Research Article

Acute kidney injury-incidence, prognostic factors, and outcome of patients in an Intensive Care Unit in a tertiary center: A prospective observational study

Sara Korula, Sindhu Balakrishnan[1], Shyam Sundar[1], Vergis Paul[2], Anuroop Balagopal[3]

Abstract

Background and Aims: The information regarding the incidence of acute kidney injury (AKI) in medical Intensive Care Units (ICUs) in South India is limited. The aim of the study was to find the incidence, prognostic factors, and outcome of patients with AKI. We also assessed whether only urine output criteria of risk, injury, failure, loss, end (RIFLE) classification can be used to look at the outcome of AKI. **Patients and Methods:** This was a prospective, cross-sectional study of 6 months duration in a 28 bedded medical ICU of a tertiary center. AKI was defined as an absolute creatinine value of >1.6 mg/dl or a 25% increase from baseline creatinine values. **Results:** The incidence of AKI was 16.1%, and mortality was 7.8% in our study population. Among patients with AKI 87 (75.7%) patients had sepsis. 71.3% patients had metabolic acidosis on admission, and 47.8% patients were in shock. 57.4% of patient's required mechanical ventilation (MV). 39.1% of AKI patients required renal replacement therapy (RRT). Requirement of RRT was significantly affected by increasing age, Acute Physiology and Chronic Health Evaluation II and sequential organ failure assessment scores on admission, serum creatinine, and use of vasopressors. 49.5% of patients with AKI died within 28 days. Increasing age, MV, hemodialysis (HD), hypertension, chronic kidney disease, and requirement of noradrenaline support were associated with increasing 28 days mortality. The maximum RIFLE score with urine output criteria showed association to the requirement of HD in univariate analysis but did not show relation to mortality. **Conclusion:** The incidence of AKI was 16.1% in critically ill patients. In patients with AKI, 39.1% patients required HD and 28 days mortality was 49.5%. The study also showed good univariate association of urine output criteria of RIFLE classification to the requirement of HD in AKI patients.

Keywords: Acute kidney injury, end, failure, incidence, injury, loss, mortality, renal replacement therapy, risk

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Introduction

Acute kidney injury (AKI) is a common clinical problem in the community and especially in critically ill patients and is associated with an increase in morbidity and mortality.[1] It is a clinical manifestation of several disorders that affect the kidney acutely characterized by the rapid loss of the kidneys excretory function and is typically diagnosed by the accumulation of

From:
Departments of Anaesthesiology and Critical Care and [2]Surgery, MOSC Medical College, [1]Department of Anaesthesiology and Critical Care, Amrita Institute of Medical Sciences, [3]Department of Anaesthesia and Critical Care, Aster Medcity, Ernakulam District, Kochi, Kerala, India

Correspondence:
Dr. Sara Korula, Department of Anaesthesiology and Critical Care, MOSC Medical College, Kolenchery, Ernakulam - 682 311, Kerala, India.
E-mail: skorula@gmail.com

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end products of nitrogen metabolism. The incidence of community-acquired AKI reported in India was 4.14/1000 admissions in 1996–2008 with a mortality of 10.98%.[2]

Multiple epidemiologic investigations have provided a broad range of estimates of the incidence of AKI in critically ill patients, and the incidence varied between 15% and 50%.[3] Better classification of renal failure by the risk, injury, failure, loss, end stage (RIFLE), and Acute Kidney Injury Network (AKIN) guidelines has made the reports more standardized.[4] AKI in the Intensive Care Unit (ICU) is associated with mortality as high as 45–50%, with dialysis dependence, with reduced quality of life, and with excess utilization of health resources.[3,5]

There is a paucity of data regarding the incidence and spectrum of AKI in critically ill patients from the Indian subcontinent, especially South India. In view of this, we have conducted a prospective, observational study of patients who have been admitted to the medical ICU in a tertiary care center in South India.

Aim of study

The aim of this study was to analyze the incidence, prognostic factors, and 28 days outcome of AKI in the setting of a medical ICU.

Objectives

- To find the incidence of AKI in critically ill patients in our center
- To assess the outcome of AKI with requirement of hemodialysis (HD) and 28 days mortality
- To assess the ability of 24 h RIFLE classification to prognosticate AKI.

Patients and Methods

This was a prospective, observational cross-sectional study conducted in the 28 bedded medical ICU of a tertiary care hospital. The population served by this multispecialty tertiary care center is a mixture of urban and rural population admitted as referrals or as primary admissions.

After Institutional Ethics Committee approval and informed consent, all patients with AKI admitted in the ICU of our institution were prospectively enrolled in the study. The study period was for 6 months from April 2012 to October 2012. AKI was defined as an absolute creatinine value of >1.6 mg/dl or a 25% increase from baseline creatinine values. All patients with age <18, a baseline serum creatinine ≥5.0 mg/dL, end-stage renal disease (ESRD) on dialysis, and transplanted kidney were excluded from the study.

In addition to the demographic factors like age, sex, date of admission to ICU, and preexisting co morbidities were recorded. The Acute Physiology and Chronic Health Evaluation (APACHE) and sequential organ failure assessment (SOFA) score on admission was calculated. The acute illness of the patient was classified as cardiovascular, respiratory, gastrointestinal, renal, or neurological. We also classified the patients according to maximum RIFLE class in the first 24 h of inclusion in the study. We used only the urine output criteria for the classification[4] [Table 1 and Figure 1].

The presence of sepsis and septic shock, requirement of mechanical ventilation (MV), or vasopressors was recorded. Sepsis was diagnosed if the patient had a possible infection and fulfilled at least two systemic inflammatory response syndrome criteria. Details regarding renal replacement therapy (RRT) were collected. HD is the only method used for support of patients with loss of renal function in our center. The patients were followed up for 28 days from admission. Outcomes looked at were 28 days mortality and requirement of HD in AKI.

Table 1: RIFLE classification

Class	Urine output	GFR
R	<0.5 mL/kg/h for 6 h	Serum creatinine 1.5 mg/dL
I	<0.5 mL/kg/h for 12 h	Serum creatinine 2.0 mg/dL
F	<0.3 mL/kg/h for 24 h or anuria for 12 h	Serum creatinine 3.0 mg/dL or creatinine 4.0 with acute rise >0.5 mg/dL
L		Complete loss of kidney Function >4 weeks
E		ESRD >3 months

ESRD: End-stage renal disease; GFR: Glomerular filtration rate; RIFLE: Risk, Injury, failure, loss, end

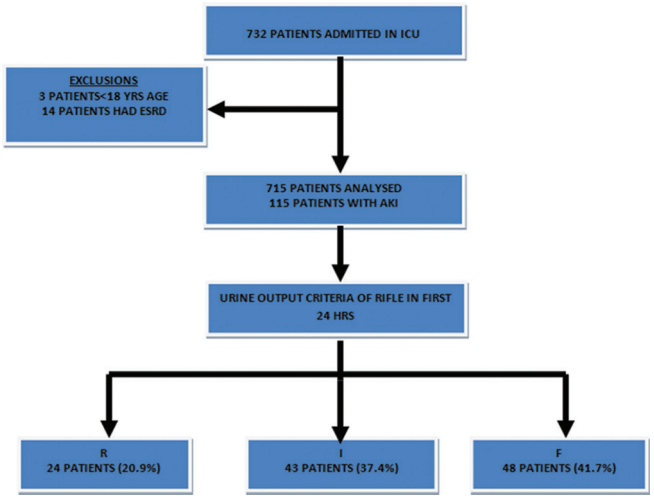

Figure 1: Classification of acute kidney injury patients to risk, injury, and failure groups

Statistical analysis was done using SPSS 14 (SPSS Inc., Chicago, IL, USA). Continuous variables were presented as mean (±standard deviation). Univariate statistical analysis was performed by Chi-square test for comparing proportions and ANOVA for comparing means. Multivariate logistic regression then done with significant variables to assess independent risk factors for mortality in patients with AKI and requirement of RRT. The value $P < 0.05$ was considered to be statistically significant.

Results

Total admissions in our medical ICU between April 2012 and October 2012 were 732 patients. After excluding patients with ESRD and patients under 18 years of age, we collected data of 715 patients. Out of these 715 patients, 115 had AKI.

The crude incidence of AKI was 16.1%, and mortality was 7.8%.

The average age of the patient with AKI was 59.7 ± 14.01. 64.3% were males. The average stay in ICU was 11.0 ± 8.5 days. The mean APACHE II score was 25.7 ± 7.81 and SOFA score was 8.8 ± 3.55 at admission. Comorbidities of the patients were recorded and diabetes mellitus (58.3%) was the most common. The clinical features and biochemical values on the admission of the AKI patients are mentioned in Table 2. In this study, 87 (75.7%) patients had sepsis, 71.3% patients had metabolic acidosis and 47.8% patients were in shock on admission. 57.4% of patient's required MV.

Among patients with AKI, 39.1% required RRT. HD was done in all patients. The number of HD expressed as median (interquartile range [IQR] 25–75%) were 4 (2–7.2) and the number of days in HD was 5 (3–10) [Table 3]. The requirement of RRT was significantly affected by increasing age, creatinine values, APACHE II and SOFA scores, and the presence of septic shock with requirement of noradrenaline support on admission [Table 4].

About 49.5% of patients with AKI died within 28 days. Demographic data were comparable between survivors and nonsurvivors. Univariate analysis was done to identify risk factors for mortality, age, sex, SOFA and APACHE II score, comorbidities, sepsis, use of vasopressors (Noradrenaline), and requirement of MV were among the factors considered.

In the logistic regression analysis, the use of vasopressors (noradrenaline) was found to be an independent predictor of mortality. Requirement of mechanical ventilatory support and increasing ICU stay was found to have a significant relation to mortality. Though SOFA score was

Table 2: Characteristics of patients with AKI on admission

Variable	Mean±SD
Age (years)	59.77±14.01
Males (%)	64.3
Hypertension (%)	53.9
DM (%)	58.3
CAD (%)	24.3
COPD (%)	19.1
Chronic liver disease (%)	25.2
CKD (%)	25.2
Heart rate	102.1±26.07
MAP	72±16.4
Respiratory rate	23.6±5.36
GCS	12.087±3.89
pH	7.33±0.113
APACHE II	25.7±7.8
SOFA score	8.86±3.5
Serum creatinine	3.21±1.70
Serum urea	99.3±56.5
Sodium	130.45±8.31
Potassium	4.2±1.06
Hemoglobin (g/dL)	11.35±9.4
Platelets (/mm^3)	196,350±131

MAP: Mean arterial pressure; GCS: Glasgow Coma Scale; APACHE: Acute Physiology and Chronic Health Evaluation; CAD: Coronary artery disease; COPD: Chronic obstructive pulmonary disease; SOFA: Sequential organ failure assessment; AKI: Acute kidney injury; SD: Standard deviation; CKD: Chronic kidney disease; DM: Diabetes mellitus

Table 3: Details of hemodialysis

	Survivors	Nonsurvivors	*P*
Number of HD (mean±SD)	7.11±6.66	4.321±2.98	0.059
Number of days in HD (mean±SD)	11.26±10.83	6.571±5.88	0.06
Day of initial dialysis (mean±SD)	1.78±1.03	2.81±3.3	0.2
HD after discharge from ICU % (*n*)	19.4 (13)		
HD after discharge from hospital % (*n*)	6.1 (4)		

HD: Hemodialysis; SD: Standard deviation; ICU: Intensive Care Unit

Table 4: Multinomial regression analysis for RRT

Outcome	SE	Significance	95% CI	
			Lower bound	Upper bound
APACHE	0.065	0.038	0.770	0.993
SOFA	0.196	0.001	1.289	2.780
Creatinine	0.455	0.000	0.066	0.394
Days in ICU	0.037	0.557	0.951	1.098
Age	0.035	0.001	1.049	1.203
DM	0.723	0.086	0.070	1.192
Hypertension	0.729	0.276	0.530	9.235
CKD	0.939	0.160	0.593	23.561
Noradrenaline	0.962	0.001	0.006	0.275
Sepsis	0.929	0.057	0.028	1.057
MV	0.763	0.053	0.051	1.022
Metabolic acidosis	0.740	0.349	0.469	8.520
RIFLE=F	1.045	0.309	0.045	2.676
RIFLE=I	0.914	0.613	0.105	3.781

RRT: Renal replacement therapy; CKD: Chronic kidney disease; MV: Mechanical ventilation; SE: Standard error; R: Risk; I: Injury; F: Failure; L: Loss; E: End; CI: Confidence interval; APACHE: Acute Physiology and Chronic Health Evaluation; SOFA: Sequential organ failure assessment; R: Risk; I: Injury; F: Failure; L: Loss; E: End; ICU: Intensive Care Unit; DM: Diabetes mellitus

found to have an association to mortality in univariate analysis, it was found to be nonsignificant in logistic regression analysis while increasing APACHE II scores showed no association. Hypertension, chronic kidney disease (CKD), and increasing age showed significant association with mortality. Other comorbidities did not affect 28 days survival [Table 5].

The median (IQR) number of days of ICU stay in R, I, and F was 10 (7–17), 7 (5–14), and 8 (5–15) days, respectively. The maximum RIFLE score in the first 24 h correlated well to the requirement of HD. Only 3 patients in group R required RRT while it was 11 and 31, respectively, in I and F group. Pearson Chi-square analysis showed a significant difference between the R, I, and F groups. The percentage of mortality in these three groups did not show a significant difference in our study [Table 6].

Discussion

AKI is common in patients admitted in the ICU. The AKI is often of multifactorial etiology, but it is known to increase mortality, length of ICU and hospital stay and also increase the cost of care in critically ill patients. It alters the outcome of patients, especially those requiring RRT.[5] Hence, data about the incidence and outcome of AKI patients can have important health resource utilization and economic implications.

Table 5: Multinomial regression analysis for 28 days mortality

Outcome	SE	Significance	95% CI	
			Lower bound	Upper bound
APACHE	0.068	0.221	0.951	1.241
SOFA	0.168	0.532	0.799	1.543
Creatinine	0.247	0.302	0.478	1.257
Days in ICU	0.048	0.024	0.817	0.986
Age	0.033	0.015	1.016	1.157
DM	0.720	0.683	0.182	3.056
Hypertension	0.665	0.033	0.066	0.890
CKD	0.913	0.022	0.021	0.738
Noradrenaline	0.719	0.012	1.487	24.895
Sepsis	0.782	0.492	0.126	2.705
MV	0.780	0.019	1.352	28.765
Metabolic acidosis	0.828	0.460	0.107	2.750
Hemodialysis	0.929	0.023	1.343	51.179
RIFLE=F	1.012	0.244	0.042	2.234
RIFLE=I	0.895	0.266	0.064	2.133

SE: Standard error; APACHE: Acute Physiology and Chronic Health Evaluation; SOFA: Sequential organ failure assessment; R: Risk; I: Injury; F: Failure; L: Loss; E: End; CI: Confidence interval; ICU: Intensive Care Unit; CKD: Chronic kidney disease; MV: Mechanical ventilation; DM: Diabetes mellitus

Table 6: RIFLE class and outcome of AKI patients

Class	Number of patients (%)	RRT required (%)	Mortality (%)
R	24 (20.9)	12.5	37.5
I	43 (37.4)	25.6	46.5
F	48 (41.7)	64.6	47.9

RRT: Renal replacement therapy; R: Risk; I: Injury; F: Failure; L: Loss; E: End; AKI: Acute kidney injury

Our study was conducted over a 6 months period in the 28 bedded medical ICU of our institution. The incidence of AKI in our study population was 16.1%. About 75% of patients in our study was admitted with sepsis. Previous studies from India have shown a similar incidence (17.1%) of AKI in medical ICU.[6] The demographic analysis of our patients revealed that the average age of our patient population was 59.77 and 64.3% of them were male. This is similar to previous studies.[7]

The decision to initiate RRT was by the nephrologist in our ICU. Indications for RRT included metabolic acidosis, hyperkalemia, uremia, and control of volume status.[8] All patients underwent HD. Based on our study, prediction of the requirement of RRT-based on admission values of bilirubin, sepsis, and metabolic acidosis does not seem to be valid. Only creatinine on admission, increasing age, APACHE II, SOFA score, and use of noradrenaline were significantly associated with the requirement of HD in multivariate analysis. There was no significant difference between survivors and nonsurvivors in the number of HD done. This is similar to other studies which compared the intensity and timing of RRT in patients with AKI.[9,10] Among the survivors, 19.3% required RRT after discharge from ICU and 6.1% required dialysis after discharge from hospital.

AKI increases the risk of mortality of patients, especially in critically ill patients.[11,12] Mortality rates in patients with AKI were 49.5% which is similar to previous studies.[6,12] The overall mortality rates in patients with AKI does not show a significant change in the last 10 years. Even though the facilities and care have improved over these years, the increased mortality might be due to the sicker patients admitted in ICU and more associated comorbidities. Older age, requirement of vasopressors, and requirement of MV and RRT still increase the risk of mortality.[11]

The newly introduced AKIN and RIFLE criteria for the diagnosis of AKI is aimed at reducing the disparities in diagnosing AKI.[4,13] In critically ill patients, the variation in creatinine can occur in short periods of time. Urine output may be a better way to assess the renal status, and it has the additional advantage that it is the same in both criteria. In our study, the RIFLE criteria correlate well with the requirement of RRT as was the case in multiple previous studies.[13,14] Though our analysis did not show significant association of all RIFLE classes with mortality, many studies have shown

good association with mortality.[15,16] One reason for the discrepancy could be that we chose only urine output criteria for the classification and not the maximum RIFLE class based on creatinine or urine output. The Thai study took the maximum RIFLE class after admission while we took the RIFLE class on inclusion into the study.[16] The study by Maccariello E on RIFLE classification and outcomes in patients requiring RRT did not show significant variation in outcome between the different classes in multivariate analysis, which is similar to our findings.[17]

Limitations of the study

This was a single-center, prospective study of only 6 months duration. The follow-up period is too short to know whether the kidneys have recovered or if the patients required longterm RRT. The AKI in postoperative patients have not been included in the study as ours was a medical ICU. A larger multicenter study can provide a more significant association between urine output criteria of RIFLE and outcome of AKI.

Conclusion

The incidence of AKI was 16.1% in critically ill patients. In patients with AKI, 39.1% patients required HD and 28 day mortality was 49.5%. AKI patients with septic shock with vasopressors have a higher requirement of RRT, especially as age increases. Underlying chronic illness such as hypertension and CKD, need for MV, vasopressor support, and RRT are associated with increased 28 days mortality in AKI. The positive univariate association of urine output criteria of RIFLE classification with the requirement of HD in AKI patients warrants further research.

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Conflicts of interest

There are no conflicts of interest.

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