

Incidence of Acute Kidney Injury in Hospitalized COVID-19 Patients

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Abstract

Background: Acute kidney injury (AKI) is common among patients hospitalized with COVID-19 and associated with worse prognosis. **Objective:** We aim to assess the incidence of AKI in hospitalized COVID-19 patients. **Materials and Methods:** This is a retrospective cross-sectional study conducted at Merjan Teaching Hospital from May 1 to October 1, 2021. It involved a review of data of 174 hospitalized polymerase chain reaction-confirmed COVID-19 patients from hospital health records. **Results:** In our hospitalized COVID-19 patients, AKI was found in 14 patients forming 8.05% of the total hospitalized patients. The age of participants with AKI was 62.64 ± 19.08 years; male patients formed the larger proportion (53.45%). More than one-third of the patients (36.21%) had a history of hypertension, and more than one-fifth of the patients had a history of diabetes mellitus (22.99%). History of ischemic heart disease was present in 4.60%, heart failure in 0.57%, asthma in 3.45%, chronic obstructive pulmonary disease in 1.15%, cerebrovascular accidents in 1.75%, and lung fibrosis in 1.15%. Patients with AKI had a significantly higher level of blood urea (22.44 ± 11.74); the level of serum creatinine was also significantly higher among patients with AKI (267.57 ± 87.27); significant relationship was observed between the outcome of the patient and the incidence of AKI. **Conclusions:** The current study showed a higher risk of mortality and morbidity in COVID-19 patients with AKI. Identifying high-risk groups and earlier diagnosis of AKI in COVID-19 patients can improve results in patients and decrease mortality.

Keywords: AKI, COVID-19, urea

INTRODUCTION

In December 2019, a new type of coronavirus was identified called novel coronavirus (2019-nCoV, or COVID-19) in Wuhan, China. After that, a rapid spread of this virus was recorded in all parts of China and the world. In March 2020, the WHO announced COVID-19 as a pandemic. Coronaviruses are a group of single-stranded RNA viruses belongs to the Coronaviridae family, Nidovirales order.^[1]

COVID-19 generally causes a fever and cough, which may appear after exposure to the virus in some patients between 2 and 14 days, particularly the elderly and others with other chronic health conditions; other reported symptoms are weakness, malaise, respiratory distress, muscle pain, sore throat, loss of taste and/or smell, confusion, and diarrhea in some patients.^[2,3]

These symptoms may develop into pneumonia, which manifests as chest discomfort, shortness of breath, and tightness, which necessitates hospitalization and

treatment. Severe pneumonia, acute respiratory distress syndrome, sepsis, and septic shock may all occur in more extreme instances, putting the patient's life at risk.^[4]

There are several ways to diagnose the disease early such as PCR method, computed tomography (CT scan), blood test for serum antibodies, and artificial intelligence. Chest CT finding of COVID-19 infection is typical to be multiple bilateral ground-glass opacities (GGOs) with a predominantly peripheral distribution. The general finding of COVID-19 disease can be with a variety of CT findings, the most common findings in general are GGO, crazy-paving pattern, and consolidation, respectively, pleural thickening, and rarely pleural effusion.^[5,6]

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About therapies, there is no specific therapy although variable antiviral agents are tried, including remdesivir, ribavirin, favipiravir, chloroquine, hydroxychloroquine, oseltamivir; immunomodulatory agents (tocilizumab, interferons); and adjunctive agents (O_2 , plasma transfusion, antibiotics, corticosteroids), among other miscellaneous agents.^[7]

The prevention includes home quarantine and avoiding any close contact with any healthy (possible asymptomatic patients) or infected person, the use of face mask, good hygiene, and avoiding travel as possible; many vaccines developed are based upon inactivated or live attenuated viruses, protein subunit, virus-like particles, viral vector, DNA, RNA, and nanoparticles.^[8]

Among admitted patients with COVID-19, acute renal failure is the most common renal manifestation. According to KDIGO (Kidney Disease Improving Global Outcomes), acute kidney injury (AKI) is defined as any of the following:

1. A serum creatinine (SCr) elevation by ≥ 0.3 mg/dL within 2 days
2. A SCr elevation ≥ 1.5 times the baseline within the prior 7 days
3. Urine volume < 0.5 mL/kg/h for 6 h.

Regarding the KDIGO staging:

1. Stage 1: SCr elevation to 1.5–1.9 times baseline or by ≥ 0.3 mg/dL
2. Stage 2: SCr elevation to 2.0–2.9 times baseline
3. Stage 3: SCr elevation to 3.0 times baseline or to ≥ 4.0 mg/dL or the initiation of renal replacement therapy.^[9]

Additionally, patients who are severely ill are considerably more likely to develop AKI, which is linked to a worse prognosis and a greater mortality rate. As a result, knowledge of the underlying pathophysiology of kidney injury during COVID-19 is essential for early detection and proper management.^[10]

MATERIALS AND METHODS

This is a retrospective cross-sectional study conducted at Merjan Teaching Hospital from May 1 to October 1, 2021. It involved a review of data of 174 hospitalized PCR-confirmed COVID-19 patients from hospital health records. The data were completely collected from patients' health records after agreement had been taken from the Department of Statistics and the manager of Merjan Teaching Hospital regarding the data collection. No direct contact was made with patients, but their information was made totally confidential. Data were collected using a predesigned questionnaire form that included: age; gender; history of chronic illnesses (DM, HTN, heart failure, ischemic heart disease, cerebrovascular accidents, asthma, chronic obstructive pulmonary disease, or any lung disease);

if female patient, pregnant or not; CT involvement; oxygen saturation; need for CPAP; lab data about urea and SCr 48 h after hospitalization, Complete blood count (white blood cells [WBC], lymphocytes, neutrophils, and platelet counts); renal size by abdominal ultrasound if available; drugs: antibiotics (meropenem, vancomycin, ceftriaxone), anti-viral agents (remdesivir, favipiravir, actemra), steroids, and non-steroidal anti-inflammatory drugs; duration of hospital stay; and finally the fate of the patient if discharged home or dead. The total number of health records during the above mentioned period was 337; only 174 of them were included in the study. Patients had been considered to have AKI when they met the criteria of AKI according to KDIGO, which is defined as an increase in SCr by ≥ 0.3 mg/dL (≥ 26.5 μ mol/L) within 48 h. In this study, the inclusion criteria included all adult hospitalized patients who tested positive by PCR testing of a nasopharyngeal sample for COVID-19 from May 1 to October 1, 2021, whereas the exclusion criteria included hemodialysis patients; previous diagnosis with CKD (known ultrasound or urine abnormality such as single kidney, cystic kidney, kidney transplants, proteinuria); patients with malignancy; diabetic nephropathy.

Data analysis

SPSS software (version 23.0) was used to perform statistical analysis for this study. Continuous variables were represented as means $\pm$ standard deviation (SD), whereas categorical variables were represented as frequencies and percentages. Student's t-test was used to compare means between two groups, whereas chi-square test was used to assess the relationship between categorical variables. *P* value of ≤ 0.05 was considered statistically significant.

Ethical approval

This study was approved by Scientific Committee of Family and Community Medicine Department and approved by ethical committee of University of Babylon, College of Medicine after reviewing the proposal of the study. The study protocol and the subject information and consent form were reviewed and approved by a local ethics committee according to the document number 65 (including the number and the date in 11/5/2022) to get this approval. Additional formal approvals were obtained from the Merjan Teaching Hospital/Department of Statistics. Information collected was treated with confidentiality during data collection and analysis.

RESULTS

This study included a total of 174 patients confirmed with COVID-19 by PCR. The age of participants ranged from 20 years to 95 years with a mean age of 53.14 ± 15.47 years and a median of 52 years. More than 45% of the patients were within age group 50–59 years. Male patients formed the larger proportion (53.45%), whereas female patients formed the remaining 46.55% of the patients.

Details of a past medical history (hypertension, diabetes mellitus, cardiac diseases, asthma) among study patients are provided in Table 1.

Patients who had AKI were 14, forming 8.05% of the total study patients. Comparisons between patients with AKI and those with no AKI regarding demographic characteristics are summarized in Table 2.

Comparisons between patients with AKI and those who had no AKI regarding laboratory tests were performed using Student's t-test [Table 3] and chi-square test [Table 4].

Regarding blood urea, patients with AKI had a significantly higher level of blood urea (22.44 ± 11.74); proportion of patients with elevated blood urea who had AKI was significantly larger than the proportion of patients with normal blood urea who had AKI (14.13% vs. 1.23%).

Table 1: Past medical history of study participants ($n = 174$)

History	Frequency	Percentage
HT	63	36.21
DM	40	22.99
IHD	8	4.60
Asthma	6	3.45
CVA	3	1.75
COPD	2	1.15
Lung fibrosis	2	1.15
Heart failure	1	0.57

CVA: cerebrovascular accidents, COPD: chronic obstructive pulmonary disease, IHD: ischemic heart disease

The level of SCr was also significantly higher among patients with AKI (267.57 ± 87.27); patients with elevated SCr who had AKI formed 63.64% of the total patients with elevated SCr, with P value of <0.001 .

No significant differences were observed between patients with AKI and patients with no AKI regarding neither WBC count, lymphocytes, nor platelets.

The need for CPAP was significantly associated with AKI, with P value of 0.007 [Table 5]. Odds ratio for patients with AKI to require CPAP was 4.45, with 95% confidence interval of 1.40–14.15. Patients with AKI were approximately 5 times more likely to require CPAP as compared to those with no AKI.

A significant relationship was observed between the outcome of the patient and the incidence of AKI. More than 19% of the patients who died in the respiratory care unit (RCU) had AKI, whereas less than 5% of those who were discharged home had AKI; P value = 0.003 [Table 6].

DISCUSSION

In our hospitalized COVID-19 patients, AKI was found in 14 patients forming 8.05% of the total hospitalized patients ($n = 174$), whereas in other study of 1392 hospitalized patients with COVID-19, AKI occurred in 99 patients (7%).^[11]

More than 45% of the patients were within the age group 50–59 years. Patients with AKI were significantly older

Table 2: Comparisons of demographic characteristics between AKI patients and non-AKI patients

Variable		Group		Total	P value
		AKI ($n = 14$)	No AKI ($n = 160$)		
Age	Mean $\pm$ SD	62.64 ± 19.08	52.31 ± 14.90	53.14 ± 15.47	0.016*
Gender	Male	8 (8.60%)	85 (91.40%)	93 (100%)	0.773
	Female	6 (7.41%)	75 (92.59%)	81 (100%)	
Pregnant	Yes	-	5 (100%)	5 (100%)	0.514
	No	6 (7.89%)	70 (92.11%)	76 (100%)	

SD: standard deviation

*Significant at $P < 0.05$

Table 3: Comparisons of levels of laboratory tests between AKI patients and non-AKI patients

Variable	Group	n	Mean $\pm$ SD	Total, mean $\pm$ SD	P value
Blood urea	AKI	14	22.44 ± 11.74	9.12 ± 6.01	$<0.001^*$
	No AKI	160	7.96 ± 3.34		
SCr	AKI	14	267.57 ± 87.27	102.18 ± 58.94	$<0.001^*$
	No AKI	160	87.71 ± 23.21		
WBC	AKI	14	9.47 ± 6.59	9.38 ± 5.49	0.950
	No AKI	160	9.37 ± 5.41		
Lymphocytes	AKI	14	0.76 ± 0.45	0.99 ± 0.74	0.227
	No AKI	160	1.01 ± 0.76		
Platelets	AKI	14	190.07 ± 100.58	220.01 ± 90.35	0.197
	No AKI	160	222.63 ± 89.27		

SD: standard deviation, WBC: white blood cells

*Significant at $P < 0.05$

Table 4: Comparisons of laboratory tests between AKI patients and non-AKI patients using chi-square test

Variable		Group		Total	P value
		AKI	No AKI		
Blood urea (mmol/L)	Low (<2.5)	-	14 (100%)	14 (100%)	0.008*
	Normal (2.5–7.5)	1 (1.23%)	80 (98.77%)	81 (100%)	
	Elevated (>7.5)	13 (14.13%)	79 (85.87%)	92 (100%)	
SCr (μmol/L)	Low (<61)	-	14 (100%)	14 (100%)	<0.001*
	Normal (61–132)	-	138 (100%)	138 (100%)	
	Elevated (>132)	14 (63.64%)	8 (36.36%)	22 (100%)	
WBC count	Low (<4.0)	4 (21.05%)	15 (78.95%)	19 (100%)	0.061
	Normal (4.0–10.0)	5 (5.05%)	94 (94.95%)	99 (100%)	
	Elevated (>10.0)	5 (8.93%)	51 (91.07%)	56 (100%)	
Lymphocytes	Low (<0.60)	6 (14.63%)	35 (85.37%)	41 (100%)	0.202
	Normal (0.60–4.10)	8 (6.06%)	124 (93.94%)	132 (100%)	
	Elevated (>4.10)	-	1 (100%)	1 (100%)	
Platelets	Low (<100)	1 (20.00%)	4 (80.00%)	5 (100%)	0.554
	Normal (100–300)	11 (8.15%)	124 (91.85%)	135 (100%)	
	Elevated (>300)	2 (5.88%)	32 (94.12%)	34 (100%)	

WBC: white blood cells

*Significant at $P < 0.05$ **Table 5: Need for CPAP of study patients**

CPAP	Group		Total	P value
	AKI	No AKI		
Yes	7 (17.50%)	33 (82.50%)	40 (100%)	0.007*
No	6 (4.55%)	126 (95.45%)	132 (100%)	
Total**	13 (7.56%)	159 (92.44%)	172 (100%)	
Odds ratio: 4.45 (95% CI = 1.40–14.15)				

*Significant at $P < 0.05$

**Two patients were excluded because they were put on endotracheal tube

Table 6: Outcome of the patients

Outcome	Group		Total	P value
	AKI	No AKI		
Died in RCU	8 (19.05%)	34 (80.95%)	42 (100%)	0.003*
Discharged home	6 (4.65%)	123 (95.35%)	129 (100%)	
Total**	14 (8.19%)	157 (91.81%)	171 (100%)	
Odds ratio: 4.82 (95% CI = 1.57–14.85)				

RCU: respiratory care unit

*Significant at $P < 0.05$

**Three patients were excluded because their outcomes were not documented

compared to those with no AKI. The age of participants with AKI was 62.64 ± 19.08 years and 52.31 ± 14.90 years without AKI. Other study showed that the age of patients with AKI and those without AKI as 68.48 ± 13.04 and 58.82 ± 16.14 years, respectively.^[12]

This study showed that the male patients formed the larger proportion (53.45%), whereas female patients formed the remaining 46.55% of the patients. Of the AKI group (14 patients), eight were males and six were females. Other study showed men and women as 55% and 45%, respectively. Men are most likely to be infected

with COVID-19 than women, maybe due to the fact that men are more outdoors and thus more chance to be infected.^[13,14]

There was no significance association between pregnancy and AKI; this can be explained by the low number of pregnant women admitted during the period specified for the study or due to less pregnant accepting hospitalization.

More than one-third of the patients (36.21%) had a history of hypertension, and more than one-fifth of the patients had a history of diabetes mellitus (22.99%). A history of ischemic heart disease was present in 4.60%, heart

failure in 0.57%, asthma in 3.45%, chronic obstructive pulmonary disease in 1.15%, cerebrovascular accidents in 1.75%, and lung fibrosis in 1.15%. More than one-third of the patients (36.21%) had history of hypertension, and more than one-fifth of the patients had history of diabetes mellitus (22.99%). History of IHD was present in 4.60%, HF in 0.57%, asthma in 3.45%, chronic obstructive pulmonary disease in 1.15%, CVA in 1.75% and lung fibrosis in 1.15%. While, in other study 140 patients with COVID-19 and 37.9%, 30.0% of those had history of hypertension and IHD (16.4%), DM (9.7%, 12.1%), COPD (1.4%),^[15] while asthma in study from reference^[16] showed 0.14% had history of asthma from 102 patients, while heart failure in 11.4% of 70 patients.^[17] Difference in comorbidities encountered may be explained by social orientation toward hospitalization.

This study showed no significant difference observed between CT involvement percentage and the incidence of AKI. Patients with AKI the CT percentage range (15%–60%) and the mean $\pm$ SD (40.50% $\pm$ 17.39%) whereas patients without AKI, CT range (5%–90%) and the mean $\pm$ SD (42.39% $\pm$ 21.59%). This could alert us not to concentrate only on the CT chest involvement to grade severity of clinical consequences.

This was in concordance with the results of oxygen saturation that showed patients with no AKI had higher SpO₂ (88.14% $\pm$ 9.96%) compared with AKI patients (82.57% $\pm$ 12.79%). However, this difference was not statistically significant (*P* value = 0.134).

In the lower ranges of oxygen saturation with the need for CPAP, it shows a significant association with AKI; patients with AKI were approximately 5 times more likely to require CPAP compared to those with no AKI. This could be explained being a component of multiple organ failure syndrome or specific renal hypoxia and tubular necrosis.

Regarding renal function tests, patients with AKI had a significantly higher level of blood urea (22.44 $\pm$ 11.74) compared to those with no AKI (7.96 $\pm$ 3.34). The proportion of patients with elevated blood urea who had AKI was significantly larger than the proportion of patients with normal blood urea who had AKI (14.13% vs. 1.23%). Other study also shows that patients with AKI had a higher level of blood urea nitrogen (BUN) compared to those with no AKI (blood urea = BUN $\times$ 2.14).^[18]

The level of SCr was also significantly higher among patients with AKI (267.57 $\pm$ 87.27) compared to those with no AKI (87.71 $\pm$ 23.21). Patients with elevated SCr who had AKI formed 63.64% of the total patients with elevated SCr. Other study also shows that patients with AKI had a higher level of SCr compared to those with no AKI.^[19] Other studies also showed that patients with AKI had a higher level of SCr compared to those with no AKI.^[19-21]

Regarding a complete blood count test, no significant differences were observed between patients with AKI and patients with no AKI regarding neither WBC count, lymphocytes, nor platelets.

The proportion of patients with low WBC (leukopenia) who had AKI was larger than the proportion of patients with normal and elevated WBC who had AKI (21.05% vs. 5.05% and 8.93%, respectively).

The proportion of patients with low lymphocytes (lymphopenia) who had AKI was larger than the proportion of patients with normal lymphocytes who had AKI (14.63% vs. 6.06%).

The proportion of patients with low platelets (thrombocytopenia) who had AKI was larger than the proportion of patients with normal and elevated platelets who had AKI (20.00% vs. 8.15% and 5.88%, respectively).

Although in another study of *n* = 95, 54 patients had AKI with normal leukocytes, lymphocytes, and platelets and 41 patients without AKI had normal leukocytes and lymphocytes but low platelets.^[16]

This study showed that a significant relationship was observed between the outcome of the patient and the incidence of AKI. More than 19% of the patients who died in the RCU had AKI, whereas less than 5% of those who were discharged home had AKI. Patients with AKI were approximately 5 times more likely to die in the RCU compared to those with no AKI; 4.65% of the patients with AKI were discharged home and 95.35% with no AKI; 19.05% with AKI died in RCU and 80.95% with no AKI. In other study (*n* = 1545), 41.08% with AKI discharged home and 90.6% with no AKI, and 58.02% with AKI died in RCU and 9.04% with no AKI, respectively.^[12]

CONCLUSIONS

The current study showed a higher risk of mortality and morbidity in COVID-19 patients with AKI. Identifying high-risk groups and earlier diagnosis of AKI in COVID-19 patients can improve results in patients and decrease mortality.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, *et al.* A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med* 2020;382:1708-20.
2. Lovato A, De Filippis C, Marioni G. Upper airway symptoms in coronavirus disease 2019 (COVID-19). *Am J Otolaryngol* 2020;41:102474.

3. D'Amico F, Baumgart DC, Danese S, Peyrin-Biroulet L. Diarrhea during COVID-19 infection: Pathogenesis, epidemiology, prevention, and management. *Clin Gastroenterol Hepatol* 2020;18:1663-72.
4. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, *et al.* Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med* 2020;382:1708-20.
5. Kim H. Outbreak of novel coronavirus (COVID-19): What is the role of radiologists? *Eur Radiol* 2020;30:3266-7.
6. Zhu J, Zhong Z, Li H, Ji P, Pang J, Li B, *et al.* CT imaging features of 4121 patients with COVID-19: A meta-analysis. *J Med Virol* 2020;92:891-902.
7. Coopersmith CM, Antonelli M, Bauer SR, Deutschman CS, Evans LE, Ferrer R, *et al.* The surviving sepsis campaign: Research priorities for coronavirus disease 2019 in critical illness. *Crit Care Med* 2021;49:598-622.
8. Hellewell J, Abbott S, Gimma A, Bosse NI, Jarvis CI, Russell TW, *et al.* Feasibility of controlling COVID-19 outbreaks by isolation of cases and contacts. *Lancet Glob Health* 2020;8:e488-96.
9. Kellum JA, Lameire N, Aspelin P, Barsoum RS, Burdmann EA, Goldstein SL, *et al.* Kidney disease: Improving global outcomes (KDIGO) acute kidney injury work group. KDIGO clinical practice guideline for acute kidney injury. *Kidney Int Suppl* 2012;2:1-138.
10. Hirsch JS, Ng JH, Ross DW, Sharma P, Shah HH, Barnett RL, *et al.* Acute kidney injury in patients hospitalized with COVID-19. *Kidney Int* 2020;98:209-18.
11. Cheng Y, Luo R, Wang X, Wang K, Zhang N, Zhang M, *et al.* The incidence, risk factors, and prognosis of acute kidney injury in adult patients with coronavirus disease 2019. *Clin J Am Soc Nephrol* 2020;15:1394-402.
12. Bandelac L, Shah KD, Purmessur P, Ghazanfar H, Nasr R. Acute kidney injury incidence, stage, and recovery in patients with COVID-19. *Int J Nephrol Renovasc Dis* 2022;15:77.
13. Olmstead T, Matthias A, Jane D, Tertilt RM. The impact of COVID-19 on gender equality. *Nat Bureau Econ Res* 2020;4:1-37.
14. Karlberg J, Chong DS, Lai WY. Do men have a higher case fatality rate of severe acute respiratory syndrome than women do? *Am J Epidemiol* 2004;159:229-31.
15. Zhang JJ, Dong X, Cao YY, Yuan YD, Yang YB, Yan YQ, *et al.* Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China. *Allergy* 2020;75:1730-41.
16. Neves PDMDM, Sato VAH, Mohrbacher S, Ferreira BMC, Oliveira ES, Pereira LVB, *et al.* Acute kidney injury due to COVID-19 in intensive care unit: An analysis from a Latin-American center. *Front Med* 2021;646. doi: 10.3389/fmed.2021.620050.
17. Arrestier R, Gendreau S, Mokrani D, Bastard JP, Fellahi S, Bagate F, *et al.* Acute kidney injury in critically-ill COVID-19 patients. *J Clin Med* 2022;11:2029.
18. Chan L, Chaudhary K, Saha A, Chauhan K, Vaid A, Zhao S, *et al.* AKI in hospitalized patients with COVID-19. *J Am Soc Nephrol* 2021;32:151-60.
19. Gu X, Huang L, Cui D, Wang Y, Wang Y, Xu J, *et al.* Association of acute kidney injury with 1-year outcome of kidney function in hospital survivors with COVID-19: A cohort study. *EbioMedicine* 2022;76:103817.
20. Sinjari HY, Ibrahim JM.. Thyroid function disorders in patients with chronic kidney disease. *Med J Babylon* 2022;19:76-80.
21. Al-Shibly KH, Al-Diwan JK.. Effect of the dietary protein intake on urea reduction rate in patients on maintenance hemodialysis in Merjan Teaching Hospital. *Med J Babylon* 2022;19:244-9.