

Original Research Article

A study on risk factors, clinical profile and outcome of patients with acute kidney injury in the intensive care unit of a tertiary care hospital

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Received: 22 August 2026

Revised: 10 September 2026

Accepted: 16 October 2026

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ABSTRACT

Background: Acute kidney injury (AKI), is a prevalent and serious condition in the intensive care unit (ICU) that significantly increases the risk of morbidity and mortality. This study aims to evaluate the risk factors, clinical profile, and outcomes of patients with AKI admitted to the intensive care unit.

Methods: This longitudinal study was conducted in patients with AKI admitted to the ICU of the ESI Medical College, Chennai. After obtaining approval from the Institutional Ethics Committee, data from patients with AKI, demographic profiles, laboratory parameters and outcomes were collected and analysed using appropriate statistical methods.

Results: Sepsis is the main cause of acute renal damage (69%) and is common in critically ill patients aged > 50 years. The results showed that the development of AKI is complicated and multifaceted, with important contributions from hypotension (27%), fever (17%), oliguria (16%), and concomitant diseases such as diabetes (43%) and hypertension (20%). Patients in the RIFLE criteria's "Failure" group (71%) had the most severe renal impairment and higher rates of both progression to CKD and death.

Conclusions: Sepsis was the most prevalent risk factor in the study. The outcomes of AKI did not show a significant correlation with age and sex, suggesting that other factors are more influential in determining the prognosis. Overall, these results emphasise the multifaceted nature of AKI and the importance of a holistic approach for its management.

Keywords: Acute kidney injury, Sepsis, hypotension, Chronic kidney disease, RIFLE criteria

INTRODUCTION

Acute kidney Injury (AKI) often occurs as a severe consequence in critically ill patients who are hospitalized in the intensive care unit (ICU).¹ Acute kidney Injury is defined by a rapid decline in kidney function, resulting in the accumulation of waste substances and disturbance of fluid, electrolyte, and acid-base balance.² The incidence of Acute kidney Injury in the ICU is reported to be as high as 50%, and it is accompanied by substantial mortality and morbidity.

The incidence of AKI in critically ill patients is caused by several risk factors leading to its development.³ The risk

factors include advanced age, sepsis, hypovolemia, preexisting chronic kidney disease, exposure to nephrotoxic drugs, and underlying comorbidities such as diabetes and hypertension.⁴

The presentation of AKI in the ICU may vary from mild changes in serum creatinine levels to severe and potentially fatal kidney failure requiring renal replacement therapy (RRT).⁵ The RIFLE (Risk, Injury, Failure, Loss, End-stage renal disease) criteria have been shown to have a direct relationship with patient outcomes, indicating the severity of AKI.⁶

The prognosis of patients with Acute kidney Injury in the ICU is often variable, with high fatality rates ranging from

20% to 80%. Factors linked with unfavourable outcomes include the severity of AKI, the presence of multiorgan failure, and the necessity for RRT.⁷ Furthermore, those who have survived AKI have a higher likelihood of acquiring chronic kidney disease (CKD) and end-stage renal disease, which emphasises the long-term effects of this illness.⁸ To fully understand the effect of AKI on critically ill patients, it is crucial to conduct thorough research that assesses the risk factors, clinical characteristics, and outcomes of AKI in the intensive care unit environment. This knowledge may influence the development of tailored strategies to prevent, identify, and manage AKI in critically ill patients, thereby improving patient outcomes and reducing the burden of Acute kidney Injury which has a significant influence on patient outcomes and healthcare expenses.^{9,10}

Characterising the clinical picture of patients with AKI in the ICU, including the degree of kidney damage, related comorbidities, and requirement for renal replacement treatment might provide useful insights into the care and resource consumption necessary for these patients.^{11,12} This information may influence the creation of evidence-based therapeutic procedures and resource allocation to improve the management of critically ill patients with AKI. Evaluating the outcomes of patients with Acute kidney Injury in the ICU, including in-hospital mortality, duration of ICU stay, and long-term renal function, might assist in identifying the factors linked with unfavourable outcomes.¹³ This information may help in the creation of prognostic models and guide the execution of focused therapies to enhance patient outcomes and reduce the long-term complications of Acute kidney Injury.¹⁴

METHODS

This longitudinal study was conducted after obtaining approval from the Institutional Ethics Committee at an ESI Medical College hospital in Chennai. Detailed Informed Consent was collected from the patients or their relatives in the case of critically ill patients from September 2022 to October 2023. Data from patients with Acute Kidney Injury, demographic profiles, comorbidities, laboratory parameters, and outcomes were collected, tabulated, and analysed using appropriate statistical methods.

This study was conducted on Patients with Clinical or biochemical evidence of Acute Kidney Injury based on the RIFLE criteria. Patient data were collected at the initial visit to help assess various risk factors and clinical presentation. Followed by a 3-month follow-up (as it takes a patient of AKI to progress to chronic kidney disease 3 months) to determine the outcome whether the patient has been Recovered/Progressed to CKD/Expired. The patients were followed up for up to 12 months after the diagnosis of Acute Kidney Injury on an outpatient basis. The association between various risk factors and concurrent outcomes was analysed.

Regarding the study done by Liano et. al, which studied the incidence of mortality among AKI patients, taking the incidence of mortality among AKI cases to be 50% with 20% relative precision and 95% CI, the sample size was calculated to be 100 using Open Epi version 3.02 online software. All inpatients admitted to the Intensive Care Unit with clinical and/or biochemical evidence of AKI, based on the RIFLE Criteria were included in the study. Patients aged <12 years, Patients with malignancy and diagnosed with chronic kidney disease were excluded from the study.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 25. Continuous variables are summarized as mean (SD) or median (IQR) based on normality. Categorical variables were summarized as frequencies and proportions. Regression methods were used to predict the risk factors. The association between categorical outcomes and independent variables was assessed using the chi-square test. Statistical significance was set at $p < 0.05$.

RESULTS

The study included 100 AKI patients, aged 30 to >60 years, with the highest number of patients aged > 60 years (38%) and the lowest in the age group 30-40 (11%). Age groups 50-60 and 40-50 had 30% and 21% of patients, respectively (Table 1). The study observed a higher proportion of male patients (54%) compared to females (46%).

Table 1: Age group of patients.

S no.	Age group (years)	No of patients	Percentage
1.	>60	38	38.0%
2.	30-40	11	11.0%
3.	40-50	21	21.0%
4.	50-60	30	30.0%

Among the risk factors for hypertension and diabetes, the proportion of patients with hypertension was lower (29%) than that of patients with diabetes (43%). Sepsis was the most prevalent risk factor among the patients in this study, affecting 69 patients (69%). Trauma/blood loss was the second most common risk factor affecting 9 patients (9.0%). Drug-related issues affected four patients (4.0%), followed by renal calculi (4%), and liver failure (4%). Acute diarrhoeal disease (ADD) affected 4 patients (4%), and both contrast-induced complications and heart failure affected 3 patients each (3.0%) (Figure 1).

Hypotension was the most common chief complaint, affecting 27 patients (27.0%). Fever was the second most prevalent complaint and was reported by 17 patients (17.0%). Oliguria affected 16 patients (16.0%), whereas oedema was a complaint in 11 patients (11.0%). Vomiting was noted in 8 patients (8.0%) and polyuria in 6 patients (6.0%). Loose stools affected four patients (4.0%).

Anorexia, dyspnoea, and fatigue each affected 3 patients (3.0%). Haematuria was the least common complaint, reported by two patients (2.0%).

According to the RIFLE criteria among the patients under study, 71 patients (71.0%) are classified under "Failure", making it the most prevalent category. This is followed by 20 patients (20.0%) classified under "Injury," and 9 patients (9.0%) classified under "Risk." This indicates a higher prevalence of severe kidney issues, with the majority of patients falling into the "Failure" category. (Figure 2) Among the patients under study, 51 (51.0%) had intrinsic renal acute kidney injury (AKI), 4 (4.0%) had post-renal AKI, and 45 (45.0%) had pre-renal AKI.

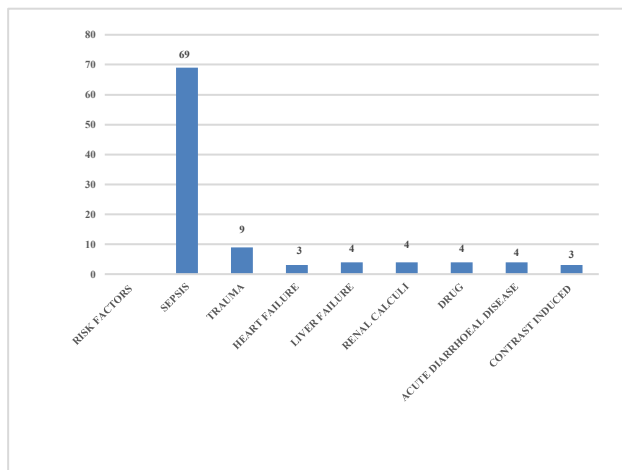


Figure 1: Risk factors among patients.

The correlation of the RIFLE criteria with acute kidney injury (AKI) outcomes showed significant differences. Among patients classified under "Failure", 24 (88.9%) developed chronic kidney disease (CKD), 32 (100.0%) expired, and 15 (36.6%) recovered. In the "Injury" category, three patients (11.1%) developed CKD, none expired, and 17 (41.5%) recovered. For those in the "Risk" category, none developed CKD or expired, and nine (22.0%) recovered. A $p < 0.0001$ indicates a highly significant statistical difference in AKI outcomes based on the RIFLE criteria.

The correlation of urine spot sodium levels with AKI outcomes showed significant differences. Among patients with urine spot sodium levels less than 40 mEq/l, 12 (44.4%) developed CKD, 7 (21.9%) expired, and 32 (78.0%) recovered. For patients with urine spot sodium levels greater than 40 mEq/l, 15 (55.6%) developed CKD, 25 (78.1%) expired, and 9 (22.0%) recovered. A $p < 0.0001$ indicates a highly significant statistical difference in CKD outcomes based on urine spot sodium levels (Table 2).

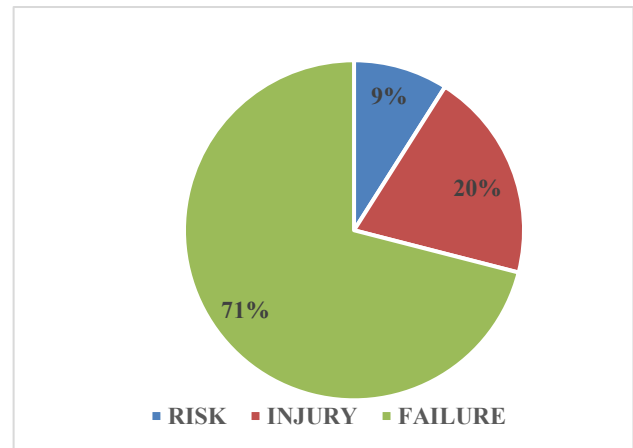


Figure 2: RIFLE Criteria among patients.

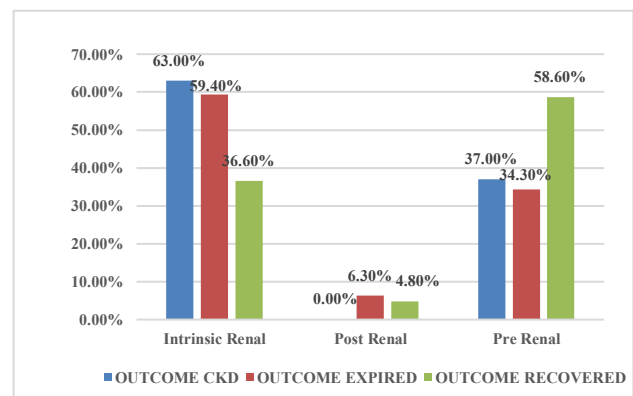


Figure 3: Correlation of AKI types with AKI outcomes in patients.

Table 2: Correlation of urine spot Na with AKI outcomes in patients.

	Outcome									
	CKD			Expired		Recovered				
	Count		Column N %	Count		Column N %	Count		Column N %	P value
Urine spot Na	<40	12	44.4%	7	21.9%	32	78.0%			<0.0001
	>40	15	55.6%	25	78.1%	9	22.0%			

The correlation of acute kidney injury (AKI) types with AKI outcomes showed notable differences. Among patients with intrinsic renal AKI, 17 (63.0%) developed CKD, 19 (59.4%) expired, and 15 (36.6%) recovered. For

patients with post-renal AKI, none (0.0%) developed CKD, 2 (6.3%) expired, and 2 (4.8%) recovered. Among those with pre-renal AKI, 10 (37.0%) developed CKD, 11 (34.3%) expired, and 24 (58.6%) recovered (Figure 3). A p-value of 0.041 indicates that the statistical difference

in CKD outcomes based on AKI types is highly significant.

DISCUSSION

Of the 100 patients who participated in the trial, a greater percentage were older than 50 years. This was consistent with related research carried out on the Indian subcontinent.^{15,16} Several connected variables contributed to the occurrence of acute kidney injury in ICU patients, especially in those over 50 years of age. Because of age-related physiological changes such as altered haemodynamics and diminished renal reserve, older persons are often more prone to Acute kidney injury.¹⁷

Men are more prone than women to suffer from diseases like heart disease and hypertension, for instance, both of which play a major role in the development of AKI.¹⁸ Men may have greater rates of AKI than women due to gender-related variations in healthcare-seeking behaviour and the frequency of risk factors such as drug addiction.¹⁹

Diabetes (43%) and hypertension (29%) were identified as important risk variables in the study of patients with AKI hospitalised in the intensive care unit. According to a study, the incidence of AKI was greater in diabetic patients (30.1%) than in those with nondiabetic (27.2%).²⁰ Renal arterioles and glomeruli may sustain damage from haemodynamic changes caused by diabetes, which lowers the kidneys tolerance to nephrotoxic drugs and raises the risk of AKI.²¹ Chronic hyperglycaemia raises the risk of AKI by damaging the renal microvasculature and resulting in diabetic nephropathy.²² An additional significant risk factor for AKI is hypertension. Hypertension is one of the comorbid illnesses that diabetic people often have, making kidney health even more difficult.²⁰

Acute kidney injury is a serious issue for patients in the intensive care unit and is often associated with several risk factors. Sepsis (69%) was the most common risk factor associated with AKI, followed by trauma (9%), blood loss (9%). According to many studies, sepsis accounts for 38.6% and 51% of AKI cases in critically sick patients.¹⁸ Hemodynamic instability and systemic inflammation are key components of the pathogenesis, and they may cause renal hypoperfusion and direct kidney damage. Multi-organ dysfunction is common in patients with sepsis, exacerbating their clinical condition and increasing the risk of AKI. In approximately 9% of cases, trauma and severe blood loss were the second most prevalent risk factor affecting patients with AKI. Hypovolemic shock may result from this, which lowers renal perfusion and damages the kidneys via ischemia.²³

Treatment-related nephrotoxic medicine and the need for resuscitation fluids often worsens the link between trauma, blood loss, and AKI. Drug-related problems are important contributing factors to the development of AKI in ICU patients. AKI may be caused by nephrotoxic medications, including contrast agents and certain antibiotics (such as

vancomycin and amikacin) that directly harm renal tissues or change renal haemodynamics. A small proportion of patients also have acute diarrhoeal disease, heart failure, liver failure, renal calculi, complications from contrast-induced nephropathy as risk factors. This was consistent with earlier studies as well.^{18,19,23} Patients with Acute kidney injury often have several chief symptoms indicative of the underlying pathophysiology and consequences of the illness. Among these, oliguria, hypotension, fever and oedema are important markers of AKI severity and underlying causes. Additional reports included polyuria, loose stools, anorexia and dyspnoea. The existence of these elements as the main grievances expressed by patients with AKI in the ICU is further supported by previous studies.^{24,25}

A categorisation system called RIFLE criteria was used to determine the degree of AKI based on variations in urine production and blood creatinine levels. In this study, a greater percentage of patients (71%) identified as having Failure were followed by patients (20%) who were at Injury and patients (9%) who were at Risk of AKI. Previous research also proposed the likely distribution of AKI ICU patients according to the RIFLE criteria.^{26,27} Patients may have fallen into the RIFLE criteria "Failure" group due to a higher incidence of hypotension, a condition that is crucial to renal perfusion.²⁸ This research highlights the importance of hypotension in renal damage in AKI patients by showing that it is a prevalent primary complaint coupled with a greater prevalence of sepsis and trauma.

The study categorised Acute kidney injury outcomes in ICU patients as CKD, Expired and recovery. Different effects have been observed when AKI risk variables are correlated with patient outcomes. Sepsis was a common risk factor for all outcomes, as shown by the fact that 17 (59.4%) patients who had sepsis expired, 24 (58.5%) recovered, and 16 (59.3%) had CKD. However, sepsis does seem to be consistently common; there was no statistically significant difference in outcomes based on these risk variables ($p=0.572$). Several studies have indicated that sepsis plays a crucial role in the onset and course of AKI in ICU patients, having a substantial influence on disease progression.² Based on the RIFLE criteria, the research showed a statistically significant difference ($p<0.0001$) in AKI outcomes.

According to these statistics, patients who are categorised as "failure" have the greatest rates of CKD and death, while patients who are classed as "injury" or "risk" do better in their recuperation. The RIFLE criteria classification of AKI has important ramifications for patient outcome. This was consistent with the majority of epidemiological research that assessed the mortality of critically ill patients with AKI by contrasting participants in the groups of recovered, injured and failed to see whether the result deteriorated with time as the severity of AKI increased.²⁹

Urine spot sodium (Na) levels and AKI outcomes in ICU patients were significantly correlated, indicating that Urine-spot Na may be a reliable indicator of patient prognosis. Although the p value is useful in theoretically representing renal tubular function and fluid balance, it shows significant difference in urine spot Na levels between individuals who proceed to CKD, those who expire, and those who recover.

Limitations

The external validity of the study may be impacted by the limited variety of the patient population resulting from its exclusive use as a tertiary care facility. This might have resulted in a selection bias and restricted the generalisability of the findings. A more thorough understanding can be obtained through multicentre investigations.

The study's sample size may be small, which may have an impact on how well the results apply to a larger population. It is possible that the findings from one tertiary care facility will not apply to different environments or geographical areas. The length of follow-up may not be long enough to record long-term consequences and outcomes related to AKI, which would restrict our knowledge of the chronic ramifications and recovery timelines.

CONCLUSION

AKI progression is complex and multifactorial, with significant contributions from hypotension, oliguria, fever, and comorbid conditions such as hypertension and diabetes. The most severe kidney impairment was observed in patients classified under the "Failure" category of the RIFLE criteria, who had higher rates of CKD and mortality. Additionally, conservative treatment approaches are associated with improved recovery. Overall, these results emphasise the multifaceted nature of AKI and the importance of a holistic approach for its management and monitoring.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Prasad R, Gnanamoorthy K, Hariprasad. A study on risk factors, clinical profile and outcome of patients with acute kidney injury in the intensive care unit of a tertiary care hospital. *Int J Adv Med* 2026;13:434-9.