Open Access

Original Article

Acute Kidney Injury in COVID-19 and its Association with Patient Outcome

Amna Ashraf, Faisal Mehmood, Zahid Farooq Baig, Muhammad Arslan Javed, Muhammad Arsalan Javaid, Karamat Hussain Shah Bukhari

Department of Medicine, Combined Military Hospital, Lahore/National University of Medical Sciences (NUMS) Pakistan

ABSTRACT

Objective: To investigate the association between acute kidney injury (AKI) with patient outcome, among patients with COVID-19 and compare its outcome with patients who did not develop AKI.

Study Design: Comparative cross sectional study.

Place and Duration of Study: COVID-19 Intensive Treatment Unit, Combined Military Hospital, Lahore Pakistan, from Apr to Jul 2020.

Methodology: We retrospectively reviewed the medical records of individuals with severe pneumonia caused by SARS-CoV-2 and having acute kidney infections hospitalized at Combined Military Hospital, Lahore. Patients were divided into two groups, Group-A (patients who developed acute kidney injury during their stay) and Group-B (patients who did not develop acute kidney injury). The outcome was compared in both groups.

Results: Of the 350 patients studied, 83 developed acute kidney injury (23.7%). Of the 350 patients with AKI, 59(71.08 %) were males, and 24(28.9%) were females, with a mean age of 68.3 years. Among acute kidney injury, urea (p=0.001), sodium (p=0.01) and potassium (p=0.001) were significantly different as compared to non-AKI patients. Independent predictors of severe AKI were chronic kidney disease and higher serum potassium at admission.

Conclusion: Acute kidney injury and renal replacement therapy are common in critically ill patients presenting with COVID-19. It is associated with increased severity of illness on admission to ICU, increased mortality and prolonged ICU and hospital length of stay.

Keywords: Acute kidney injury, Chronic kidney disease, COVID-19. Comorbidities.

How to Cite This Article: *Ashraf A, Mehmood F, Baig ZF, Javed MA, Javaid MA, Bukhari KHS. Acute Kidney Injury in COVID-19 and its Association with Patient Outcome. Pak Armed Forces Med J 2023; 73(5): 1472-1475. DOI: https://doi.org/10.51253/pafmj.v73i5.7876*

INTRODUCTION

Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) was initially identified in December 2019 and was the cause of the present worldwide pandemic and coronavirus disease 2019 (COVID-19).[1] The pulmonary signs of COVID-19 are the most visible. However, acute kidney injury (AKI) is now acknowledged as a public problem of the condition, and it is commonly visible at the time of admission to the hospital. Though early data from China revealed comparatively low rates of renal involvement,[2,3] consequent findings from the United States and Europe show substantially greater rates of AKI, mostly in the critical care setting, with up to 45% of ICU patients demanding kidney replacement treatment (KRT).[4,5] Hospitalized patients with COVID-19-associated AKI (COVID-19 AKI) had a greater death rate than those who do not have renal disease.[6] The death rate for patients admitted to the Intense Care Unit with COVID-19 AKI needing KRT is particularly high, as it is in other cases of AKI in the circumstance of multi-organ failure requiring ICU admission. Anecdotal accounts of a deficiency of renal recovery in those who stay alive, compared to other types of AKI, are particularly concerning.[7] Long-term patient consequences, however, are still unknown due to longer hospital stays and a paucity of recorded follow-up.[8] Due to disparities in the underlying comorbidities of the populations studied, as well as significant variation in the practice and techniques of AKI diagnosis and reporting, determining the exact epidemiology of COVID-19 AKI is difficult. Patients with COVID-19 have an increased risk of AKI when they are older, have a history of Hypertension, or have diabetes mellitus.[9] Chronic kidney disease (CKD) is a well-known risk factor for AKI patients in hospitals, and in 3,099 critically sick patients with COVID-19, it was found to be the most important risk factor for AKI needing KRT.[10] The study was carried out to investigate the association between acute kidney injury (AKI) with patient outcome, among patients with COVID-19 and to compare its outcome with patients who did not develop AKI.

METHODOLOGY

The cross sectional study was carried out the COVID-19 ITC, Department of Medicine, Combined

Correspondence: Dr Amna Ashraf, Department of Medicine, Combined Military Hospital, Lahore Pakistan

Received: 19 Dec 2021; revision received: 10 Jul 2023; accepted: 23 Jul 2023

Military Hospital, Lahore Pakistan, from April 2021 to July 2021. The sample was calculated using the WHO sample size calculator, taking prevalence of AKI of 28%.[11] Ethical approval was obtained from the Institutional Review Board (Number 296/2021).

Inclusion Criteria: Patients of either gender aged 18-95 years, diagnosed with COVID-19 based on RT-SARS CoV-2 PCR were included in the study.

Exclusion Criteria: Patients with a history of Chronic kidney disease, patients on maintenance hemodialysis, patients with renal transplant, patients with baseline deranged Renal Function tests at the time of admission, pregnancy and patients who were readmitted for AKI were excluded.

Non-probability consecutive sampling was employed. After informed written consent, patients admitted to COVID-19 ITC fulfilling the inclusion criteria were included in the study. Patients were divided into two groups. Group-A patients who developed Acute Kidney injury during their stay and Group-B patients who did not develop acute kidney injury. Then, the outcome was compared in both groups. History taking and the trainee researcher performed a physical examination. Demographic, clinical and laboratory data was obtained from the medical records. Previous comorbidities and medications were documented. Laboratory data, including renal function tests and chest CT findings, was obtained at admission. Serial monitoring was done, and patients who developed AKI were marked as Group-A. Patients who did not develop AKI during the COVID-19 stay were marked as Group-B. Outcome was compared in both groups regarding mortality. Age, gender and co-morbid were also recorded to ascertain their correlation with AKI. KDIGO defines

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 23.00 and MS Excel 2016 software. Mean±SD was calculated for continuous variables. Frequencies and percentages were calculated for qualitative variables. Chi-square test was applied to explore the inferential statistics. The *p*-value of 0.05 or less was taken as significant.

RESULTS

Data from 350 patients with acute kidney injuries was collected. The age range of the patients was from 18-95 years, with a mean age of 68.3±10.6 years. In our study, 208(59.4%) were males, while the rest were females. Among males, 81 patients had AKI, and among females, 52 patients had AKI, as shown in Table-I. Among people with diabetes, 43 patients developed AKI, and 33 patients did not develop AKI. Among Ischemic Heart Disease (IHD), 22 patients developed AKI, and 28 patients did not develop AKI, with a *p*-value of 0.347, (Table-II)

Table-I: Comparison of demographics of COVID- 19 patients suffering from Acute Kidney Injury and Non- acute kidney injury (n=350)

Demographic Variables	Acute Kidney Injury (n=133)	Non-Acute Kidney Injury(n=217)	*p*-value
Age Groups			
18–77 Years	105(78.9%)	177(81.6%)	0.549
78–95 Years	28(21.1%)	40(18.4%)	
Gender			
Male	81(60.9%)	127(58.5%)	0.66
Female	52(39.1%)	90(41.5%)	

Table-II: Association of Co-morbids with the development of Acute Kidney Injury in COVID-19 (n=350)

Co-morbids	Study Groups		*p*-value
	Acute Kidney Injury (n=133)	Non- Acute Kidney Injury (n=217)	
Diabetes Mellitus			
Yes	43(32.3%)	33(15.2%)	0.001
No	90(67.7%)	184(84.8%)	
Hypertension			
Yes	20(15.0%)	24(11.1%)	0.277
No	113(85.0%)	193(88.9%)	
Ischemic Heart Disease			
Yes	22(16.5%)	28(12.9%)	0.347
No	111(83.5%)	189(87.1%)	

Patient outcome was measured in terms of mortality and compared with the development of AKI. Thirty-nine patients who developed AKI were expired, as compared to 11 patients who died without having any evidence of AKI, with a *p*-value of 0.001 which is significant (Table-III).

Table III: Association of Acute Kidney Injury with Patient Outcome (n=350)

Patient Death	Study Groups		*p*-value
	Acute Kidney Injury (n=133)	Non-Acute Kidney Injury (n=217)	
Yes	39(29.3%)	11(5.1%)	0.001
No	94(70.7%)	206(94.9%)	

DISCUSSION

Acute kidney injury and renal replacement therapy are common in critically ill patients presenting with COVID-19. It is associated with increased severity of illness on admission to ICU, increased mortality and prolonged ICU and hospital length of stay.

According to initial data, it was shown that AKI and kidney abnormalities appear to be linked with the

severity and consequences of coronavirus syndrome 2019 (COVID-19).[12,13] A recent study which used autopsy samples from 26 patients who passed away due to COVID-19 in China revealed signs of SARS-CoV-2 invasion into kidney tissue, with major acute tubular damage and endothelial destruction, as well as glomerular and vascular variations revealing underlying diabetic or hypertensive illness.[14]

Enormous discrepancies had been detected in the occurrence of comorbidities in patients with COVID-19 and AKI. For example, we found out that Hypertension was present in 45.7% of AKI patients and 34.08% of non-AKI patients in our population, which was higher as compared to other studies.[14] In the current study, diabetes was present in 43.3% of AKI patients and 21.3% of non-AKI patients, which was marginally constant with other studies from the United States, which reported 41-47% of people with diabetes but contradicted China work, which described 14% diabetics.[15] In contrast to research from the United States, it was not found that Hypertension and diabetes are risk factors for death in COVID-19 individuals with AKI.[5] In contrast to the study by Kolhe and Fluck's work, cardiac and thromboembolic problems like CCF, ACS, PVD, and CVA were scarce and did not demonstrate any relationship with the three disease consequences.[16] After being admitted to the hospital, the majority of our patients established Acute Kidney Injury. As revealed in meta-analyses, the enlargement of AKI in hospitals and the public influences the conclusion. Community-acquired AKI had enhanced diagnosis and required less time to stay in the ICU.[17]

In current history, the number of patients with AKI who required acute RRT had never been higher. Although anecdotal reports of AKI's occurrence and severity, the epidemiology of AKI, particularly recovery from AKI in hospitalized patients in the United States, notably in New York City, remained little understood.[18] The goal of this research was to characterize the occurrence, harshness, risk factors, and results of AKI in the context of COVID-19 hospitalization in a large NYC healthcare system.

The significant connection between AKI and respiratory failure in hospitalized patients with severe COVID-19 was formerly described.[5] In our study, it was described that individuals with AKI had higher serum creatinine on admission, which had previously been reported in a Chinese population.[1] AKI patients had 282µmol/L of creatinine, but non-AKI patients had 97.8µmol/L. Patients who are associated with kidney disease at the time of admission had more possibility to develop AKI. Finally, our research was conducted at a national referral centre for respiratory diseases, which sees a disproportionately high number of patients with severe COVID-19, which might lead to referral bias. However, this specific group was appropriate to recognize the risk elements for AKI in Mexican patients with severe COVID-19.

CONCLUSION

Acute kidney injury and renal replacement therapy are common in critically ill patients presenting with COVID-19. It is associated with increased severity of illness on admission to ICU, increased mortality and prolonged ICU and hospital length of stay.

Conflict of Interest: None.

Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

AA & FM: Data acquisition, data analysis, critical review, approval of the final version to be published.

ZFB & MAJ: Study design, drafting the manuscript, data interpretation, critical review, approval of the final version to be published.

MAJ& KHSB: Critical review, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ. Clinical characteristics of coronavirus disease 2019 in China. N Eng J Med 2020; 382(18): 1708-1720. https://doi.org/10.1056/NEJMoa200 2032
2. Batlle D, Soler MJ, Sparks MA, Hiremath S, South AM, Welling PA, et al. Acute kidney injury in COVID-19: emerging evidence of a distinct pathophysiology. J Ame Soc Nephrol 2020; 31(7): 1380-1383. https://doi.org/10.1681/ASN.2020040419.
3. Cheng Y, Luo R, Wang K, Zhang M, Wang Z, Dong L, et al. Kidney disease is associated with in-hospital death of patients with COVID-19. Kidney Int 2020; 97(5): 829-838. https://doi.org/10.1016/j.kint.2020.03.005.
4. Goldfarb DS, Benstein JA, Zhdanova O, Hammer E. Impending shortages of kidney replacement therapy for COVID-19 patients. Clin J Ame Soc Nephrol 2020; 15(6): 880-882.
5. Hirsch JS, Ng JH, Ross DW, Sharma P, Shah HH, Barnett RL, et al; Northwell COVID-19 research consortium; Northwell nephrology COVID-19 research consortium. Acute kidney injury in patients hospitalized with COVID-19. Kidney Int 2020; 98(1): 209-218. https://doi.org/10.1016/j.kint.2020.05.006.
6. Mohamed MMB, Lukitsch I, Ortiz AE, Walker JB, Varghese V, Arroyo CF, et al. Acute kidney injury associated with coronavirus disease 2019 in Urban New Orleans. Kidney 360 2020; 1(7): 614-622. https://doi.org/10.34067/KID.0002652020.
7. Cummings MJ, Baldwin MR, Abrams D, Jacobson SD, Meyer BJ, Balough EM, et al. Epidemiology, clinical course, and outcomes

of critically ill adults with COVID-19 in New York City: a prospective cohort study. Lancet 2020; 395(10239): 1763-1770.
8. Ng JH, Hirsch JS, Hazzan A, Wanchoo R, Shah HH, Malieckal DA, et al; Northwell nephrology COVID-19 research consortium. Outcomes among patients hospitalized with COVID-19 and acute kidney injury. Am J Kidney Dis 2021; 77(2): 204-215.e1. https://doi.org/10.1053/j.ajkd.2020.09.002.
9. Gupta S, Coca SG, Chan L, Melamed ML, Brenner SK, Hayek SS, et al. AKI treated with renal replacement therapy in critically ill patients with COVID-19. J Am Soc Nephrol 2021; 32(1): 161-176. https://doi.org/10.1681/ASN.2020060897.
10. Carlson N, Kristensen KE, Freese Ballegaard E, Rasmussen B, Hornum M. Increased vulner-ability to COVID-19 in chronic kidney disease. J Int Med 2021; 290(1): 166-178.
11. Silver SA, Beaubien-Souligny W, Shah PS, Harel S, Blum D, Kishibe T, et al. The Prevalence of acute kidney injury in patients hospitalized with COVID-19 infection: A systematic review and meta-analysis. Kidney Med. 2021; 3(1): 83-98.e1. https://doi.org/10.1016/j.xkme.2020.11.008.
12. Yanez ND, Weiss NS, Romand JA, Treggiari MM. COVID-19 mortality risk for older men and women. BMC Public Health 2020; 20(1): 1742. https://doi.org/10.1186/s12889-020-09826-8.
13. Ioannidis JPA, Axfors C, Contopoulos-Ioannidis DG. Population-level COVID-19 mortality risk for non-elderly individuals overall and for non-elderly individuals without underlying diseases in pandemic epicenters. Environ Res 2020; 188: 109890. https://doi.org/10.1016/j.envres.2020.109890.
14. Shibata S, Arima H, Asayama K, Hoshide S, Ichihara A, Ishimitsu T, et al. Hypertension and related diseases in the era of COVID-19: a report from the Japanese society of hypertension task force on COVID-19. Hypertens Res 2020; 43(10): 1028-1046. https://doi.org/10.1038/s41440-020-0515-0.
15. Cheng Y, Luo R, Wang K, Zhang M, Wang Z, Dong L, et al. Kidney disease is associated with in-hospital death of patients with COVID-19. Kidney Int 2020; 97(5): 829-838. https://doi.org/10.1016/j.kint.2020.03.005.
16. Kolhe NV, Fluck RJ, Selby NM, Taal MW. Acute kidney injury associated with COVID-19: A retrospective cohort study. PLoS Med 2020; 17(10): e1003406. https://doi.org/10.1371/journal.pmed.1003406.
17. Huang L, Xue C, Kuai J, Ruan M, Yang B, Chen X, et al. Clinical characteristics and outcomes of community-acquired versus hospital-acquired acute kidney injury: A Meta-Analysis. Kidney Blood Press Res 2019;44(5):879-896. https://doi.org/10.1159/000502546.
18. Murugan R, Karajala-Subramanyam V, Lee M. Genetic and inflammatory markers of sepsis (GenIMS) Investigators: Acute kidney injury in non-severe pneumonia is associated with an increased immune response and lower survival. Kidney Int 2010; 77(6): 527-535. https://doi.org/10.1038/ki.2009.502.