

Determining the Incidence of Acute Kidney Injury Using the RIFLE Criteria in the Medical Intensive Care Unit in a Tertiary Care Hospital Setting in Pakistan

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Disclosures can be found in Additional Information at the end of the article

Abstract

Background

Acute kidney injury (AKI) is a frequently encountered clinical condition in hospitalized patients, particularly those admitted to intensive care units (ICU). AKI has its systemic sequelae and contributes to the morbidity of underlying diseases.

Methods

This descriptive case series aimed to determine the frequency of acute kidney injury in critically ill patients admitted to the ICU at Shifa International Hospital, Islamabad, according to the RIFLE (risk, injury, failure, loss, and end-stage) criteria. A total of 124 patients were enrolled in this study. RIFLE criteria were applied to determine the frequency of AKI in critically ill patients.

Results

The frequency of AKI was 68.55% and mortality was 18.55%. The severity of AKI was found to be significantly associated with mortality ($p < 0.001$).

Conclusion

AKI is very common in critically ill patients and contributes to the mortality and morbidity of the patients. Early identification of AKI can reduce mortality in critically ill patients.

Categories: Internal Medicine, Pulmonology

Keywords: : akin, kdigo, rifle, acute kidney injury, oliguria, end stage renal disease, aki

Introduction

The term acute kidney injury (AKI) encompasses a wide spectrum of disease states, ranging from mild injury characterized by temporary derangement of renal functions at one end to complete loss of renal function at the other end as a result of a severe insult to the renal function [1]. Known to account for 5%-7% of all hospitalized patients, the incidence of acute kidney injury in intensive care units (ICU) patients is almost 20%-50% [2]. AKI is both a cause

Received 02/04/2019

Review began 02/12/2019

Review ended 02/13/2019

Published 02/13/2019

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How to cite this article

Hussain S, Qadeer A, Munawar K, et al. (February 13, 2019) Determining the Incidence of Acute Kidney Injury Using the RIFLE Criteria in the Medical Intensive Care Unit in a Tertiary Care Hospital Setting in Pakistan. Cureus 11(2): e4071. DOI 10.7759/cureus.4071

of and a life-threatening complication of critical illnesses with increased immediate and late morbidity and mortality [3-5].

The criteria used to define acute kidney injury have evolved over a period of time, from relying upon simple markers of renal function, such as serum urea and serum creatinine levels and decreased urine output, to complex definitions, such as the RIFLE (risk, injury, failure, loss, and end-stage) definition, the AKIN (acute kidney injury network) definition, and the KDIGO (kidney disease improving global outcomes) definition [6-10].

The RIFLE classification of acute kidney injury relies on urine output and serum creatinine levels to predict the severity of acute kidney injury in an individual in terms of risk, injury, or failure to describe two possible outcomes, i.e., loss of renal function and end-stage renal disease. However, one has to know the baseline serum creatinine to apply this classification. The RIFLE classification has been found to be a valid classification system for predicting acute kidney injury in hospitalized patients as well as for the prediction of prognosis in such patients [11-15].

With this knowledge, we decided to determine the incidence of acute kidney injury in patients admitted to the intensive care unit at Shifa International Hospital, Islamabad, using the RIFLE criteria and to determine the outcome in terms of length of stay and mortality.

Materials And Methods

After approval from the institutional review board (IRB) at Shifa International Hospital, a prospective study designed as a case series was conducted from July 2017 to January 2018. This was at the medical intensive care unit (ICU), Shifa International Hospital, Islamabad. For the purpose of this study, acute kidney injury was defined as an abrupt (occurring within 48 hours of admission to the medical ICU) reduction in kidney function. The reduction in kidney function was defined in terms of “either an absolute increase in serum creatinine of more than or equal to 0.3 mg/dL, a percentage increase in serum creatinine of $\geq 50\%$ (1.5-fold from baseline), or a reduction in urine output (documented oliguria of <0.5 mL/kg/hr for >6 hrs)” [16]. Serum creatinine was measured using spectrophotometry at the pathology laboratory of Shifa International Hospital and the glomerular filtration rate (GFR) for each patient was determined using the Cockcroft-Gault formula. The outcome of the study was measured in terms of length of stay (days) in the medical ICU and mortality. For the purpose of this study, a sample size of 124 was arrived at using the World Health Organization (WHO) sample size calculator software with the following assumptions: Confidence Interval (CI) 95%, anticipated proportion of acute kidney injury in critically ill patients (p): 8.8%, and absolute precision (d): 5% [14].

The consecutive non-probability sampling technique was used to complete the sample size. All patients admitted to the medical ICU of Shifa International Hospital, Islamabad, except those with chronic kidney disease, were enrolled in this study. Prior approval was obtained from the hospital ethics committee and informed consent was obtained from either the patients or their family members, where applicable. Serum levels of creatinine, as well as urine output, were monitored during the first 24 hours stay at the ICU. Urine output was measured specifically at 6 hrs, 12 hrs, and 24 hrs, in addition to the hourly monitoring of urine output. Then, using the creatinine increase/calculated GFR and urine output, the RIFLE category was assessed for each patient. Based on the RIFLE criteria, the outcome in terms of ICU mortality and ICU length of stay was recorded by the trainee researcher and findings were recorded in the proforma. The collected data were entered into and analyzed using SPSS 16 (IBM Corp., Armonk, NY, US). Descriptive statistics were computed, as mean and standard deviations were presented for age and duration of ICU stay. Frequencies and percentages for variables like gender, AKI using the RIFLE criteria, the RIFLE class, and mortality were calculated. Analysis of variance (ANOVA) was used for the comparison of quantitative variables (length of stay) and

Chi-square was used to determine differences in the outcome of RIFLE categories. The RIFLE criteria are explained in Table 1.

	GFR Criteria	Urine Output Criteria
RISK	Increased Cr _{Serum} x 1.5 or GFR decreased > 25%	Urine output < 0.5 ml/kg/h x 6 hours
INJURY	Increased Cr _{Serum} x 2.0 or GFR decreased > 50%	Urine output < 0.5 ml/kg/h x 12 hours
FAILURE	Increased Cr _{Serum} x 3.0 or GFR decreased > 75% Or Cr _{Serum} >4 mg/dl	Urine output < 0.3 ml/kg/h x 24 hours or anuria x 12 hours
LOSS	Persistent Acute Kidney Failure = Complete loss of kidney functions> 4 weeks	
ESRD	End Stage Renal Disease (ESRD) Complete loss of kidney function> 3 months	

TABLE 1: RIFLE criteria

RIFLE: risk, injury, failure, loss, and end-stage; GFR: glomerular filtration rate

Results

There were 77 (62.1%) males and 47 (37.9%) females with the mean \pm SD age of study participants as 55.71 ± 18.06 years (age range from 18 to 97 years). The mean length of ICU stay was 4.73 ± 3.75 days (with a range of 1-20 days). Fifty-eight (46.8%) of the patients stayed in the ICU for one to three days (Table 2).

Length of ICU stay	Percentage
1-3 Days	46.8
4-6 Days	30.6
7-9 Days	15.3
10-12 Days	1.6
13-15 Days	2.4
16-18 Days	1.6
19-21 Days	1.6

TABLE 2: Length of ICU stay

ICU: intensive care unit

The commonest reasons for admission to the ICU were pulmonary disease (n= 29; 23.4%),

cardiac disease (n=27; 21.8%), and sepsis (n=25; 20.2%). Other reasons for admission to the ICU were central nervous system (CNS) disease (n=21; 16.9%), poisoning/overdose (n=6; 4.8%), hepatic disease (n=5; 4%), malignancy (n=4; 3.2%), and miscellaneous causes (n=7; 5.6%) (Table 3).

Diagnosis	Frequency	Percentage (%)
Cardiac	27	21.8
Sepsis	25	20.2
Pulmonary	29	23.4
Malignancy	4	3.2
Poisoning/overdose	6	4.8
CNS	21	16.9
Hepatic	5	4.0
Misc	7	5.6
Total	124	100.0

TABLE 3: Primary diagnosis of ICU patients

ICU: intensive care unit

The frequency of AKI in our study was 68.54%, with 85 patients developing AKI during their stay in the ICU. Of these 85 patients, 34 (40%) were categorized as R (risk), 38 (44.70%) as I (injury), and 13 (15.3%) as F (failure) (Table 4). Twenty-three (18.5%) patients died during the period of this study.

RIFLE Class	Frequency	Percentage (%)
Risk	34	40
Injury	38	44.7
Failure	13	15.3
Total (n)	85	100.0

TABLE 4: RIFLE severity category

RIFLE: risk, injury, failure, loss, and end-stage

In terms of patient outcome with reference to mortality, of the patients falling in class R,

85.29% (n=29) were transferred out of the ICU while 14.7% (n=5) of them expired while in class I, 84.2% (n=32) got transferred out, and 15.78% (n=6) expired. In class F, 38.46% (n=5) patients were transferred out whereas 61.53% (n=8) patients expired (Table 5). This shows that as the severity of renal failure increases, the patient mortality also increases since the highest mortality of AKI patients is seen in those falling in class F.

RIFLE Class	Outcome		Total
	Transferred out of ICU	Expired	
Risk	29 (85.29%)	5 (14.7%)	34
Injury	32 (84.2%)	6 (15.78%)	38
Failure	5 (38.46%)	8 (61.53%)	13
No AKI	35 (89.7%)	4 (10.3%)	39
Total	101	23	124

TABLE 5: RIFLE category outcome cross-tabulation

AKI: acute kidney injury; ICU: intensive care unit; RIFLE: risk, injury, failure, loss, and end-stage

Only four (10.3%) patients with no AKI expired as compared to 5 (14.7%) in R, six (15.8%) in I, and eight (61.5%) in F. When the outcome was cross-tabulated with the RIFLE category, a statistically significant association was found between the severity of AKI and mortality ($p < 0.001$). There was, however, no difference in length of ICU stay and RIFLE class.

Discussion

Acute kidney injury is commonly diagnosed in medical ICUs across the world and is characterized by morbidity related to its systemic sequelae and its extra-renal organ system effects [17-19]. Additionally, the presence of AKI adversely affects the prognosis of a disease in both the short and long terms [20]. Whereas the incidence of AKI in the general population is considered to be low, its incidence in hospitalized patients is much greater, and in ICU patients, it can be as much as 50% [21-24]. With the introduction of classification systems, such as AKIN and RIFLE, the incidence of AKI has increased, partly because of increased identification, so much so that up to 70% of ICU patients have been reported to have some sort of AKI or renal dysfunction [25]. AKI has a mortality rate of 20%-90% [26].

The incidence of AKI in our study was 68.55% with a mortality rate of 18.55%. A variable incidence of AKI has been reported in the literature. For example, a study from the Netherlands reported a 35% incidence of AKI according to the RIFLE criteria in critically ill patients [6]. The authors noted that the reported incidence of AKI in critically ill patients depends on a number of factors such as the definition of AKI used, the used of baseline or reference serum creatinine, and the inclusion/omission of urine output in the staging of AKI.

Another study reported that the frequency of AKI was 57.3% in critically ill patients. The authors reported that the increasing severity of AKI was associated with increased mortality in the hospital. Our results point toward similar findings [17]. A study from the US reported that

AKI was diagnosed in 52.6% of ICU patients and AKI was independently associated with a longer duration of hospital stay and short-term (in hospital/ICU) and long-term mortality (after discharge from the hospital) [27].

The authors also identified certain factors, such as hypotension, the severity of underlying illness, diabetes mellitus, and surgical reasons for hospital admission, as predictors for AKI. In our study, the most common cause of ICU admission was pulmonary and the other common causes were cardiac and sepsis, whereas in most international data, sepsis is the most common cause of ICU admission and, in turn, an important contributory factor for the development of AKI in the ICU [28].

Our study had some limitations. First, it included only 124 patients, which is a small sample size for being a powerful study. Second, despite the fact that we had hourly monitoring of the urine output, we didn't have data regarding diuretic usage in patients, which can influence the urine output. Third, the patients included did not have a longer follow-up so AKI was only categorized as R, I, and F and further classification into loss of kidney function and end-stage kidney disease was not possible. Despite these limitations, our study had some strength. First, it is providing local data in terms of AKI classification and severity. Second, both creatinine and urine output criteria were used to define and categorize AKI.

Conclusions

AKI is very common in critically ill patients and contributes to the mortality and morbidity of the patients. Early identification of AKI can reduce mortality in critically ill patients.

Additional Information

Disclosures

Human subjects: Consent was obtained by all participants in this study. Shifa International Hospital issued approval 018-508-2019. The study "Determining the Incidence of Acute Kidney Injury Using the RIFLE Criteria in the Medical Intensive Care Unit in a Tertiary Care Hospital Setting in Pakistan" has been approved by Shifa International Hospital ethical committee.

Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Case J, Khan S, Khalid R, Khan A: Epidemiology of acute kidney injury in the intensive care unit. *Crit Care Res Pract.* 2013, 2013:479730. [10.1155/2013/479730](#)
2. Gomes E, Antunes R, Dias C, Araújo R, Costa-Pereira A: Acute kidney injury in severe trauma assessed by RIFLE criteria: a common feature without implications on mortality?. *Scand J Trauma Resusc Emerg Med.* 2010, 18:1. [10.1186/1757-7241-18-1](#)
3. Linder A, Fjell C, Levin A, Walley KR, Russell JA, Boyd JH: Small acute increases in serum creatinine are associated with decreased long-term survival in the critically ill. *Am J Respir Crit Care Med.* 2014, 189:1075-1081. Accessed: 2019: [10.1164/rccm.201311-2097OC](#)
4. Gammelager H, Christiansen C, Johansen M, Tønnesen E, Jespersen B, Sørensen H: Five-year risk of end-stage renal disease among intensive care patients surviving dialysis-requiring acute kidney injury: a nationwide cohort study. *Crit Care.* 2013, 17:145. [10.1186/cc12824](#)

5. Vaara ST, Pettilä V, Kaukonen K-M, Bendel S, Korhonen A-M, Bellomo R, Reinikainen M: The attributable mortality of acute kidney injury: a sequentially matched analysis*. *Crit Care Med*. 2014, 42:878-885. [10.1097/CCM.0000000000000045](https://doi.org/10.1097/CCM.0000000000000045)
6. Koeze J, Keus F, Dieperink W, van der Horst ICC, Zijlstra JG, 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 Nephrol*. 2017, 18:70. [10.1186/s12882-017-0487-8](https://doi.org/10.1186/s12882-017-0487-8)
7. Bellomo R, Ronco C, Kellum JA, Mehta RL, Palevsky P: Acute Dialysis Quality Initiative workgroup. Acute renal failure - definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. *Crit Care Lond Engl*. 2004, 8:204-212. [10.1186/cc2872](https://doi.org/10.1186/cc2872)
8. Lopes JA, Jorge S: The RIFLE and AKIN classifications for acute kidney injury: a critical and comprehensive review. *Clin Kidney J*. 2013, 6:8-14. [10.1093/ckj/sfs160](https://doi.org/10.1093/ckj/sfs160)
9. KDIGO: Acute kidney injury work group (KDIGO) clinical practice guideline for acute kidney injury. *Kidney Int Suppl*. 2012, 2:1. Accessed: 2019: [https://www.kisupplements.org/article/S2157-1716\(15\)31038-8/fulltext](https://www.kisupplements.org/article/S2157-1716(15)31038-8/fulltext).
10. Mehta RL, Kellum JA, Shah SV, et al.: Acute kidney injury network: report of an initiative to improve outcomes in acute kidney injury. *Crit Care Lond*. 2007, 11:31. [10.1186/cc5713](https://doi.org/10.1186/cc5713)
11. Uchino S, Bellomo R, Goldsmith D, Bates S, Ronco C: An assessment of the RIFLE criteria for acute renal failure in hospitalized patients. *Crit Care Med*. 2006, 34:1913-1917. [10.1097/01.CCM.0000224227.70642.4F](https://doi.org/10.1097/01.CCM.0000224227.70642.4F)
12. Lopes JA, Gonçalves S, Jorge S, et al.: Contemporary analysis of the influence of acute kidney injury after reduced intensity conditioning haematopoietic cell transplantation on long-term survival. *Bone Marrow Transplant*. 2008, 42:619-626. [10.1038/bmt.2008.207](https://doi.org/10.1038/bmt.2008.207)
13. Bagshaw SM, George C, Dinu I, Bellomo R: A multi-centre evaluation of the RIFLE criteria for early acute kidney injury in critically ill patients. *Nephrol Dial Transplant*. 2008, 23:1203-1210. [10.1093/ndt/gfm744](https://doi.org/10.1093/ndt/gfm744)
14. Hoste EAJ, Clermont G, Kersten A, Venkataraman R, Angus DC, De Bacquer D, Kellum JA: RIFLE criteria for acute kidney injury are associated with hospital mortality in critically ill patients: a cohort analysis. *Crit Care Lond Engl*. 2006, 10:73. [10.1186/cc4915](https://doi.org/10.1186/cc4915)
15. Ostermann M, Chang RWS: Acute kidney injury in the intensive care unit according to RIFLE. *Crit Care Med*. 2007, 35:1837-1843. [10.1097/01.CCM.0000277041.13090.0A](https://doi.org/10.1097/01.CCM.0000277041.13090.0A)
16. Dennen P, Douglas IS, Anderson R: Acute kidney injury in the intensive care unit: an update and primer for the intensivist. *Crit Care Med*. 2010, 38:261-275. [10.1097/CCM.0b013e3181bfb0b5](https://doi.org/10.1097/CCM.0b013e3181bfb0b5)
17. Hoste EAJ, Bagshaw SM, Bellomo R, et al.: Epidemiology of acute kidney injury in critically ill patients: the multinational AKI-EPI study. *Intensive Care Med*. 2015, 16:1411-1423. Accessed: 2019: <http://link.springer.com/10.1007/s00134-015-3934-7>.
18. Poukkanen M, Vaara ST, Pettilä V, et al.: Acute kidney injury in patients with severe sepsis in Finnish intensive care units: severe sepsis-associated AKI. *Acta Anaesthesiol Scand*. 2013, 16:863-872. [10.1111/aas.12133](https://doi.org/10.1111/aas.12133)
19. Seller-Pérez G, Más-Font S, Pérez-Calvo C, Villa-Díaz P, Celaya-López M, Herrera-Gutiérrez ME: Acute kidney injury: renal disease in the ICU. *Med Intensiva*. 2016, 16:374-382.
20. Chertow GM, Levy EM, Hammermeister KE, Grover F, Daley J: Independent association between acute renal failure and mortality following cardiac surgery. *Am J Med*. 1998, 104:343-348.
21. Liaño F, Pascual J, Madrid Acute Renal Failure Study Group: Epidemiology of acute renal failure: a prospective, multicenter, community-based study. *Kidney Int*. 1996, 50:811-818. [10.1038/ki.1996.380](https://doi.org/10.1038/ki.1996.380)
22. Liangos O, Wald R, O'Bell JW, Price L, Pereira BJ, Jaber BL: Epidemiology and outcomes of acute renal failure in hospitalized patients: a national survey. *Clin J Am Soc Nephrol*. 2005, 16:43-51. [10.2215/CJN.00220605](https://doi.org/10.2215/CJN.00220605)
23. Uchino S, Kellum JA, Bellomo R, Doig GS, Morimatsu H, Morgera S: Acute renal failure in critically ill patients. A multinational, multicenter study. *JAMA*. 2005, 16:813-818. [10.1001/jama.294.7.813](https://doi.org/10.1001/jama.294.7.813)
24. Herrera-Gutiérrez ME, Seller-Pérez G, Maynar-Moliner J, Sánchez-Izquierdo-Riera JA: Epidemiology of acute kidney failure in Spanish ICU. Multicenter prospective study FRAMI [Article in Spanish]. *Med Intensiva*. 2006, 30:260-267.

25. Zaragoza JJ, Renteria FJ: Acute kidney injury in the intensive care unit . Intensive Care. Nissar Shaikh (ed): IntechOpen Limited, London, UK; 2017. [10.5772/intechopen.68348](https://doi.org/10.5772/intechopen.68348)
26. Hashemian SM, Jamaati H, Farzanegan BB, et al.: Outcome of acute kidney injury in critical care unit, based on AKI Network. Tanaffos. 2016, 15:89-95.
27. Fuhrman DY, Kane-Gill S, Goldstein SL, Priyanka P, Kellum JA: Acute kidney injury epidemiology, risk factors, and outcomes in critically ill patients 16-25 years of age treated in an adult intensive care unit. Ann Intensive Care. 2018, 8:26. [10.1186/s13613-018-0373-y](https://doi.org/10.1186/s13613-018-0373-y)
28. Ali T, Khan I, Simpson W, Prescott G, Townend J, Smith W, MacLeod A: Incidence and outcomes in acute kidney injury: a comprehensive population-based study. J Am Soc Nephrol. 2007, 18:1292-1298. [10.1681/ASN.2006070756](https://doi.org/10.1681/ASN.2006070756)