Section: Nephrology

Original Research Article

PROGNOSTIC FACTORS AND OUTCOME OF ACUTE KIDNEY INJURY IN CRITICALLY ILL PATIENTS

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ABSTRACT

Background: The incidence of acute kidney injury (AKI) among critically ill patients admitted in hospital is extremely high. The aetiology and symptoms of AKI varies in each case butearly diagnosis, timely intervention and preventing exposure to nephrotoxic drugs can be achieved in patients who are at risk of developing AKI. **Aims:** The aim of this study is to investigate the prognostic factors and outcomes of acute kidney injury (AKI) in critically ill patients. **Objective:** To determine the incidence, severity, and outcomes of AKI in critically ill patients, including mortality.

Materials and Methods: This Prospective Cohort Study is conducted in tertiary care center in south India in medical and surgical intensive care unit during the study period January 2014 to march 2015, after obtaining institutional ethical committee clearance. Patients who have admitted in the hospital ICU aged more than 18 years developing acute kidney injury (AKI) during hospital stay in the intensive care unit (ICU) were included in this study. Around 1400 patients were admitted in ICU during this period and in them 61 developed AKI during their stay. Clinical and laboratory data were collected at admission and monitored daily thereafter. The recorded data included patient characteristics, primary underlying medical conditions, co-morbidities, AKIN KDIGO stage, SOFA score, duration of ICU stay, and final outcomes.

Results: The major causes of AKI during the course of hospital were Sepsis 39(63.9%) followed by drug induced 10 (16.4%), preoperative 8(13.1%), cardiac diseases 4(6.6%). The overall in-hospital mortality of AKI in this study is 16.4%. Refractory septic shock and multi organ dysfunction were the chief cause of death in critically ill patient with AKI. Sepsis was the most common cause of AKI in intensive care unit of which survivors and non survivors were 32(82.1%) and 7(17.9%) respectively. In our study, increased KDIGO staging and SOFA score were significantly associated with higher mortality rates ($P < 0.005$), indicating that both KDIGO staging and SOFA score are independent prognostic factors for mortality in patients with acute kidney injury.

Conclusion: The incidence of AKI in patient admitted in ICU in the present study was 4.35% and the mortality of AKI in critically ill patient was 16.4%. Most of the causes of AKI are avoidable, so early diagnosis and timely treatment can save the patients.

Keyword: Acute Kidney Injury, Sequential Organ Failure Assessment (SOFA) score, kidney disease improving global outcomes (KDIGO).

INTRODUCTION

The incidence of acute kidney injury (AKI) among patients admitted in hospital is around 0.7% to 31%, and it exceeds around 50% in patients admitted in intensive care unit.[1] Among those who develop AKI, 20–50% of patients progresses in to CKD, whereas 3–15% advances to end-stage kidney

disease (ESKD), and it was associated with augmented mortality.[2] Even though the aetiology and symptoms of AKI differ from patient to patient, early diagnosis, timely intervention and preventing exposure to nephrotoxic drugs can be achieved in patients who are at risk of developing AKI.[3]

Some possible and common risk factors of AKI include diabetes, hypertension, or lower grade chronic renal failure. The inflammatory reactionrelated with life-threateningdisease may induce AKI. The inflammatory reaction is related with critical illness that leads to AKI. Adding on to that other factors such as nephrotoxic drugs, hypoxia, hypovolemia, and arterial hypotension can also have a role in thedevelopment of AKI in critically ill patients.[4] The AKI severity is typically graded by the different type of classifications mainly kidney disease improving global outcomes (KDIGO) staging system. More severe AKI is connected with poorer outcomes.[5]

There exists a lacuna of data about the incidence and spectrum of AKI in critically ill patients from South India. The aim of this study is to predict prognostic factors and outcome of acute kidney injury in critically ill patients.

Aims: The aim of this study is to investigate the prognostic factors and outcomes of acute kidney injury (AKI) in critically ill patients

Objective: To determine the incidence, severity, and outcomes of AKI in critically ill patients, including mortality.

MATERIALS AND METHODS

This Prospective Cohort Study is conducted in tertiary care center in south India in medical and surgical intensive care unit during the study period January 2014 to march 2015, after obtaining institutional ethical committee clearance (IEC:2014/22). Patients who have admitted in the hospital ICU aged more than 18 years developing acute kidney injury (AKI) during hospital stay were included in this study. Around 1400 patients were admitted in ICU during this period and in them 61 developed AKI during their stay. After obtaining informed consent form, data from patients with AKI was collected and systematically analyzed for age, gender, etiology, risk factors, course, prognostic factors and outcome (renal and patient).

All patients who have developed AKI according to KDIGO criteria after admission to ICU were included in this study. Serum creatinine, blood urea, complete hemogram, urine analysis, random blood sugar, arterial blood gas analysis, serum electrolytes and other relevant investigations to establish etiology were done. The Sequential Organ Failure Assessment (SOFA) score evaluates the severity of organ dysfunction in critically ill patients. It assesses six organ systems, including respiratory, cardiovascular, hepatic, coagulation, renal, and neurological. The score ranges from 0-24, with higher scores indicating more severe organ failure. This score is used to predict mortality and morbidity in critically ill patients.

Inclusion Criteria

All patients >18 years who developed AKI according to KDIGO criteria after admission to ICU were included in this study.

- Increase rise in SCr by ≥0.3 mg/dL (≥26.5 µmol/L) within 48 hours, or a rise in SCr to ≥1.5 times baseline
- Increase in serum creatinine to 1.5 times or more than the baseline within the prior 7 days, in accordance with the KDIGO criteria Absolute increase in serum creatinine of >0.3 mg/dl
- Reduction in urine output, defined as <0.5ml/kg/hr for more than 6 hours.

Exclusion Criteria

- Patients who were discharged or died within 48 hours of admission
- Patients who were admitted with acute kidney injury
- Patients with known case of CKD.

Statistical Analysis

The data was analyzed using SPSS software version 2020. Categorical data, including baseline and clinical variables, were presented as frequency and percentage. The distribution of variables such as gender, co-morbid illness, urinary output, KIDGO score, onset of AKI, causes, and SOFA score were compared between survivors and non-survivors using the Chi-square test (df = n-1, where n is the sample size), with a 95% confidence interval (CI). Continuous data were compared using the Student's t-test (df = n1 + n2 - 2, where n1 and n2 are the sample sizes of the two groups), with a 95% CI. The results of the statistical analysis were considered significant at a p-value < 0.05.

RESULTS

There were a total of 61 patients who developed acute kidney injury in medical and surgical intensive care unit during the study period January 2014 to march 2015.

Table 1: Baseline clinical and laboratory features of patients with AKI(n=61)

Clinical & Laboratory Variables	Frequency	Percentage
Age in Years	Mean: 56.49	SD: 11.46
Gender		
Male	40	65.6
Female	21	34.4

Primary diagnosis – Medical – 44 (72.14)		
Respiratory Illness	13	29.54
Cardiac Illness	13	29.54
Genitourinary Illness	11	25.00
Infection related	05	11.36
Hepatobiliary Illness	02	4.45
Primary diagnosis – Surgical- 17 (27.86)		
Cellulitis	09	52.94
Gastro intestinal related	04	23.52
Malignancy	03	17.64
Traffic accident	01	05.55
Co morbid Illness		
Diabetes	37	60.7
Hypertension	27	44.3
Coronary artery disease	10	16.4
Cerebrovascular accident	07	11.5
Chronic obstructive pulmonary disease	06	09.8
Urinary Output ml/24 hours		
<400	32	52.5
>400	29	47.5
Biochemical Parameter		
Admission Urea	Mean: 28.49	SD: 8.33
Admission Creatinine	Mean: 0.99	SD: 0.24
KDIGO- STAGING		
Stage 1	46	75.4
Stage 2	07	11.5
Stage 3	08	13.1
Mean Arterial Pressure		
0. MAP ≥70 without vasopressors	25	40.98
1. MAP <70 without vasopressors	18	29.5
2. MAP ≥ 70 mmHg with dopamine ≤ 5 µg/kg/min or dobutamine	11	18.03
3.Dopamine > 5 µg/kg/min or epinephrine ≤ 0.1 µg/kg/min or norepinephrine ≤ 0.1 µg/kg/min	05	8.19
4. Dopamine > 15 µg/kg/min or epinephrine > 0.1 µg/kg/min or norepinephrine > 0.1 µg/kg/min	02	3.27
Onset of AKI (In days)		
Medical	Mean: 2.04	SD: 1.55
Surgical	Mean: 4.44	SD: 03
Causes		
Sepsis	39	63.9
Cardiac	04	06.6
Preoperative	08	13.1
Drug/ contrast induced	10	16.4
SOFA score	Mean: 7.16	SD:4.54

MAP – Mean Arterial Pressure, KIDGO- kidney disease improving global outcomes, AKI – Acute Kidney injury, SOFA- Sequential Organ Failure Assessment.

The study population consisted of 61 patients with a mean age of 56.49 ± 11.47 years, with 65.6% males and 34.4% females. The primary diagnoses were respiratory tract infection (29.55%), genitourinary tract infection (25%), and cardiac disorders (29.55%). Common co-morbidities included diabetes (60.7%), hypertension (44.3%), and coronary artery disease (16.4%). The mean urea and creatinine levels at admission were 28.49 ± 8.332 mg/dl and 0.99 ± 0.24 mg/dl, respectively. The majority of patients (41%) had a mean arterial pressure (MAP) ≥ 70 mmHg without vasopressors, while 30% had MAP < 70 mmHg without vasopressors, and the remaining patients required varying levels of vasopressor support, including dopamine, epinephrine, or norepinephrine. The onset of AKI occurred earlier in medical patients (mean: 2.04 days, SD: 1.55) compared to surgical patients (mean: 4.44 days) suggesting differences in the timing of AKI between these two groups. Sepsis (63.9%) was the leading cause of AKI, followed by drug-induced (16.4%) and preoperative (13.1%) causes. According to KDIGO staging, 75.4% of patients had stage 1 AKI, 11.5% had stage 2, and 13.1% had stage 3.

The comprehensive analysis of the numerous factors that impact the progression of acute kidney injury in both individuals who survive and those who do not is presented in detail in (table 2).

Table 2: Factors influencing outcome in patients with AKI (survivors vs. non survivors)

Clinical Variables	Survivors N =51 N (%)	Non Survivors N= 10 N (%)	Total N =61 N (%)	X^2 - Value	p - value
Gender					
Male	34 (66.6)	06 (60.0)	40 (65.5)	0.165	0.725 (ns)
Female	17 (33.4)	04 (40.0)	21(34.5)		
Diabetes Mellitus					
Present	32 (62.7)	05 (50.0)	37 (60.6)	0.569	0.495 (ns)
Absent	19 (37.3)	05 (50.0)	24 (39.4)		
Hypertension					
Present	25 (49.0)	02 (20.0)	27 (44.3)	2.854	0.162 (ns)
Absent	26 (51.0)	08 (80.0)	34 (55.7)		
Coronary artery disease					
Present	08 (15.7)	03 (30)	10 (16.3)	0.114	0.663 (ns)
Absent	43 (84.3)	08 (80)	51 (83.7)		
Cerebro vascular accident					
Present	08 (15.7)	0	08 (13.1)	1.585	0.589
Absent	43 (84.3)	10 (100)	53 (86.9)		
COPD					
Present	06 (11.7)	0	06 (09.8)	1.305	0.577 (ns)
Absent	45 (88.3)	10 (100)	55 (90.2)		
Urinary Output ml/24 hours					
<400	22 (43.2)	10 (100)	32 (52.5)	10.839	**0.001*** **
>400	29 (56.8)	0	29 (47.5)		
KDIGO- staging					
Stage 1	45 (88.3)	01 (10)	46 (75.4)	37.05	**0.005*** **
Stage 2	05 (09.8)	02 (20)	07 (11.4)		
Stage 3	01 (01.9)	07 (70)	08 (13.2)		
Causes					
Sepsis	32 (62.8)	07 (70)	39 (63.9)	0.672	0.880 (ns)
Cardiac	03 (05.8)	01 (10)	04 (06.5)		
Preoperative	07 (13.7)	01 (10)	08 (13.2)		
Drug/ contrast induced	09 (17.7)	01 (10)	10 (16.4)		
SOFA score					
1-6	35 (68.7)	0	35 (57.5)	47.67	**0.001*** **
7 – 12	14 (27.5)	01 (10)	15 (24.5)		
13 – 18	01 (01.9)	08 (80)	09 (14.7)		
19 - 24	01 (01.9)	01 (10)	02 (03.3)		
Study Variables	**Survivors Mean ± SD**	**Non Survivors Mean ± SD**		**t - Value**	**p - value**
Age in years	55.71 ± 11.0	60.50 ± 13.33		1.213	0.23 (ns)
Duration of ICU stay	6.12 ± 0.98	6.90 ± 3.95		0.61	0.55 (ns)
SOFA Score	5.55 ± 2.69	15.4 ± 2.59		10.923	**0.001*** **

KIDGO- kidney disease improving global outcomes, AKI – Acute Kidney injury, SOFA- Sequential Organ Failure Assessment

There was no significant difference in age, gender, or type of underlying risk factor between survivors and non-survivors (p-values: 0.23, 0.725, and 0.880).

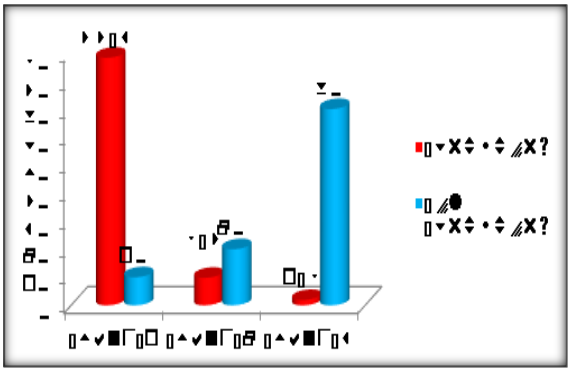
The causes of AKI were predominantly sepsis (62.8% in survivors and 70% in non-survivors), followed by drug/contrast-induced, preoperative, and cardiac causes. This suggests that sepsis is the most common cause of AKI in both survivors and non-survivors.

The overall mortality was 16.4%. The mean total duration of ICU stay was slightly longer (6.90± 3.957) in non survivors compared to survivors (6.12± 1.986). We observed increased mortality in urinary output less 400 ml in 24 hours in patients, which was found to be statistically significant (p=0.001)

The mortality rate in KDIGO stage 1, 2, 3, was 10%, 20%, and 70% respectively that shows statistical significant when compared to survivors group. In our study, increased KDIGO staging score were significantly associated with higher mortality rates (P < 0.005),

The mean SOFA score was significantly lower in survivors (5.55 ± 2.69) compared to non-survivors (15.4 ± 2.59). The distribution of SOFA scores showed that the majority of survivors (68.7%) had scores ranging from 1-6, whereas the majority of non-survivors (80%) had scores ranging from 13-18, indicating a strong association between higher SOFA scores and increased mortality.

This showed that both KDIGO staging and SOFA score are independent prognostic factors for mortality in patients with acute kidney injury.



We observed that higher the KDIGO staging higher the mortality (p=0.005).

DISCUSSION

AKI is one of common complications in critically ill patients admitted in the ICU. The AKI is multifactorial in origin, but it is recognizedfor its increase mortality, duration of ICU and hospital stay and also elevates of cost of medical care.

In the present study, the incidence of AKI in the present study was 61 out 1400 that is 4.35%. Past studies reported that the incidence of AKI was somewhere between 0.7% to 31%, with intensive care unit (ICU) patients exceeding 50%.[6]

The major causes of AKI during the course of hospital were Sepsis 39(63.9%) followed by drug induced 10(16.4%), preoperative 8(13.1%), cardiac diseases 4(6.6%). Among the patient with sepsis around 17.9% of patients died. Sepsis is the leading cause of mortality in non-survivors when compared with other causes which was around 70%. This is in accordance with the past studies.[7,8]

In the present study, the co-morbidities noticed along with AKI between survivor and non survivor as Diabetes mellitus was more common in survivors (62.7%) compared to non-survivors (50%), Hypertension was more prevalent in survivors (49%) than non-survivors (20%), Coronary artery disease was similarly distributed between survivors (15.7%) and non-survivors (20%), Cerebrovascular accidents (15.7%) and COPD (11.7%) were only observed in survivors. Our study found that diabetes, hypertension, and other comorbidities were common among patients with AKI, but we did not observe a significant association between these variables and the risk of developing AKI.

Hypotension (systolic BP<90mmHg) and respiratory distress were the commonest presenting feature at admission in ICU. The complications arising from persistent oliguria, such as metabolic acidosis, hyperkalemia, hypotension, and pulmonary edema, likely contributed to the mortality observed in our study population.

Similar risk factors were reported in past studies for the development of AKI was a MAP below 73, hypertension, diabetes and heart disease.[9]

Severity of illness was assessed using SOFA scoring system. Overall Mean SOFA score in our patients were 7.16± 4.54. Mean SOFA score in survivors and in non survivors were 5.55± 2.693 and 15.40± 2.591 respectively.

Among drug induced AKI, 8 were due to contrast induced nephropathy (post coronary angiography (13.11%), one due to aminoglycosides (1.639%) and one due to ACE inhibitors (1.639%). Among 4 patients developing AKI due to cardiac disease, 3(4.91%) patients had cardiogenic shock and 1(1.71%)had congestive heart failure.

Patients who developed AKI in hospital were graded according to KDIGO STAGING. KDIGO Stage 1 was the most common (n=46, 75.4%) followed by stage 2(n=7, 11.5%) and stage 3(n=8, 13.1%).

Thirty-two (52.5%) patients were oliguric while twenty-nine (47.5%) were non oliguric. The patients admitted in intensive care unit were treated accordingly with Antibiotics, IV fluids, and stopping nephrotoxic drugs.

Outcome of patients with AKI

The overall in-hospital mortality of AKI in this study is 16.4% whereas few past studies reported varied mortality such as 12.8%, 44.4% and, 20.3%.[10-12]

In this study; the mean total duration of ICU stay was slightly longer (6.90± 3.957) in non survivors compared to survivors (6.12± 1.986) and it was not statistically significant. Similar reports were observed in other studies where the non-survivors had ≤7 days in hospital,[9] and it was also similar in a Nigerian study.[13]

Refractory septic shock and multi organ dysfunction were the chief cause of death in critically ill patient with AKI. Sepsis was the most common cause of AKI in intensive care unit of which survivors and non survivors were 32(82.1%) and 7(17.9%) respectively, but our study suggested that sepsis is the most common cause of AKI in both survivors and non-survivors. The complications arising from persistent oliguria, such as metabolic acidosis, hyperkalemia, hypotension, and pulmonary edema, likely contributed to the mortality observed in our study population (p=0.001). The incidence according to KDIGO AKI stages 1, 2, and 3 was 26.2, 11.7, and 15.7%, respectively. The mortality rate in KDIGO stage 1, 2, 3, was 2.17%, 28.57 and 87.5% respectively. We observed that higher the KDIGO staging higher the mortality (p=0.005). Higher KDIGO staging in non-survivors was around 15.4± 2.591 and were associated with higher rate of mortality in our study (P<0.005). This was in accordance with past studies also.[14]

Limitations of The Study

Sample size and duration of the study is less. Most of the patient lost follow-up so we could not monitor the patients in long term.

CONCLUSION

The present study shows the incidence of AKI in the present study was 61 out 1400 that is 4.35%and the

mortality of AKI in critically ill patient was 16.4%. Sepsis was the primary cause for AKI and its related mortality in ICU admitted patients followed by drug induced and cardiac reasons. Given that many causes of AKI are preventable, as supported by KDIGO guidelines and various studies, our findings underscore the importance of early recognition and intervention to mitigate AKI risk.

Author Contibution

Both authors contributed to the formation and design of the study, with Shobana Sundaram taking the lead in data collection and analysis drafting the manuscript, and Hemachandar Radhakrishnan reviewed and approved the final version.

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