Pakistan Journal of Intensive Care Medicine
eISSN: 2708-2261; pISSN: 2958-4728
www.pjicm.com
DOI: https://doi.org/10.54112/pjicm.v4i01.22
Pak. J. Inten. Care Med., volume 2024: 22
Original Research Article

A SINGLE-CENTER STUDY EVALUATING THE PREVALENCE, RISK FACTORS, AND CONSEQUENCES OF ACUTE KIDNEY INJURY IN THE INTENSIVE CARE UNIT

PERVAIZ R[*1], QAYYUM MA[2], KHALID SA[3], HAFEEZ T[2], MUNAWAR MU[1], ARIF HMH[1], KANDEEL H[4], ELMASRY WG[5], RAZA S[1]

[1]Department of Internal and Critical Care Medicine, Bahria International Hospital, Lahore, Pakistan
[2]Department of Nephrology, Division of Medicine, Bahria International Hospital, Lahore, Pakistan
[3]Department of Nephrology, Rashid Latif Khan University, Lahore, Pakistan
[4]Department of Critical Care Medicine, Hatta Hospital, Dubai Health, UAE
[5]Medical Intensive Care Unit, Rashid Hospital, Dubai Health, Dubai, UAE
**Corresponding author's email address:* drrizwanpervaiz@gmail.com

(Received, 30th November 2023, Revised 27th December 2023, Accepted 4 January 2024, Published 15 January 2024)

ABSTRACT

Background: *Acute kidney injury (AKI) is a significant complication in critically ill patients in intensive care units (ICUs), impacting morbidity, mortality, and overall patient outcomes.* ***Objectives:*** *To assess the frequency, risk factors, and implications of AKI among individuals admitted to the medical ICU at Bahria International Hospital between 2021 and 2022.* ***Study Design:*** *This study utilized a retrospective design.* ***Setting:*** *The study was conducted at Bahria International Hospital's medical ICU.* ***Duration of Study:*** *Data were collected between September 2022 and September 2023.* ***Material and Methods:*** *AKI frequency and risk factors were assessed using the Acute Kidney Injury Network (AKIN) criteria for staging. Risk factors such as age, hypertension, ACEI/ARB usage, and severity of underlying illnesses (measured by APACHE II scores) were analyzed. Multivariate analysis was performed to identify independent predictors of AKI occurrence.* ***Results:*** *The study found that 32.7% of ICU patients experienced AKI, primarily categorized as stage 1 AKI (60.12%). Advanced age, hypertension, ACEI/ARB usage, and higher APACHE II scores were significant risk factors for AKI development. Multivariate analysis identified age (HR 1.3, 95% CI 1.2-1.5, P = 0.01) and APACHE II score (HR 1.6, 95% CI 1.3-1.8, P = 0.02) as independent predictors of AKI occurrence.* ***Conclusion:*** *The incidence of AKI among ICU patients is substantial and associated with increased mortality and morbidity. Early identification and management of modifiable risk factors are crucial for mitigating AKI-related complications and improving patient outcomes. Proactive measures in critical care settings are necessary to reduce AKI burden and enhance patient care.*

Keywords: Acute Kidney Injury, Critical Illness, Intensive Care Units, Mortality, Risk Factors

INTRODUCTION

Acute kidney injury (AKI) is a common complication among critically sick patients in the intensive care unit (ICU), leading to higher mortality, morbidity, and duration of stay (1). Early detection and care of acute kidney injury (AKI) is crucial to reduce the likelihood of death, hospital stay, and chronic kidney disease (CKD), as the prevalence ranges from 2.5% to 92% (2-7). AKI is expected in the ICU because of several illnesses that impair organ self-regulation. The extent of dysfunction caused by AKI varies based on the original disease's genesis and severity, making treatment challenging. With this understanding, the application of treatment resources establishes clinical stability and prevents other challenges (5).

There is no standardized description of AKI in ICU settings. Several studies have utilized several categories to identify AKI in ICU patients, such as RIFLE (risk, injury, failure, loss, and end-stage renal failure), AKIN (acute kidney injury network), KDIGO (kidney disease improving global outcomes), and CK (creatinine kinetics) (8-12). There is less research on the prevalence of acute kidney injury (AKI) among patients in ICUs in Pakistan.

The purpose of this study was to analyze the prevalence, risk factors, and outcomes of acute kidney injury (AKI) in medical ICU patients in Pakistan.

METHODOLOGY

Data were gathered from patients hospitalized in the medical ICU of Bahria International Hospital in Lahore using a retrospective research methodology. Every patient hospitalized in a medical ICU during *September 2022 and September 2023* had their medical records examined. In cases when the patient had many admissions, analysis was done on the initial admission. From patient files, demographic information was taken out, such as gender, years of age, concurrent medical conditions, reason for admission, drugs, laboratory findings, and duration of ICU stay. To characterize and stage AKI, we employed the categorization system (AKIN) (13, 14).

AKIN is an amended version of the previous RIFLE classification for AKI, which calls for 48 hours, during which there must be a minimum 26.4 μmol/l rise in serum creatinine or a reduction in urine output. AKI is considered, per AKIN, following the achievement of appropriate hydration and the exclusion of urinary blockage. The glomerular filtration rate (eGFR) was estimated using the Modification of Diet in Renal Disease (MDRD) equation. Intravenous contrast injection within one week of the beginning of AKI was regarded as contrast exposure.

The hospital's institutional review board gave the study approval without any restriction.

The data analysis was done with SPSS version 21. Patients were split into two groups: those who had AKI and those who did not. We utilized the unpaired t-test to compare differences among naturally distributed data and the mean and standard deviation (±SD) for continuous variables. For categorical variables, percentages were employed. In cases where the data were not normally distributed, the nonparametric categories were compared using the Mann-Whitney U-test. +e The categorical variables were tested using the Pearson chi-square test. The independent predictors of AKI were identified using univariate and multivariate regression analyses (depending on essential variables in the univariate analysis along those factors

[Citation Pervaiz, R., Qayyum, M.A., Khalid, S.A., Hafeez, T., Munawar, M.U., Arif, H.M.H., Kandeel, H., Elmasry, W.G., Raza, S. (2024). A single-center study evaluating the prevalence, risk factors, and consequences of acute kidney injury in the intensive care unit. *Pak. J. Inten. Care Med.* ***2024****: 22*. doi: https://doi.org/10.54112/pjicm.v4i01.22]

considered clinically significant by consultant nephrologists, like age, gender, comorbidities, APACHE II score, and serum albumin).

RESULTS

After 210 patients' records were examined, 70 were not included: 18 patients had end-stage renal disease and were receiving chronic hemodialysis, and 52 patients due to missing data. The study population was divided into the AKI group and the non-AKI group. Using the mean of the first three successive measurements, the mean arterial pressure (MAP) among the AKI cohort was 81.2 mmHg upon admission, while the non-AKI group's MAP was 78.2 mmHg (P = 0.08). At admission, the average eGFR was 90.3 ml/min (SD ± 72.1); the AKI groups was 71.2 ml/min (SD ± 61.6), while the non-AKI groups were 99.1 ml/min (SD ± 75.1) (P < 0.001).other details of [patient demographics are given in Table 1 below.

Table 1: Patient demographics details

Variable	(N) % N=140
Gender	
Male	80 (57%)
Female	60 (43%)
Comorbidities	
Diabetes	65(46%)
Hypertension	72(51%)
Ischemic heart disease	22(15%)
Peripheral vascular disease	6(4%)
Cerebrovascular accident	16(11%)
Cancer	14(10)
Drugs	
Angiotensin-converting enzyme inhibitors/ Angiotensin II receptor blockers	57(41%)
Nonsteroidal anti-inflammatory drugs	17(12%)
Contrast	27(19%)
APACHE II score, mean (±SD)	12.2 ±4.12
Mortality	
At the time of discharge	82(58%)
30 days after discharge	4(2.8%)

Neurological conditions accounted for the majority of admissions (24.2%), followed by respiratory conditions (22.1%) (Table 2). While sepsis (30.14%) was the most frequent cause of AKI, neurological diseases (19.8%) came in second. AKI was found in 32.7% of cases, with stage 1 AKI accounting for 60.12% of cases (Figure 1). Of the patients who experienced AKI, 21.8% began hemodialysis for various reasons: Dialysis was initiated for three reasons: 16.2% for long-lasting hyperkalemia, 47.7% for fluid overload that did not respond to diuretic medications, and 36.8% for a combination of the two. At the point of discharge, the non-AKI group had a mean eGFR of 128.2 ml/min (SD ± 186.8), while the AKI group had a mean of 62.2 ml/min (SD ± 84.7) (P < 0.001) while mean eGFR was 105.6 ml/min (SD ± 163.1).

Univariate data analysis revealed that AKI was predicted by increasing age (P = 0.002), hypertension (P = 0.003), use of ACEI/ARBs (P = 0.004), and APACHE II score (13.1 ±3.9 for AKI vs. 9.8 ± 4.4 for non-AKI) p =0.01 (Table 3). In the multivariate analysis, age (HR 1.3, 95% CI 1.2-1.5, P = 0.01) and APACHE II score (HR 1.6, 95% CI 1.3-1.8, P = 0.02) were significant predictors of AKI. The mean duration of the ICU stay was 12.7 days, with 10.5 days among the AKI group and 11.4 days among the non-AKI group (P = 0.08). The investigation failed to gather data on the time frame between ICU admission and AKI incidence due to insufficient or inaccurate data. The AKI group had a mortality rate of 60.9%, compared to 39.1% in the non-AKI group (P = 0.02). At 30 days following discharge, the AKI group had a 75% death rate compared to the non-AKI group's 25% (P = 0.04). Patients with severe AKI (stage 3) reported a greater death rate (89%) than those with stage 2 (74.9%) or stage 1 (60.1%) (P = 0.03).

Table 2: Principal reasons for admission

Variable	(N) % N=140
Respiratory	31(22.1%)
Respiratory failure	7(5)
Severe pneumonia	17(12)
Pulmonary embolism	4(2.8)
Bronchial asthma	3(2.14)
Cardiology	17(12.1%)
Acute coronary syndrome	8(5.7)
Arrhythmia	5(3.5)
Cardiac arrest	2(1.4)
Hypertensive emergency	2(1.4)
Neurology	34(24.2)
Hemorrhagic stroke	15(10.7)
Ischemic stroke	12(8.5)
Seizure	7(5)
Gastrointestinal	18(12.8)
Liver cirrhosis	6(4.2)
Upper gastrointestinal bleeding	9(6.4)
Abdominal pain	3(2.1)
Endocrinology	13(9.2)
Diabetic ketoacidosis	12(8.5)
Hypoglycemia	1(0.7)
Sepsis	19(13.5)
Electrolyte disorders	13(9.2)
Malignancy	14(10)

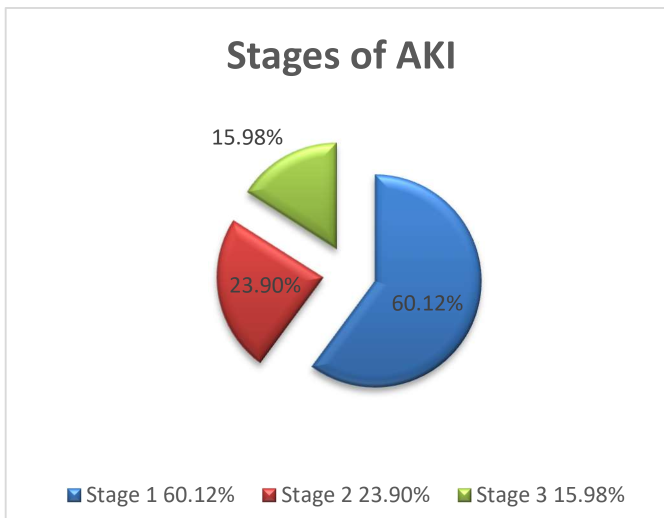

Figure 1: Stages of AKI in the study population

[Citation Pervaiz, R., Qayyum, M.A., Khalid, S.A., Hafeez, T., Munawar, M.U., Arif, H.M.H., Kandeel, H., Elmasry, W.G., Raza, S. (2024). A single-center study evaluating the prevalence, risk factors, and consequences of acute kidney injury in the intensive care unit. *Pak. J. Inten. Care Med.* ***2024****: 22*. doi: https://doi.org/10.54112/pjicm.v4i01.22]

Table 3: Comparison between both groups

Variable	AKI group N= 70 (%)	Non-AKI group N=70 (%)	P value
Age (Years), mean (± SD)	61.4 ± 19.2	52.9 ± 22.1	0.0002
Age Groups (Years)			
<60	20(28.5)	30(43.8)	0.06
60–69	34(48.5)	32(45.7)	
>70	16(22.8)	8(11.4)	
Sex			
Male	42(60)	38(54.3)	0.25
Female	28(40)	32(45.7)	
Comorbidities			
Diabetes mellitus	24(36.9)	41(63.1)	0.16
Hypertension	30(41.6)	42(58.4)	0.003
Ischemic heart disease	7(31.8)	15(0)	0.08
Cerebrovascular accident	6(37.5)	10(62.5)	0.14
Cancer	5(35.7)	9(64.3)	0.04
Peripheral vascular disease	2(33.3)	4(66.6)	0.59
Drugs			
Angiotensin-converting enzyme inhibitors/Angiotensin II receptor blockers	21(36.8)	36(63.2)	0.004
Non-steroidal anti-inflammatory drugs	5(29.4)	12(70.6)	0.21
Contrast	9(33.3)	18(66.6)	0.07
APACHE II	13.1 (±SD3.9)	9.8 (±SD 4.4)	0.01
Mortality			
At the time of discharge	50(60.9)	32(39.1)	0.02
30 days after discharge	4 3(75)	1(25)	0.04

DISCUSSION

AKI is a global issue that requires significant resources and varies between prosperous and low-income nations(15)**.** Early identification and treatment are crucial for reducing mortality, morbidity, CKD, and lengthy hospital stays, particularly in critically ill and ICU patients. This research is the first to examine the prevalence and risk factors causing AKI across ICU patients in Pakistan.

In our ICU patients, the incidence of AKI was 32.7%. Risk factors for developing AKI were advancing age, high blood pressure, usage of ACEI/ARBs, and severe critical illness (higher APACHE II score).AKI incidences among ICU patients range from 2% to 92%(3). This variation can be due to the use of various classifications (RIFLE, AKIN, KDIGO, and CK) among studies (3, 16, 17), including or excluding urine output parameters (18-21). Some studies show that using AKIN criteria for evaluating the incidence of AKI is more accurate, but RIFLE parameters may be more effective in predicting mortality (16, 22)**.**

Our cohort had a 32.7% incidence of AKI, which can be attributed to a broader range of ICU patients, including those with coronary artery disease and neurological conditions, excluding urine output parameters (21, 23). Sepsis was the leading cause of AKI, with 30.1% of patients with septicemia developing AKI. Studies on septic patients have shown a greater prevalence of AKI and death (24-30)**.**

Research from Iran (a nearby nation) found a 37% prevalence of AKI utilizing RIFLE criteria. The study did not specify the reason for admission to the ICU. However, it is possible that their cohort contained more septic patients, given that the rate of AKI was similar to ours (Kebar et al., 2018). An analysis of 300 ICUs globally found that the frequency of AKI was 33.4% in wealthy nations and 37.7% in underdeveloped nations (3)**.**

Our study found that 60.12% of individuals with AKI fell into stage 1 of the AKIN criteria. This is in line with previous research whereby the vast majority of individuals with AKI were in stage 1. In a Chinese dataset of 3107 individuals suffering from AKI, 23.1% were in stage 1 (4)**.** Zhang et al. found that 41.2% of AKI patients in the UK ICU were in stage 1 (31). Compared to our sample, patients with AKI had significantly lower eGFR levels at admission and discharge. Patients with past AKI may have an increased risk of developing CKD, particularly when the stage and degree of AKI rise (7). Severe AKI increases the chance of developing CKD following hospital discharge. Regardless of less severe cases, the risk of CKD remains apparent and requires longer follow-up (7). Compared to other research, the 30-day mortality rate ranged between 22% and 52% [2, 38]. Our analysis split fatality rates by time of discharge. Patients with AKI had a greater mortality rate regardless of discharge time, with most deaths occurring during hospitalization.

Previous research on AKI in the elderly has shown that patients over 60 had a higher risk of AKI, morbidity, mortality, more extended hospital stays, and requirement for RRT (32). Santos et al. conducted an overview of AKI in ICUs, using data from 67,033 patients from over 300 ICUs worldwide. The study found that mortality rates in septic patients ranged from 5% – 80% (highest), with RRT rates ranging from 0.8% to 59.2% (3). In ICUs with less septic individuals, there is less total morbidity and mortality in AKI patients. This suggests that sepsis possesses a significant role in the higher death rate of AKI patients, emphasizing the importance of early identification and treatment. Our study found that the AKI group had a shorter hospital stay, which can be attributed to higher in-hospital mortality (60.9%) and faster recovery times for patients with acute cardiac diseases.

Our study had many limitations. Our retrospective analysis was conducted at a single center and included fewer sepsis patients than prior studies. The small sample size of the study population should be considered when interpreting the results of this study. Prospective and multicenter investigations are required to examine demographic disparities at the national level and determine their impact on the risk of developing AKI in the area we serve.

CONCLUSION

The frequency of AKI among our ICU patients was 32.7%. Getting Older, high blood pressure, ACEI/ARB use, and significant critical

[Citation Pervaiz, R., Qayyum, M.A., Khalid, S.A., Hafeez, T., Munawar, M.U., Arif, H.M.H., Kandeel, H., Elmasry, W.G., Raza, S. (2024). A single-center study evaluating the prevalence, risk factors, and consequences of acute kidney injury in the intensive care unit. *Pak. J. Inten. Care Med.* ***2024****: 22*. doi: https://doi.org/10.54112/pjicm.v4i01.22]

illness (higher APACHE II scores) were all risk factors associated with AKI. Acute kidney injury (AKI) in the ICU leads to more extended stays and higher morbidity and fatality rates. Early detection of acute kidney injury (AKI) and treatment-modifiable risk factors might prevent negative outcomes and adverse effects, reducing mortality as well as morbidity in ICU patients. To enhance ICU care, reduce mortality and morbidity, and reduce medical costs, prospective, locally-based, and national studies are necessary to evaluate the prevalence of AKI and identify risk factors. This information can be utilized to alter ICU policies.

DECLARATIONS

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department Concerned.
Consent for publication
Approved
Funding
Not applicable

CONFLICT OF INTEREST

The authors declared absence of conflict of interest.

AUTHOR CONTRIBUTION

RIZWAN PERVAIZ
Conception of Study, Final approval of manuscript.
Manuscript revisions, critical input.
Coordination of collaborative efforts.
MOHAMMED AHAD QAYYUM
Study Design, Review of Literature.
Conception of Study, Development of Research Methodology Design, Study Design,, Review of manuscript, final approval of manuscript
SYED ARSALAN KHALID
Data acquisition, analysis.
Manuscript drafting.
TAYYABA HAFEEZ
Conception of Study, Development of Research Methodology Design, Study Design,, Review of manuscript, final approval of manuscript.
MUHAMMAD USMAN MUNAWAR
Manuscript revisions, critical input.
Coordination of collaborative efforts
HAFIZ MUHAMMAD HAMZA ARIF
HUSSEIN KANDEEL
Study Design, Review of Literature.
WAEL GHALY ELMASRY
Data acquisition, analysis.
SITARA RAZA
Data entry and Data analysis, drafting article.
Coordination of collaborative efforts.

REFERENCES

1. Chertow GM, Burdick E, Honour M, Bonventre JV, Bates DW. Acute kidney injury, mortality, length of stay, and costs in hospitalized patients. Journal of the American Society of Nephrology. 2005;16(11):3365-70.
2. Priyamvada P, Jayasurya R, Shankar V, Parameswaran S. Epidemiology and outcomes of acute kidney injury in critically ill: experience from a tertiary care center. Indian Journal of Nephrology. 2018;28(6):413.
3. Santos RPd, Carvalho ARS, Peres LAB, Ronco C, Macedo E. An epidemiologic overview of acute kidney injury in intensive care units. Revista da Associação Médica Brasileira. 2019;65:1094-101.
4. Jiang L, Zhu Y, Luo X, Wen Y, Du B, Wang M, et al. Epidemiology of acute kidney injury in intensive care units in Beijing: the multi-center BAKIT study. BMC nephrology. 2019;20:1-10.
5. Dos Santos RP, Carvalho ARdS, Peres LAB. Incidence and risk factors of acute kidney injury in critically ill patients from a single centre in Brazil: a retrospective cohort analysis. Scientific Reports. 2019;9(1):18141.
6. Forni L, Darmon M, Ostermann M, Oudemans-van Straaten H, Pettilä V, Prowle J, et al. Renal recovery after acute kidney injury. Intensive care medicine. 2017;43:855-66.
7. Rubin S, Orieux A, Clouzeau B, Rigothier C, Combe C, Gruson D, et al. The incidence of chronic kidney disease three years after non-severe acute kidney injury in critically ill patients: a single-center cohort study. Journal of Clinical Medicine. 2019;8(12):2215.
8. Ülger F, Pehlivanlar Küçük M, Küçük A, İlkaya N, Murat N, Bilgiç B, et al. Evaluation of acute kidney injury (AKI) with RIFLE, AKIN, CK, and KDIGO in critically ill trauma patients. European Journal of Trauma and Emergency Surgery. 2018;44:597-605.
9. Hoste EA, Clermont G, Kersten A, Venkataraman R, Angus DC, De Bacquer D, et al. RIFLE criteria for acute kidney injury are associated with hospital mortality in critically ill patients: a cohort analysis. Critical care. 2006;10(3):1-10.
10. Mehta RL, Kellum JA, Shah SV, Molitoris BA, Ronco C, Warnock DG, et al. Acute Kidney Injury Network: report of an initiative to improve outcomes in acute kidney injury. Critical care. 2007;11:1-8.
11. Khwaja A. KDIGO clinical practice guidelines for acute kidney injury. Nephron Clinical Practice. 2012;120(4):c179-c84.
12. Waikar SS, Bonventre JV. Creatinine kinetics and the definition of acute kidney injury. Journal of the American Society of Nephrology: JASN. 2009;20(3):672.
13. Hashemian SM, Jamaati H, Bidgoli BF, Farrokhi FR, Malekmohammad M, Roozdar S, et al. Outcome of acute kidney injury in critical care unit, based on AKI network. Tanaffos. 2016;15(2):89.
14. Zeng X, McMahon GM, Brunelli SM, Bates DW, Waikar SS. Incidence, outcomes, and comparisons across definitions of AKI in hospitalized individuals. Clinical journal of the American Society of Nephrology: CJASN. 2014;9(1):12.
15. Hoste EA, Kellum JA, Selby NM, Zarbock A, Palevsky PM, Bagshaw SM, et al. Global epidemiology and outcomes of acute kidney injury. Nature Reviews Nephrology. 2018;14(10):607-25.
16. Xiong J, Tang X, Hu Z, Nie L, Wang Y, Zhao J. The RIFLE versus AKIN classification for incidence and mortality of acute kidney injury in critical ill patients: a meta-analysis. Scientific reports. 2015;5(1):17917.
17. Rodrigo E, Suberviola B, Albines Z, Castellanos Á, Heras M, Rodriguez-Borregán JC, et al. Comparación de los sistemas de clasificación del fracaso renal agudo en la sepsis. Nefrología (Madrid). 2016;36(5):530-4.
18. Koeze J, Keus F, Dieperink W, Van der Horst I, Zijlstra J, Van Meurs M. Incidence, timing and outcome of AKI in critically ill patients varies with the definition used and the addition of urine output criteria. BMC nephrology. 2017;18(1):1-9.
19. Luo X, Jiang L, Du B, Wen Y, Wang M, Xi X, et al. A comparison of different diagnostic criteria of acute kidney injury in critically ill patients. Critical care. 2014;18:1-8.

[Citation Pervaiz, R., Qayyum, M.A., Khalid, S.A., Hafeez, T., Munawar, M.U., Arif, H.M.H., Kandeel, H., Elmasry, W.G., Raza, S. (2024). A single-center study evaluating the prevalence, risk factors, and consequences of acute kidney injury in the intensive care unit. *Pak. J. Inten. Care Med.* ***2024****: 20*. doi: https://doi.org/10.54112/pjicm.v4i01.22]

20. Jiang F, Chen Y, Liang X, Xu L, Ma G, Hu P, et al. The sensitivity and accuracy of RIFLE and AKIN criteria for acute kidney injury diagnosis in intensive care unit patients. Zhongguo wei zhong bing ji jiu yi xue= Chinese critical care medicine= Zhongguo weizhongbing jijiuyixue. 2011;23(12):759-62.
21. Allen JC, Gardner DS, Skinner H, Harvey D, Sharman A, Devonald MA. Definition of hourly urine output influences reported incidence and staging of acute kidney injury. BMC nephrology. 2020;21(1):1-8.
22. Ratanarat R, Skulratanasak P, Tangkawattanakul N, Hantaweepant C. Clinical accuracy of RIFLE and Acute Kidney Injury Network (AKIN) criteria for predicting hospital mortality in critically ill patients with multi-organ dysfunction syndrome. Journal of the Medical Association of Thailand= Chotmaihet Thangphaet. 2013;96:S224-31.
23. Macedo E, Malhotra R, Claure-Del Granado R, Fedullo P, Mehta RL. Defining urine output criterion for acute kidney injury in critically ill patients. Nephrology Dialysis Transplantation. 2011;26(2):509-15.
24. Yue J, Wu D, Li C, Zhai Q, Chen X, Ding S, et al. Use of the AKIN criteria to assess the incidence of acute renal injury, outcome and prognostic factors of ICU mortality in critically ill patients. Zhonghua yi xue za zhi. 2011;91(4):260-4.
25. Zhou J, Yang L, Zhang K, Liu Y, Fu P. Risk factors for the prognosis of acute kidney injury under the Acute Kidney Injury Network definition: a retrospective, multicenter study in critically ill patients. Nephrology. 2012;17(4):330-7.
26. Zhang Q, Fei Y, Jiang L. Risk factors for mortality in intensive care unit patients with sepsis combined with acute kidney injury after continuous renal replacement therapy: secondary analysis of the data from a multicenter observational study. Zhonghua wei Zhong Bing ji jiu yi xue. 2019;31(2):155-9.
27. Pinheiro KHE, Azêdo FA, Areco KCN, Laranja SMR. Risk factors and mortality in patients with sepsis, septic and non septic acute kidney injury in ICU. Brazilian Journal of Nephrology. 2019;41:462-71.
28. Papadimitriou-Olivgeris M, Assimakopoulos SF, Kolonitsiou F, Solomou A, Vamvakopoulou S, Spyropoulou A, et al. Risk factors for acute kidney injury in critically ill patients with bacteraemia by carbapenem non-susceptible Gram negative bacteria. Infez Med. 2019;27(4):380-92.
29. Montomoli J, Donati A, Ince C. Acute kidney injury and fluid resuscitation in septic patients: are we protecting the kidney? Nephron. 2019;143(3):170-3.
30. Ralib AM, Nanyan S, Ramly NF, Har LC, Cheng TC, Nor MBM. Acute kidney injury in Malaysian intensive care setting: incidences, risk factors, and outcome. Indian journal of critical care medicine: peer-reviewed, official publication of Indian Society of Critical Care Medicine. 2018;22(12):831.
31. Zhang J, Crichton S, Dixon A, Seylanova N, Peng ZY, Ostermann M. Cumulative fluid accumulation is associated with the development of acute kidney injury and non-recovery of renal function: a retrospective analysis. Critical Care. 2019;23:1-10.
32. Oweis AO, Alshelleh SA. Incidence and outcomes of acute kidney injury in octogenarians in Jordan. BMC Research Notes. 2018;11(1):1-5.

[Citation Pervaiz, R., Qayyum, M.A., Khalid, S.A., Hafeez, T., Munawar, M.U., Arif, H.M.H., Kandeel, H., Elmasry, W.G., Raza, S. (2024). A single-center study evaluating the prevalence, risk factors, and consequences of acute kidney injury in the intensive care unit. *Pak. J. Inten. Care Med.* ***2024****: 20*. doi: https://doi.org/10.54112/pjicm.v4i01.22]