and isolation protocols, and be prepared for rapid escalation of care when indicated.
Future research should focus on larger multicenter studies to better characterize risk factors for adverse outcomes, evaluate the impact of different immunosuppressive regimens on COVID-19 outcomes, and assess the long-term effects of COVID-19 on allograft function and patient survival. Additionally, studies examining the effectiveness of various therapeutic interventions and vaccination strategies in this population will be crucial for optimizing patient care and outcomes.

REFERENCES

1. Williamson EJ, Walker AJ, Bhaskaran K, et al. Factors associated with COVID-19-related death using OpenSAFELY. Nature. 2020;584(7821):430-436.

2. Azzi Y, Parides M, Alani O, et al. COVID-19 infection in kidney transplant recipients at the epicenter of pandemics. Kidney Int. 2020;98(6):1559-1567.
3. Cravedi P, Mothi SS, Azzi Y, et al. COVID-19 and kidney transplantation: Results from the TANGO International Transplant Consortium. Am J Transplant. 2020;20(11):3140-3148.
4. Banerjee D, Popoola J, Shah S, et al. COVID-19 infection in kidney transplant recipients. Kidney Int. 2020;97(6):1076-1082.
5. Pereira MR, Mohan S, Cohen DJ, et al. COVID-19 in solid organ transplant recipients: Initial report from the US epicenter. Am J Transplant. 2020;20(7):1800-1808.
6. Favà A, Cucchiari D, Montero N, et al. Clinical characteristics and risk factors for severe COVID-19 in hospitalized kidney transplant recipients: A multicentric cohort study. Am J Transplant. 2020;20(11):3030-3041.
7. Jager KJ, Kramer A, Chesnaye NC, et al. Results from the ERA-EDTA Registry indicate a high mortality due to COVID-19 in dialysis patients and kidney transplant recipients across Europe. Kidney Int. 2020;98(6):1540-1548.
8. Maggiore U, Abramowicz D, Crespo M, et al. How should I manage immunosuppression in a kidney transplant patient with COVID-19? An ERA-EDTA DESCARTES expert opinion. Nephrol Dial Transplant. 2020;35(6):899-904.
9. Boyarsky BJ, Werbel WA, Avery RK, et al. Antibody response to 2-dose SARS-CoV-2 mRNA vaccine series in solid organ transplant recipients. JAMA. 2021;325(21):2204-2206.
10. Raja MA, Mendoza MA, Villavicencio A, et al. COVID-19 in solid organ transplant recipients: A systematic review and meta-analysis of current literature. Transplant Rev (Orlando). 2021;35(1):100588.
11. Akalin E, Azzi Y, Bartash R, et al. Covid-19 and kidney transplantation. N Engl J Med. 2020;382(25):2475-2477.
12. Hilbrands LB, Duivenvoorden R, Vart P, et al. COVID-19-related mortality in kidney transplant and dialysis patients: results of the ERACODA collaboration. Nephrol Dial Transplant. 2020;35(11):1973-1983.
13. Williamson EJ, Walker AJ, Bhaskaran K, et al. Factors associated with COVID-19-related death using OpenSAFELY. Nature. 2020;584(7821):430-436.
14. Lubetzky M, Aull MJ, Craig-Schapiro R, et al. Kidney allograft recipients, immunosuppression, and coronavirus disease-2019: a report of consecutive cases from a New York City hospital. Nephrol Dial Transplant. 2020;35(7):1250-1261.
15. Mehta P, McAuley DF, Brown M, et al. COVID-19: consider cytokine storm syndromes and immunosuppression. Lancet. 2020;395(10229):1033-1034.
16. Nadim MK, Forni LG, Mehta RL, et al. COVID-19-associated acute kidney injury: consensus report of the 25th Acute Disease Quality Initiative (ADQI) Workgroup. Nat Rev Nephrol. 2020;16(12):747-764.
17. Mohamed IH, Chowdary PB, Shetty S, et al. Outcomes of renal transplant recipients with SARS-CoV-2 infection in the intensive care unit: A single-center experience. Transplantation. 2021;105(3):e81-e86.
18. Cravedi P, Mothi SS, Azzi Y, et al. COVID-19 and kidney transplantation: Results from the TANGO International Transplant Consortium. Am J Transplant. 2020;20(11):3140-3148.
19. Favà A, Cucchiari D, Montero N, et al. Clinical characteristics and risk factors for severe COVID-19 in hospitalized kidney transplant recipients: A multicentric cohort study. Am J Transplant. 2020;20(11):3030-3041.
20. Meshram HS, Kute VB, Chapal M, et al. Feasibility and safety of remdesivir in SARS-CoV2 infected renal transplant recipients: A retrospective cohort from a developing nation. Transpl Infect Dis. 2021;23(2):e13449.