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Acute kidney injury in critically ill patients: risk factors, renal recovery patterns, and in-hospital mortality.

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Abstract

Background: Acute kidney injury (AKI) is a frequent complication among critically ill patients and is associated with prolonged hospitalization, need for renal replacement therapy (RRT), incomplete renal recovery, and increased mortality. Early risk stratification and assessment of renal recovery may improve prognostication and clinical management. ***Material and Methods:*** This prospective observational study included 75 critically ill adults with AKI admitted under the Department of General Medicine at a tertiary care centre. AKI was classified according to KDIGO criteria. Demographic characteristics, comorbidities, precipitating factors, laboratory parameters, vasopressor and mechanical ventilation requirements, RRT, renal recovery, ICU stay, and in-hospital mortality were assessed. ***Results***: The mean age was 59.6 ± 12.2 years and 70.7% were male. Sepsis was present in 57.3% of patients. KDIGO Stage 1, 2, and 3 AKI occurred in 36.0%, 29.3%, and 34.7%, respectively. Complete renal recovery occurred in 49.3%, while 18.7% achieved partial recovery. RRT was required in 21.3%. In-hospital mortality was 26.7% and increased significantly from 11.1% in Stage 1 to 46.2% in Stage 3. Higher AKI severity was associated with longer ICU stay, delayed renal recovery, vasopressor requirement, mechanical ventilation, and mortality. ***Conclusion***: Severe AKI in critically ill patients is associated with delayed renal recovery, greater organ-support requirements, and increased mortality. Early identification of high-risk patients and close monitoring of renal recovery may improve outcomes.

Keywords: Acute kidney injury; Critical illness; KDIGO; Renal recovery; Mortality; Renal replacement therapy; Intensive care unit.

INTRODUCTION

Acute kidney injury (AKI) is a major complication of critical illness. It represents an abrupt decline in kidney function, identified mainly by changes in serum creatinine and/or urine output, and develops through interaction between pre-existing susceptibility and acute insults such as sepsis, shock, major surgery, nephrotoxic exposure, mechanical ventilation and multiorgan dysfunction. Contemporary studies indicate that AKI affects a substantial proportion of intensive care unit (ICU) patients and is associated with prolonged hospitalization, greater organ-support requirements and higher short- and long-term mortality [1,2]. Importantly, AKI is increasingly understood not as a single event but as a heterogeneous syndrome with different etiologies, severities and trajectories, making early risk stratification essential for identifying patients likely to develop persistent kidney dysfunction or adverse outcomes [3].

The clinical course after AKI is highly variable. Some patients demonstrate rapid reversal of renal dysfunction, whereas others develop persistent AKI, acute kidney disease, dialysis dependence or progression toward chronic kidney disease. Renal recovery has therefore emerged as a key outcome. Jiang et al. reported that new-onset AKI occurred in 30% of critically ill adults in a multicentre ICU cohort and found that sepsis, higher SOFA and APACHE II scores, vasopressor use, nephrotoxic drugs and comorbidities were important risk factors; persistent, rather than transient, AKI was strongly associated with 28-day mortality [4]. Abdel-Nabey et al. demonstrated distinct recovery trajectories among ICU patients, with AKI severity and mechanical ventilation associated with poorer recovery [5]. In a large longitudinal cohort, Ozrazgat-Baslanti et al. showed that persistent AKI and absence of renal recovery were associated with substantially reduced long-term survival independently of initial AKI severity [6]. A recent meta-analysis further suggested that earlier renal recovery is associated with lower risks of chronic kidney disease progression, renal replacement therapy and adverse composite renal outcomes [7].

Despite these advances, predicting which critically ill patients will recover kidney function remains difficult. Traditional tools such as APACHE and SOFA reflect overall illness severity but were not designed specifically to predict the dynamic course of AKI. More recent models using multiple clinical variables and machine-learning approaches have improved prediction of hospital mortality and major adverse kidney events, including renal non-recovery, but require further validation across heterogeneous ICU populations [8]. Contemporary reviews also emphasize that serum creatinine and urine output provide limited information about the biological heterogeneity of AKI, while biomarker- and phenotype-based approaches are not yet routinely integrated into practice [3]. Recent multicentre work on persistent severe AKI has shown strong associations with renal non-recovery, readmission and 90-day mortality [9].

Thus, an important research gap remains in integrating readily available clinical risk factors, AKI severity and temporal course, renal recovery, and mortality within the same critically ill population. A clearer understanding of these relationships may improve early prognostication, guide renal-protective strategies, support appropriate use of kidney replacement therapy, and identify patients who require closer follow-up. Therefore, the present study aims to evaluate AKI in critically ill patients with particular emphasis on risk stratification, patterns and determinants of renal recovery, and their association with mortality.

MATERIALS AND METHODS

This hospital-based prospective observational study was conducted in the Department of General Medicine at a tertiary care centre. The study included critically ill adult patients admitted to the intensive care unit during the study period who developed or were diagnosed with acute kidney injury (AKI). A total of 75 eligible patients were enrolled after applying the predefined inclusion and exclusion criteria. Patients were followed during their hospital stay to assess clinical risk factors, severity of AKI, pattern of renal recovery, requirement for renal replacement therapy, and in-hospital outcome. AKI was identified and staged using standard Kidney Disease: Improving Global Outcomes (KDIGO) criteria based on changes in serum creatinine and urine output.

Sample Size

A total of 75 patients fulfilling the eligibility criteria were included in the study. Consecutive eligible patients admitted during the study period were recruited until the required sample size was achieved.

Inclusion Criteria

- Patients aged 18 years and above.
- Critically ill patients admitted to the ICU under the Department of General Medicine.
- Patients fulfilling the diagnostic criteria for acute kidney injury according to KDIGO criteria**.**
- Patients with available baseline and follow-up renal function parameters.
- Patients or legally authorised representatives willing to provide informed consent.

Exclusion Criteria

- Patients with known end-stage kidney disease or those already receiving maintenance dialysis.
- Patients with a history of renal transplantation.
- Patients with advanced chronic kidney disease requiring long-term renal replacement therapy.
- Patients admitted for less than 24 hours where adequate assessment and follow-up were not possible.
- Patients with incomplete clinical or laboratory data required for evaluation of AKI and renal recovery.
- Patients who declined consent for participation.

Study Tool

A structured, predesigned study proforma was used to record relevant demographic, clinical, laboratory, and outcome-related information. The study tool included:

- Demographic details such as age and sex.
- Presenting diagnosis and indication for ICU admission.
- Pre-existing comorbidities including diabetes mellitus, hypertension, cardiovascular disease and chronic kidney disease.
- Potential AKI risk factors such as sepsis, shock, dehydration, nephrotoxic drug exposure and mechanical ventilation.
- Vital parameters and hemodynamic status at admission.
- Serum creatinine, blood urea, electrolytes and urine output.
- Severity of AKI according to KDIGO staging.
- Requirement for vasopressors, mechanical ventilation and renal replacement therapy.
- Duration and progression of AKI.

- Renal recovery status at discharge.
- Length of ICU and hospital stay.
- Final outcome, including survival or in-hospital mortality.

Data Collection

Data were collected systematically from each enrolled patient through the following steps:

- Detailed history was obtained from the patient, relatives and available medical records.
- Baseline demographic characteristics, comorbid illnesses and cause of critical illness were documented.
- Clinical examination and vital parameters were recorded at the time of enrolment.
- Serum creatinine, blood urea, electrolytes and other relevant laboratory investigations were recorded at baseline and subsequently during hospitalisation.
- Urine output was monitored to aid diagnosis and staging of AKI.
- Patients were classified into KDIGO Stage 1, Stage 2 or Stage 3 AKI according to the maximum severity reached during hospitalisation.
- Exposure to nephrotoxic drugs, sepsis, hypotension, vasopressor requirement and mechanical ventilation was documented for risk stratification.
- Requirement and indication for renal replacement therapy were recorded.
- Renal function was followed throughout the hospital stay to determine complete, partial or absent renal recovery.
- Patient outcomes were documented as recovery and discharge, persistent renal dysfunction, dialysis dependence or in-hospital death.

Outcome Assessment

The primary outcomes evaluated were renal recovery and in-hospital mortality**.** Renal recovery was assessed based on improvement in serum creatinine and return of kidney function toward the patient's baseline level. Secondary assessment included factors associated with severe AKI, requirement for renal replacement therapy, persistent renal dysfunction and prolonged ICU stay.

Statistical Analysis

Data were entered into a computerized database and analysed using SPPS version 23.0. Continuous variables were expressed as mean ± standard deviation or median with interquartile range depending on data distribution, while categorical variables were presented as frequencies and percentages. The Chi-square test or Fisher's exact test was used to compare categorical variables, and the Student's t-test or Mann–Whitney U test was used for continuous variables as appropriate. Factors associated with renal non-recovery and mortality were assessed using suitable univariate and, where applicable, multivariable logistic regression analysis. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1. Baseline demographic and clinical characteristics of the study population (n=75)

Parameter	Value
Age, years, Mean ± SD	59.6 ± 12.2
Age >60 years, n (%)	36 (48.0)
Male, n (%)	53 (70.7)
Female, n (%)	22 (29.3)
Diabetes mellitus, n (%)	32 (42.7)
Hypertension, n (%)	39 (52.0)
Cardiovascular disease, n (%)	16 (21.3)
Pre-existing CKD, n (%)	8 (10.7)
Sepsis, n (%)	43 (57.3)
KDIGO Stage 1, n (%)	27 (36.0)
KDIGO Stage 2, n (%)	22 (29.3)
KDIGO Stage 3, n (%)	26 (34.7)

The mean age of the study population was 59.6 ± 12.2 years, with nearly half of the patients aged above 60 years. There was a male predominance, with males accounting for 70.7% of the cohort. Hypertension was the most frequent comorbidity, present in 52.0%, followed by diabetes mellitus in 42.7%. Pre-existing chronic kidney disease was present in 10.7% of patients. Sepsis was documented in more than half of the study population (57.3%), indicating its important contribution

to AKI in critically ill patients. The distribution of KDIGO stages showed that approximately one-third of patients had Stage 3 AKI, representing a substantial burden of severe kidney injury.

Table 2. Distribution of AKI risk factors according to KDIGO stage

Risk factor	Stage 1 (n=27)	Stage 2 (n=22)	Stage 3 (n=26)	Total (n=75)	p-value
Sepsis	12 (44.4%)	13 (59.1%)	18 (69.2%)	43 (57.3%)	0.186
Shock/hypotension	5 (18.5%)	9 (40.9%)	15 (57.7%)	29 (38.7%)	0.013
Dehydration/hypovolemia	12 (44.4%)	5 (22.7%)	5 (19.2%)	22 (29.3%)	0.095
Nephrotoxic drug exposure	7 (25.9%)	9 (40.9%)	10 (38.5%)	26 (34.7%)	0.483
Vasopressor requirement	5 (18.5%)	9 (40.9%)	18 (69.2%)	32 (42.7%)	0.001
Mechanical ventilation	4 (14.8%)	10 (45.5%)	18 (69.2%)	32 (42.7%)	<0.001
Diabetes mellitus	10 (37.0%)	9 (40.9%)	13 (50.0%)	32 (42.7%)	0.622
Hypertension	13 (48.1%)	11 (50.0%)	15 (57.7%)	39 (52.0%)	0.766
Pre-existing CKD	2 (7.4%)	2 (9.1%)	4 (15.4%)	8 (10.7%)	0.617

Statistical test: Pearson Chi-square test. p<0.05 considered statistically significant.

Sepsis was the most frequent acute risk factor for AKI and increased from 44.4% in Stage 1 to 69.2% in Stage 3, although the difference was not statistically significant. Shock or hypotension was significantly associated with increasing AKI severity (p=0.013). Vasopressor requirement increased markedly across KDIGO stages, from 18.5% in Stage 1 to 69.2% in Stage 3 (p=0.001). A similar pattern was observed for mechanical ventilation, which was required in 69.2% of Stage 3 patients compared with only 14.8% of Stage 1 patients (p<0.001). Diabetes, hypertension and pre-existing CKD were common background risk factors but did not show statistically significant differences between AKI stages. These findings suggest that hemodynamic instability and greater overall severity of critical illness were particularly associated with severe AKI.

Table 3. Clinical and laboratory profile of patients according to KDIGO stage

Parameter	Stage 1 (n=27)	Stage 2 (n=22)	Stage 3 (n=26)	p-value
Admission serum creatinine, mg/dL	1.7 ± 0.4	2.4 ± 0.3	3.1 ± 0.4	<0.001
Peak serum creatinine, mg/dL	2.1 ± 0.5	3.2 ± 0.5	5.1 ± 0.5	<0.001
Blood urea, mg/dL	53.1 ± 14.0	78.5 ± 21.4	106.5 ± 16.0	<0.001
Serum potassium, mEq/L	4.2 ± 0.5	4.4 ± 0.7	5.1 ± 0.6	<0.001
Urine output, mL/24 h, median (IQR)	1266 (1101–1388)	963 (796–1058)	519 (380–642)	<0.001
Oliguria, n (%)	0 (0.0)	2 (9.1)	18 (69.2)	<0.001
Vasopressor requirement, n (%)	5 (18.5)	9 (40.9)	18 (69.2)	0.001
Mechanical ventilation, n (%)	4 (14.8)	10 (45.5)	18 (69.2)	<0.001
Renal replacement therapy, n (%)	0 (0.0)	2 (9.1)	14 (53.8)	<0.001

Values are Mean ± SD unless otherwise specified. ANOVA/Kruskal–Wallis test was used for continuous variables and Chi-square test for categorical variables.

Renal biochemical abnormalities showed a progressive increase with worsening KDIGO stage. Mean peak serum creatinine increased from 2.1 ± 0.5 mg/dL in Stage 1 to 5.1 ± 0.5 mg/dL in Stage 3 (p<0.001), while blood urea demonstrated a similar trend. Median urine output declined substantially with increasing AKI severity and reached 519 mL/24 hours in Stage 3 patients. Oliguria was observed in 69.2% of Stage 3 patients compared with 9.1% in Stage 2 and none in Stage 1 (p<0.001). More severe AKI was also associated with substantially greater vasopressor and ventilatory support requirements. Renal replacement therapy was required in 53.8% of Stage 3 patients, demonstrating the increasing need for kidney support with progressive AKI severity.

Table 4. Pattern of renal recovery according to KDIGO stage

Renal outcome	Stage 1 (n=27)	Stage 2 (n=22)	Stage 3 (n=26)	Total (n=75)	p-value
Complete renal recovery	20 (74.1%)	11 (50.0%)	6 (23.1%)	37 (49.3%)	**0.001**
Partial renal recovery	3 (11.1%)	5 (22.7%)	6 (23.1%)	14 (18.7%)	—
No renal recovery at discharge*	1 (3.7%)	1 (4.5%)	2 (7.7%)	4 (5.3%)	—
Died before renal recovery	3 (11.1%)	5 (22.7%)	12 (46.2%)	20 (26.7%)	—
Time to renal recovery, days, median (IQR)**	3.0 (2.2–4.0)	5.4 (4.9–7.0)	7.6 (7.4–8.1)	4.4 (2.7–6.9)	**<0.001**

No recovery at discharge refers to survivors with persistent renal dysfunction. *Time-to-recovery analysis included the 51 patients with complete or partial renal recovery. p=0.001 represents comparison of complete recovery rates between KDIGO stages.

The probability of complete renal recovery decreased markedly with increasing AKI severity. Complete recovery occurred in 74.1% of Stage 1 patients but in only 23.1% of Stage 3 patients, and this difference was statistically significant (p=0.001). Partial recovery was more frequent among patients with Stage 2 and Stage 3 AKI. In addition, 46.2% of Stage 3 patients died before demonstrating renal recovery compared with 11.1% of Stage 1 patients. Among patients who recovered, the median time to renal recovery progressively increased from 3.0 days in Stage 1 to 7.6 days in Stage 3 (p<0.001). These findings demonstrate that increasing AKI severity was associated with both a lower probability and delayed achievement of renal recovery.

Table 5. Clinical outcomes according to KDIGO stage

Outcome	Stage 1 (n=27)	Stage 2 (n=22)	Stage 3 (n=26)	Total (n=75)	p-value
AKI duration, days, median (IQR)	3.1 (2.0–4.2)	5.9 (5.1–6.6)	8.6 (8.1–9.7)	5.8 (3.7–8.2)	<0.001
ICU stay, days, median (IQR)	4.6 (3.8–6.9)	8.2 (6.1–9.9)	10.2 (7.9–11.3)	7.7 (4.8–10.1)	<0.001
Hospital stay, days, median (IQR)	10.8 (9.6–13.5)	15.9 (13.7–17.3)	18.2 (16.4–21.3)	15.3 (11.2–18.0)	<0.001
RRT requirement, n (%)	0 (0.0)	2 (9.1)	14 (53.8)	16 (21.3)	<0.001
In-hospital mortality, n (%)	3 (11.1)	5 (22.7)	12 (46.2)	20 (26.7)	0.014
Dialysis dependence at discharge, n (%)	0 (0.0)	1 (4.5)	2 (7.7)	3 (4.0)	0.356

Clinical outcomes worsened progressively with increasing severity of AKI. Median AKI duration increased from 3.1 days in Stage 1 to 8.6 days in Stage 3 (p<0.001), while median ICU and hospital stays also increased significantly. Overall, 16 patients (21.3%) required renal replacement therapy, with more than half of Stage 3 patients requiring RRT. In-hospital mortality was 26.7% for the overall cohort and increased from 11.1% in Stage 1 to 46.2% in Stage 3 (p=0.014). Dialysis dependence at discharge occurred in only three patients and did not show a statistically significant difference between stages. Overall, the findings demonstrate a clear relationship between AKI severity, increased resource utilization, prolonged hospitalization and mortality.

Table 6. Spearman correlation between AKI severity, renal parameters and clinical outcomes

Variables correlated	n	Spearman's ρ	p-value
KDIGO stage vs peak serum creatinine	75	0.911	<0.001
KDIGO stage vs ICU stay	75	0.656	<0.001
KDIGO stage vs hospital stay	75	0.654	<0.001
KDIGO stage vs duration of AKI	75	0.895	<0.001
KDIGO stage vs time to renal recovery*	51	0.898	<0.001
Peak creatinine vs ICU stay	75	0.670	<0.001
Peak creatinine vs time to renal recovery*	51	0.855	<0.001
Blood urea vs ICU stay	75	0.449	<0.001

Time-to-recovery correlations include only the 51 patients demonstrating complete or partial renal recovery.

KDIGO stage showed a very strong positive correlation with peak serum creatinine (ρ=0.911, p<0.001), supporting progressive biochemical impairment with increasing AKI severity. Higher KDIGO stage also correlated significantly with longer ICU and hospital stays. A particularly strong relationship was observed between KDIGO stage and duration of AKI (ρ=0.895, p<0.001). Among patients demonstrating renal recovery, increasing KDIGO stage correlated strongly with longer time to recovery (ρ=0.898, p<0.001). Peak creatinine was similarly associated with both ICU stay and delayed renal recovery. Blood urea demonstrated a moderate positive association with ICU duration, suggesting that worsening renal dysfunction was accompanied by greater overall critical-care burden.

Table 7. Univariate logistic regression analysis of factors associated with in-hospital mortality and incomplete renal recovery

Predictor	Mortality OR (95% CI)	p-value	Incomplete renal recovery OR† (95% CI)	p-value
Age >60 years	1.12 (0.40–3.11)	0.834	0.60 (0.19–1.90)	0.387
Diabetes mellitus	2.63 (0.92–7.50)	0.072	0.56 (0.17–1.92)	0.359
Pre-existing CKD	5.78 (1.24–27.01)	0.026	1.03 (0.09–12.16)	0.982
Sepsis	24.54 (3.06–196.51)	0.003	2.90 (0.91–9.29)	0.073
Shock/hypotension	20.31 (5.09–81.05)	<0.001	6.60 (1.64–26.58)	0.008
Vasopressor requirement	26.36 (5.42–128.20)	<0.001	6.40 (1.71–23.95)	0.006

Mechanical ventilation	15.11 (3.87–59.07)	<0.001	5.17 (1.45–18.43)	0.011
KDIGO Stage 3	4.39 (1.49–12.95)	0.007	4.13 (1.15–14.81)	0.029
RRT requirement	3.92 (1.22–12.58)	0.022	—‡	—

Several indicators of severe critical illness were significantly associated with in-hospital mortality. Shock, vasopressor requirement and mechanical ventilation showed particularly strong associations with death, although the wide confidence intervals reflect the relatively small sample size. Stage 3 AKI was associated with approximately four-fold higher odds of mortality compared with Stages 1–2 (OR 4.39, p=0.007). RRT requirement and pre-existing CKD were also significantly associated with mortality. Among hospital survivors, shock, vasopressor requirement, mechanical ventilation and Stage 3 AKI were significantly associated with incomplete renal recovery. These findings suggest that both AKI severity and the degree of systemic/hemodynamic compromise are important determinants of short-term renal and survival outcomes.

DISCUSSION

Acute kidney injury remains an important determinant of outcome among critically ill patients, particularly when it occurs in association with sepsis, circulatory failure and multiorgan dysfunction. In the present study of 75 critically ill patients with AKI, the mean age was 59.6 ± 12.2 years, with a male predominance of 70.7%. Hypertension and diabetes mellitus were the most frequent comorbidities, while sepsis was identified in 57.3% of patients. Approximately one-third of the study population had severe AKI (KDIGO Stage 3). The overall in-hospital mortality was 26.7%, and 21.3% required renal replacement therapy (RRT). These findings are comparable with the prospective Brazilian ICU cohort reported by Inda-Filho et al., in which mortality among patients with AKI was 25.7%, 29.7% had Stage 3 AKI and 26.6% required RRT [10]. Their study also demonstrated progressively greater mortality with increasing AKI stage, supporting the severity-dependent pattern observed in the present study.

Renal recovery was another important finding. Complete recovery occurred in 49.3% of patients, while an additional 18.7% achieved partial recovery. Recovery decreased markedly with increasing AKI severity, from 74.1% complete recovery in Stage 1 to only 23.1% in Stage 3. Moreover, the median time to recovery increased from 3.0 days in Stage 1 to 7.6 days in Stage 3. Duarte and Magro demonstrated that renal recovery following hospital-acquired AKI was associated with a significantly lower risk of mortality, with recovery acting as a protective factor against death [11]. Although their population consisted predominantly of non-critical patients, the findings reinforce the prognostic importance of assessing recovery rather than considering AKI merely as a transient biochemical abnormality.

The combined complete and partial recovery rate in the present study was 68.0%, closely resembling the 67.9% renal recovery reported by Zhao et al. among 12,321 critically ill patients with AKI [12]. That study identified early serum creatinine measurements, blood urea nitrogen, vasopressin exposure and other markers of critical illness as important predictors of renal recovery and short-term reversibility. In the present study, higher peak creatinine was strongly correlated with delayed renal recovery ($\rho=0.855$, $p<0.001$), while vasopressor requirement was associated with incomplete recovery. These observations further indicate that both the magnitude of renal dysfunction and systemic hemodynamic instability influence renal recovery.

The present study also demonstrated progressive biochemical deterioration with increasing KDIGO stage. Peak creatinine increased from 2.1 ± 0.5 mg/dL in Stage 1 to 5.1 ± 0.5 mg/dL in Stage 3, accompanied by higher blood urea and potassium levels and markedly lower urine output. Patschan et al. emphasized that conventional creatinine-based assessment remains central to AKI diagnosis and prognostication, although biomarkers may provide additional information regarding renal recovery and survival [13]. Importantly, the very strong correlation between KDIGO stage and peak creatinine observed in the present study ($\rho=0.911$) should be interpreted cautiously because serum creatinine itself forms part of the KDIGO staging criteria.

Increasing AKI severity was also associated with longer ICU stay, longer hospitalization, greater RRT requirement and higher mortality. Mortality increased from 11.1% in Stage 1 to 22.7% in Stage 2 and 46.2% in Stage 3. The long-term SALTO study similarly demonstrated the considerable prognostic burden associated with severe AKI in critically ill patients; only 39.4% of the original severe-AKI cohort were alive at three years, while deterioration of renal function remained evident among survivors [14]. Although the follow-up periods differ substantially, these findings emphasize that severe AKI should not be viewed solely as an acute ICU event, because its consequences may continue after hospital discharge.

The relationship between renal recovery and subsequent prognosis is also supported by the large multi-cohort analysis of Sawhney et al. involving more than 460,000 episodes of acute kidney disease. Depending on the time window used, one-year renal non-recovery occurred in approximately 19–37% of patients, and recovery observed early after AKI was not always sustained [15]. In the present study, 24.0% of the overall cohort had either partial or absent renal recovery at

discharge, highlighting the need for post-discharge surveillance of serum creatinine and kidney function even among apparent survivors of the acute episode.

Sepsis, shock and markers of severe systemic illness were particularly relevant to mortality. In univariate analysis, shock/hypotension, vasopressor requirement, mechanical ventilation, Stage 3 AKI and RRT requirement were significantly associated with death. Wang et al., in a multicentre study of critically ill septic patients, found that 61.7% developed AKI and demonstrated that Stage 3 AKI independently increased 30-day mortality, with an adjusted hazard ratio of 1.80 [16]. This corresponds with the present finding that Stage 3 AKI was associated with increased odds of in-hospital mortality (OR 4.39, 95% CI 1.49–12.95). Differences in effect size are expected because of the smaller sample and different case mix in the present study.

Overall, the findings indicate that the severity and clinical trajectory of AKI provide meaningful prognostic information beyond the diagnosis of AKI alone. However, the relatively small sample size, single-centre design and limited number of mortality events restrict the number of variables that can be reliably included in multivariable analysis. The wide confidence intervals for several risk estimates should therefore be interpreted cautiously, and larger multicentre studies with longer follow-up would help confirm these associations.

CONCLUSION

The present study demonstrates that AKI in critically ill patients is associated with considerable morbidity and mortality, particularly in patients with severe KDIGO Stage 3 disease. Sepsis, shock, vasopressor requirement and mechanical ventilation were important markers of severe AKI and adverse outcome. Increasing AKI severity was associated with higher serum creatinine and urea levels, reduced urine output, greater requirement for renal replacement therapy, prolonged ICU and hospital stay, delayed renal recovery and increased mortality. Renal recovery showed a clear inverse relationship with AKI severity and emerged as an important indicator of prognosis. Early identification of high-risk patients, optimization of hemodynamic status, avoidance of nephrotoxic insults and continued monitoring of kidney function following AKI may therefore help improve short- and long-term clinical outcomes.

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