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Original Article

Mortality Analysis due to Acute Kidney Injury and Associated Factors – A Prospective Study in Tertiary Care Hospital and Training Institute of Western India

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Abstract

Background: Acute kidney injury (AKI), formerly known as acute renal failure, is a medical condition characterized by a sudden and rapid decline in kidney function. It is typically diagnosed by an abrupt increase in waste products, such as urea and creatinine, in the blood and a decrease in urine output. AKI can range from mild to severe complications.

Materials and Methods: This was a prospective observational study at a tertiary healthcare institute in western India on 160 patients admitted to the general ward or intensive care unit (ICU) with AKI in the period of 1 year from February 2017 to January 2018. Data were collected from the patient's treatment sheet after informed consent. The data entry was processed in the Microsoft Excel 2013 version, and statistical analysis was performed in IBM SPSS software version 13.

Results: Out of 160 study participants, more than half of the patients were in the 44–59 age group. 60.6% were male patients. The mean ICU stay duration was 5.5 ± 3.6 days. The maximum number of patients were in stage 1 AKI (38.1%). The mean age of the patients surviving was 51.4 ± 9.1 years, which was significantly lower ($P = 0.034$) than those who did not survive (63.7 ± 11.2 years). Among the patients who survived, the ICU requirement rate was 17.5%, while this rate was 91.3% among the patients who did not survive. The hemodialysis requirement rate was 41.6% in the patients who survived and 91.3% in the patients who expired. This was also statistically significant.

Conclusion: AKI is associated with high incidence and mortality in the Indian population. The study reports that the male population was more affected by AKI. Mortality in AKI is increased with increasing age, stage, the requirement of hemodialysis, and ICU requirements. This signifies the urgent need for AKI prevention, early detection, and intervention to reduce risk factors and improve clinical outcomes.

Key words: Clinical outcome, Hospital stay, Intensive care unit mortality, Renal failure, Survival

INTRODUCTION

Acute kidney injury (AKI) presents an increasingly prevalent challenge for medical professionals, including nephrologists, intensivists, general physicians, and surgeons.[1] Formerly referred to as acute renal failure, AKI is a syndrome characterized by the rapid deterioration of the kidney's excretory function. Diagnosis typically involves detecting elevated levels of nitrogen metabolism in products (urea and creatinine), reduced urine output, or a combination of these factors. This condition represents the clinical manifestation of various disorders that suddenly affect kidney function.

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The Kidney Disease Improving Global Outcomes (KDIGO) criteria define AKI as a sudden decline in kidney function, which encompasses, but is not limited to, acute renal failure.[2]

AKI can be defined as meeting any of the following criteria:"

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Increase in serum creatinine ≥0.3 mg/dL within 48 h; or 2. Increase in serum creatinine to ≥1.5-time baseline, which is known or presumed to have occurred within the prior 7 days; or 3. Urine volume <0.5 mL/kg/h for 6 h [Table 1].

The estimated occurrence of AKI during hospitalization ranges from 2% to 5%. Notably, around two-thirds of patients in the intensive care unit (ICU) develop AKI, and approximately 4–5% of general ICU patients require renal replacement therapy (RRT).[3] This growing incidence of AKI is a concerning trend.

Patients in ICU who experience AKI tend to have extended hospital stays, resulting in higher health-care costs. Furthermore, AKI causes increased mortality, even after adjusting for other contributing factors. For patients with AKI requiring RRT, the mortality rate remains notably high at 50–60%. Among those who survive, 5–20% still rely on dialysis upon hospital discharge.[3]"

Numerous studies conducted in Western countries have examined the causes, clinical characteristics, and prognosis of AKI in patients. However, in the context of India, there needs to be more comprehensive research, particularly in this geographical area, about AKI. Therefore, this study investigated the contributing factors and the clinical outcomes of AKI among patients in an ICU within a tertiary public health-care facility in India.

MATERIALS AND METHODS

Study Design and Settings

This was a prospective observational study conducted at a tertiary healthcare institute in western India.

Study Population

The present study was conducted on patients admitted to tertiary care hospitals, general wards, or ICUs. Patients included in the study were those willing to provide informed consent, aged more than 12 years, and diagnosed with AKI as per KDIGO criteria, whereas the patients with chronic kidney disease (excluded by USG KUB showing small contracted kidneys and/or reduced GFR for more than 3 months), transplanted kidneys, and congenital kidney diseases who took discharge against medical advice were excluded.

Sampling Technique

A convenience sampling technique was used. All patients admitted to the hospital with AKI in the period of 1 year from February 2017 to January 2018 were included in the study.

Sample Size

The final sample size was 160, with a type 1 error of 0.05 and a β of 0.20 (power of 80%), using a mortality rate of 10.98% among AKI cases[1] at a 95% confidence interval. Using the below-mentioned formula, the sample size calculated was 151. Considering dropouts of 6%, the total sample size calculated was 160. n = (Z2 × P (1–P))/e2

where Z = value from standard normal distribution corresponding to desired confidence level (Z = 1.96 for 95% CI), P is expected true proportion, and e is chosen precision (half desired CI width).

Data Collection

The patient's treatment sheet was used to collect data. The patients admitted to the hospital were screened for the eligibility criteria, and informed consent was obtained by the willing patients. The demographic details of the patients, including age, gender, date of admission, detailed clinical history, and discharge, were recorded from the case record. The hospital stay and ICU stay duration were also recorded. Patients' records were observed for the etiology of AKI. The outcome of the patients recorded as having survived or not survived.

For calculating the incidence of AKI in the ICU, a retrospective analysis was planned as part of the thesis. As all ICU records were available as computer records, the total number of admissions during a year was measured, and the total number of AKI cases was calculated based on clinical reports.

Statistical Analysis

The data entered was in the Microsoft Excel 2013 version, and all the statistical analysis was performed in IBM SPSS software version 13. The data are represented as mean ± standard deviation for quantitative parameters and median with range for qualitative parameters. An unpaired *t*-test was used for the comparison of parametric variables between the two groups. An analysis of variance was used to compare more than two groups. The Chi-square test was used to compare the proportion rates. A $P < 0.05$ was considered statistically significant.

RESULTS

We recruited 160 AKI patients for the study, satisfying the eligibility criteria and following them until discharge. The baseline characteristics of the study population have been described in the table below.

Table 2 shows that out of 160 study participants, more than half of the patients were in the 40–59 year age group. We found that all patients in this study were above

Table 1: Staging of AKI-KDIGO[2]

Stage	Serum creatinine	Urine output
1	1.5–1.9 times baseline or≥0.3 mg/dl (≥26.5 μmol/L) increase	<0.5 mL/kg/h for 6–12 h
2	2.0–2.9 times baseline	<0.5 mL/kg/h for≥12 h
3	3.0 times baseline or increase in serum creatinine to≥4.0 mg/dL (≥353.6 μmol/l) or initiation of renal replacement therapy or in patients<18 years a decrease in eGFR to<35 mL/min/1.73 m^2	<0.3 mL/kg/h for≥24 h or anuria for≥12 h

AKI-KDIGO: Acute kidney injury-Kidney Disease Improving Global Outcomes

Table 2: Study population characteristics

Feature	Observation (*n*=160%)
Age (year)	
40–59	93 (58.13)
60–75	67 (41.87)
Mean age	57.7±12.2 years
Gender	
Male	97 (60.6)
Female	63 (39.4)
Admission ward	
General medicine ward	115 (71.9)
ICU (+general ward)	45 (28.1)
Mean hospital stay	8.6±5.2 days
Mean ICU stay	5.5±3.6 days

ICU: Intensive care unit

40 years of age. 60.6% were male patients, while 39.4% were female patients. All the patients were admitted to the hospital's general ward at least once during their stay at the hospital. Those who stayed exclusively in the general hospital ward were 71.9%. 28.1% of patients required ICU admission. The mean hospital stay for the total (ICU and ward patients) study population was 8.6 ± 5.2 days. While the patients who required only ICU stay had a mean stay duration of 5.5 ± 3.6 days [Figure 1].

Table 3 shows that the maximum number of patients was in stage 1 (38.1%), followed by stage 2 (35.6%). The maximum number of male patients (63.93%) had stage 1 AKI, whereas the majority of female patients (43.85%) were in stage 2. This association was not significant.

Table 4 denotes that the mean age of the patients surviving was 51.4 ± 9.1 years, which was significantly lower ($P = 0.034$) than that of those who did not survive (63.7 ± 11.2 years). Among the patients who survived, the ICU requirement rate was 17.5%, while this rate was 91.3% among the patients who did not survive. In the overall population, the mortality rate was 14.4% ($n = 23$). Splitting this up, the mortality rate for patients exclusively in the general medicine ward was 1.7% and higher (46.7%) in patients admitted to the ICU. This association was statistically significant ($P = 0.0039$). The mortality rate was significantly affected by the stage of the AKI ($P = 0.014$), as described in the figure below. The patients who did not survive were mostly from the stage 3 AKI group (82.6%), followed by a few (17.4%) in the stage 2 group.

Table 3: KDIGO staging and gender distribution of study population

KDIGO stage	Stage 1 (*n*=61) (%)	Stage 2 (*n*=57) (%)	Stage 3 (*n*=42) (%)	*P*-value
Male	39 (63.93)	32 (56.14)	26 (61.90)	0.674
Female	22 (36.06)	25 (43.85)	16 (38.09)	
Total	61 (38.10)	57 (35.60)	42 (26.30)	

KDIGO: Kidney Disease Improving Global Outcomes

Table 4: Mortality assessment in the study population

Variables	Survived (*n*=137) (%)	Not survived (*n*=23) (%)	*P*-value
Mean age	51.4±9.1 years	63.7±11.2 years	0.034
ICU requirement	24 (17.5)	21 (91.3)	0.002
Stage			
Stage 1	61 (44.5)	0 (0)	0.016
Stage 2	53 (38.7)	04 (17.4)	
Stage 3	23 (16.8)	19 (82.6)	
Hemodialysis requirement	57 (41.6)	21 (91.3)	0.027

ICU: Intensive care unit

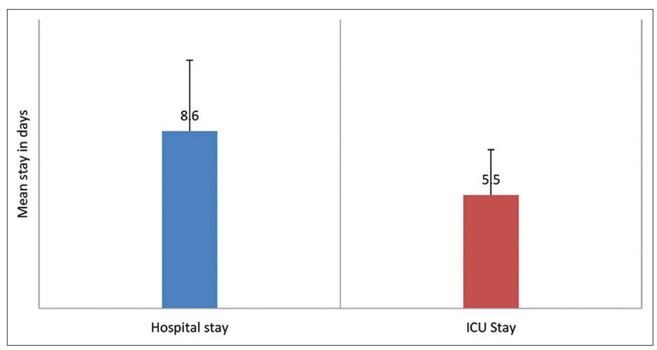

Figure 1: Duration of stay at hospital and intensive care unit (in days)

The hemodialysis requirement rate was 41.6% in the patients who survived, while it was 91.3% in the patients who expired. This relationship was also statistically significant, with a $P = 0.027$.

The mortality rate was significantly affected by the stage of the AKI ($P = 0.016$), as described in Figure 2. The patients who did not survive were mainly from the stage

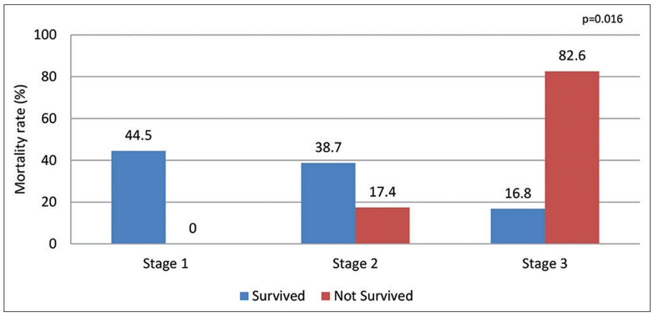

Figure 2: Mortality based on the kidney disease improving global outcomes stage of acute kidney injury

3 AKI group (82.6%), followed by 17.4% in the stage 2 group [Figure 2].

Mortality Timeline

We performed a Kaplan–Meier survival probability analysis for the patients who did not survive ($n = 23$), as described in the figure below. Almost three-fourths of patients expired before 10 days of admission. The final patient expired within a timeline of 20 days. The graphical representation shows that the mortality rate is higher in the early days of hospital admission for the diagnosis of AKI [Figure 3].

Incidence of AKI in ICU

We retrospectively analyzed the computed patient record of admission in the ICU during the study period. A total of 2130 admissions to the ICU were reported during the study period, out of which 297 cases had AKI diagnosed in their reports. Thus, the incidence of AKI in the ICU of the tertiary healthcare setup was determined to be 13.9%.

DISCUSSION

Our study included 160 patients diagnosed with AKI based on KDIGO criteria. We collected all available clinical profile details for these patients and followed them until their hospital discharge. The patients had a mean age of around 57 years, with a gender ratio of approximately 1.5:1 (male to female).

Two large studies have shown the median age of AKI in critically ill patients to be 63 and 67 years, respectively.[2,3] Our results are coherent with the findings of Korula *et al.*, which described the average age of the patient with AKI as 59.7 ± 14.01 and included 64.3% males,[1] highlighting the fact that this may be a common demographic profile in Indian patients diagnosed with AKI. Similar findings were also shown by Eswarappa *et al.* and Gurjar *et al.* in an Indian case scenario with single-center experience.[4,5]

In the present study, the mean age of the patients surviving was 51.4 ± 9.1 years, which was significantly

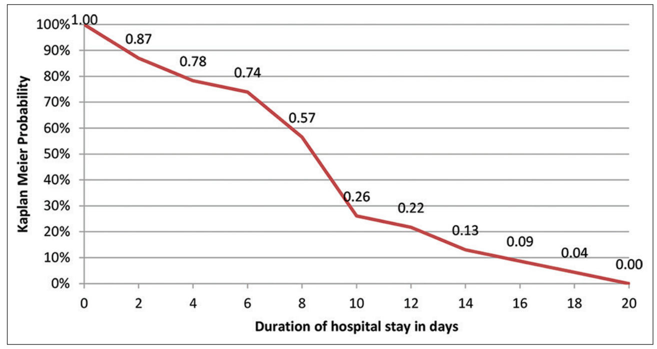

Figure 3: Kaplan–Meier survival probability in patients who expired

lower ($P = 0.034$) than that of those who did not survive (63.7 ± 11.2 years).

Out of total patients, more than one-fourth of patients required ICU admission during their stay at the hospital, and their mean stay duration in the ICU was 5.5 ± 3.6 days. Eswarappa *et al.* showed the average duration of an ICU stay was 5.6 days, which is in total agreement with our finding.[4] The figures are slightly different from the other Indian studies. Korula *et al.* reported an average ICU stay of 11.0 ± 8.5 days,[1] and Gurjar *et al.*[5] observed an ICU stay length of 16 versus 28 days in patients who survived versus those who did not. This association was observed to be statistically significant, indicating that the duration of the ICU stay was associated with mortality.

We calculated the ICU requirement for the patients in our study based on mortality and observed that the ICU requirement rate was 17.5% among those who survived, while this rate was 91.3% among those who did not survive.

Shusterman *et al.* observed 10-fold increased odds of death and a doubling of the length of stay among patients with AKI.[6] Cely *et al.*, in their single-center experience, demonstrated that the median length of hospital stay was higher among patients who developed AKI (8 versus 6 days) and was associated with an increased requirement for dialysis and in-hospital death.[7]

As per the KDIGO staging, in the present study, the maximum proportion of patients is in stage 1, followed by stage 2. The mortality rate was significantly affected by the stage of the AKI ($P = 0.014$). The patients who did not survive were mainly from the stage 3 AKI group (82.6%), followed by a few (17.4%) in the stage 2 group. This is in favor of the study of Cely *et al.*[7] Also, in the study of Biyik *et al.*, out of 277 patients, the majority reported AKI stage 1 (53.7%), followed by stage 3 (27.7%). Mortality was found to be associated with the presence, stage, and progression of AKI.[8] Our results regarding the relationship between the stage of AKI and mortality are consistent with the existing literature and provide an additional Indian perspective.

In the present study, half of the patients required hemodialysis (41.6% of the patients survived, while 91.3% of the non-survived patients). These observations also echo the findings many workers have published in the literature. Korula *et al.* found that 39.1% of AKI patients required RRT.[1] Moreover, Eswarappa *et al.* found that among patients receiving RRT, 41.5% (*n* = 78) of patients expired.[4]

In the present study, the decision to initiate RRT was taken by the nephrologist. Indications for RRT included hyperkalemia, uremia, metabolic acidosis, and control of volume status.

Although some of the studies, e.g., Korula *et al.*,[1] did not establish the requirement of dialysis as the prognostic factor, our results are consistent with the findings of Chertow *et al.*, who established this relationship.[9]

Our study showed a mortality rate of 14.4% (*n* = 23). Splitting this up, the mortality rate for patients exclusively in the general medicine ward was 1.7%, and the same was 46.7% in patients admitted to the ICU. Joannidis *et al.*, in their study of ICU patients, showed a mortality rate of 36.5% among AKI patients classified by RIFLE criteria.[2] Likewise, Eswarappa *et al.* reported an ICU mortality rate of 37.6% (4). In the study by Ali *et al.*, the in-hospital mortality was found to be 32.7%.[10]

Many studies included ICU-specific patients and thus reported higher mortality rates. In our study, the hospital's general mortality was also on the higher side, which can be explained by the tertiary healthcare nature of our institute, which usually receives referred patients of higher severity.

In our study, almost three-fourths of patients expired before the 10 days of admission. The final patient expired within a timeline of 20 days. In their survival analysis, Korula *et al.* showed that almost 50% of patients expired within the first 28 days of the diagnosis of AKI.[1]

The incidence rate of AKI was calculated based on ICU admissions in our study. The overall AKI incidence in ICU admissions was 13.9%. Similar results were found in the study of Paudel *et al.* in a prospective observational study of 100 critically ill patients in New Delhi, India, which showed that the incidence of AKI is 17.3 cases/100 person-years,[11] and Korula *et al.* reported the incidence of AKI in their study population of 16.1%,[1] whereas some studies showed an incidence between 20 and 50%.[2,4,12] However, it becomes obvious that the incidence rate reported is not uniform in the literature, and our study aims to highlight this rate in a typical tertiary healthcare ICU setup.

Limitation

We report the mortality analysis in both the hospital general ward and the ICU setting. We did not include the long-term or post-hospital discharge prognosis of the patients. This would let us understand the mortality rates of the patients surviving. This also limited us from studying the persistent dialysis requirement and our patients' recommendations for transplants. We did not consider community-acquired AKI as our study included only admitted patients. Furthermore, our study excluded patients with CKD, so the various causes of AKI in CKD, which are very common in CKD patients, could not be studied.

CONCLUSION

AKI is associated with high incidence and mortality in the Indian population. The study reports that the male population was more affected by AKI. Mortality in AKI is increased with increasing age, stage, requirement of hemodialysis, and ICU requirement. This signifies the urgent need for prevention of AKI, early detection, and intervention to lessen reversible risk factors to improve clinical outcomes.

Study Approval

The study was conducted after formal approval from the Institutional Ethics Committee for academic research projects at T.N. Medical College BYL Nair *Charitable*. Hospital, Mumbai, Maharashtra, with reference number ECARP/2016/156.

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