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Spectrum of acute kidney injury in intensive care unit: a single centre experience

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ABSTRACT

Background: Acute kidney injury (AKI) in the intensive care unit (ICU) is associated with high mortality. A thorough understanding of the clinical spectrum of the disease is needed in order to device methods to improve the final outcome due to this problem. **Aims and Objectives:** The aim of present study was to analyze the clinical spectrum, causes, risk and prognostic factors and final outcome of AKI in the setting of ICU. **Materials and Methods:** This prospective study involved patients admitted to ICU during the period between June 09 to June 10. Patients who developed AKI during the ICU stay were included in the study. The clinical and laboratory data were collected at admission and then on daily basis. Data recorded includes patients demographic profile, underlying clinical illness responsible for ICU admission, dialysis requirement, need for ventilation, total duration of ICU stay, acute physiology and chronic health evaluation (APACHE)-IV score and final outcome and these data were analyzed for predicting survival using univariate and multivariate analysis. **Results:** 574 patients were admitted to ICU from June 09 to June 10 and (n = 124; 21.6%) patients developed AKI after admission to ICU. Mean age 44.87 ± 15.14 years and (n = 71; 57.1%) were males and (n = 53; 42.9%) were females. Out of 124 patients (50.80%; n = 63) had medical, (33.87% n = 42) had surgical and (15.32%; n = 19) had obstetric cause of admission in ICU. Of the 574 patients (12.02%; n = 69) had associated co morbidities, hypertension is the most common associated morbidities (4.7%; n = 27), others were diabetes mellitus (3.6%; n = 21), coronary artery disease (3.0%; n = 17), cerebrovascular disease (0.3%; n = 2), chronic obstructive pulmonary disease (0.3%; n = 2;). The etiology of AKI was multi-factorial, sepsis were the most common cause observed in (69.64%; n = 39), hypotension (67.84%; n = 38), volume depletion (19.64%; n = 11), nephrotoxic drugs (64.28%; n = 36) patients. Multi organ system failure (MOSF) was noted in (29.03%; n = 36) patients. MOSF and sepsis were found to be significant adverse prognostic factors when multiple logistic regression analysis was done. **Conclusion:** AKI was seen in 21.6% of cases in our ICU and associated with poor prognosis. Presence of sepsis, MOSF, higher APACHE IV scores and ventilation requirement were correlated with higher mortality in AKI patients in ICU. Early recognisition and intervention improves the outcome.

Key words: *Acute kidney injury, acute physiology and chronic health evaluation score, intensive care unit, multi organ system failure*

INTRODUCTION

Acute kidney injury (AKI) is characterized by a rapid decline glomerular filtration rate (GFR) and retention of nitrogenous waste products such as blood urea nitrogen (BUN) and creatinine. For the purpose of diagnosis and management AKI is divided into three categories: Prerenal, intrarenal and postrenal AKI. Recently a new definition of AKI has been widely accepted which is referred to by the acronym RIFLE and classified as follows: Table 1. AKI in the setting of intensive care unit (ICU) has attracted number of publications for the past two decades. More than 35 definitions of AKI currently exist in the literature. The acute dialysis quality initiative convened in 2002 and proposed the RIFLE classification (risk, injury, failure, loss, end stage kidney disease) specifically for AKI in critically ill patients. Using serum creatinine and urine output (UO), the RIFLE criteria define three grades of severity and two outcome classes. According to AKI network, the most current consensus diagnostic criteria for AKI is an abrupt (within 48 h) reduction in kidney function currently defined as an absolute increase in serum creatinine of more than or equal to 0.3 mg/dl, a % increase in serum creatinine of 50% (1.5-fold from baseline), or a reduction in UO (documented oliguria of 0.5 ml/kg/hr for 6 hrs). AKI occurs in approximately 7% of all hospitalized patients and in up to 36% to 67% of critically ill patients depending on the definition used.[1] This study was done to analyze the spectrum of AKI in ICU patients and various factors affecting the outcome in such patients.

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MATERIALS AND METHODS

This study has been carried out in department of Nephrology, division of Medicine, Bokaro General Hospital, Bokaro Steel City, from June 2009-June 2010. Patients who developed the AKI during the course of their hospitalization in ICU formed the subject load of this study. Routine and special investigation done, patients laboratory investigations were reviewed from their case sheet. Severities of illness and survival prediction were assessed using acute physiology and chronic health evaluation (APACHE)-IV score. Dialytic support was initiated in patients with anuria, oliguria, serum creatinine >4 mg/dl, severe acidosis, hyperkalemia and volume overload unresponsive to conservative measures. Statistical analysis was done by using mean, standard deviation and paired *t*-test. χ^2-test applied for qualitative data and *z*-test was applied to compare the two proportions. Multinational logistic analysis was performed on the various parameters in both survivors and non-survivors.

Inclusion criteria

Patients with diverse medical and surgical and obstetric diseases were admitted to our ICU. Patients included had neither AKI nor any renal disease prior to admission. AKI had been defined according to RIFLE criteria for this study.

Exclusion criteria

Patients who had AKI at the time of admission to ICU were excluded from this study.

RESULTS

The present study comprised of 124 patients who developed AKI during the course of ICU stay. The baseline clinical and laboratory features are summarized in Table 2 and varies parameters influencing the outcome of patients with AKI in survivors and non-survivors are shown in Table 3. Mean age was 44.87 ± 15.14 years and (57.1%; *n* = 71) were males and (42.9%; *n* = 53) were females.The co-morbidity was observed in (12.02%; *n* = 69) patients. Hypertension, diabetes mellitus and coronary artery disease were prominent co-morbidities associated. Hypotension (mean arterial blood pressure < 80 mm Hg), altered sensorium (Glasgow Coma scale < 15) and respiratory distress were most common presenting features. Out of 124 patients (66.1%; *n* = 82) patients were oliguric. Evidence of sepsis were present in (69.64%; *n* = 39), patients and multi-organ failure was seen in (64.28%; *n* = 79) patients. Medical disorders were the predominant underlying causes (50.8%; *n* = 63) responsible for admission to ICU. Surgical and obstetric causes accounted for (33.8%; *n* = 42) and (15.3%; *n* = 19) cases respectively. Among medical disorders sepsis related to respiratory infection was the most common cause for ICU admission. Post gastrointestinal surgeries associated AKI (15; 12.5%) were the most common among the surgical patients. Sepsis (*n* = 39; 69.64%), hypotension (*n* = 38; 67.85%), nephrotoxic exposure (*n* = 36; 64.28%), volume depletion (*n* = 11; 19.64%) were the causes of AKI in most of our patients. Eighty four patients (67.85%) needed ventilatory support in the present study. Out of 84 patients requiring dialysis, (65.46%; *n* = 55) had intermittent hemodialysis while (34.52%; *n* = 29) underwent intermittent peritoneal dialysis. Mortality was observed in (72.61%; *n* = 61) patients and recovery of renal function was not uniform in survivors with complete recovery observed in (*n* = 13; 29.76%) patients, partial recovery with dialysis independent status in (*n* = 7; 19.04%) and dialysis dependency in (*n* = 3; 7.1%) patients. Duration of stay in ICU was longer in non survivors 20.80 ± 3.88 days compared to survivors 14.85 ± 1.87 days. Multi organ system failure (MOSF) and refractory hypotension were the commonest causes of death in ICU patients developing AKI. However AKI *per se* was not the cause of death in any of these patients. The age, gender, and type of underlying basic illness, did not show any significant statistically significant difference among survivors and non-survivors. Patients with co-morbid conditions, oliguria, sepsis, MOSF, ventilatory and dialysis support had higher mortality. Mean APACHE IV score was 60.57 ± 10.96 amongst survivors and 110.31 ± 15.93 amongst non-survivors. The number of organ system failure

Table 1: RIFLE classification of AKI[2,3]

	GFR criteria	*UO criteria*
Risk	↑s. cr.×1.5 or GFR decrease >25%	UO <0.5 ml/kg/hr×6 h
Injury	↑s. cr.×2 or GFR decrease >50%	UO <0.5 ml/kg/hr ×12 h
Failure	↑s. cr.×3 or GFR decrease >75% ↑s. cr. >4 mg/dl Acute rise >0.5 ml/dl	UO <0.3 ml/kg/hr× 12 h or Anuria×12 h
Loss	Persistent ARF=Complete loss of kidney function >4 weeks	
ESKD	End stage kidney disease >3 months	

AKI=Acute kidney injury, s. cr.=Serum creatinine, ESKD=End stage kidney disease, GFR=Glomerular filtration rate, RIFLE= Risk, Injury, Failure, Loss of kidney function and End stage kidney disease, UO=Urine output, ↑= Increase

Table 2: Baseline clinical and lab features of patients with AKI (*n*=124)

	No. (%)
Mean age (years)	44.87±15.14
Sex no. (%)	
Male	71 (57.1)
Female	53 (42.9)
Comorbid conditions (%)	
Hypertension	27 (4.7)
Diabetes mellitus	21 (3.6)
Coronary artery disease	17 (3.0)
Cerebrovascular disease	2 (0.3)
Chronic obstructive pulmonary disease	2 (0.3)
Urine output (ml/24 h)	
<400	82 (66.1)
>400	42 (33.9%)
Hematological examination	
Hemoglobin (gm/dl)	10.05±2.68
Total leukocyte count(/mm^3)	12116±3590.17
Platelets (/mm^3)	114643±46387
Biochemistry	
Blood urea (mg/dl)	146.17±41.68
Serum creatinine (mg/dl)	5.59±2.79
Serum sodium (meq/dl)	129.5±5.97
Serum potassium (meq/dl)	4.62±0.96
Multi-organ system failure	79 (64.28%)
Respiratory and cardiovascular	17 (22.2%)
Respiratoty, CVS and CNS	31 (38.8%)
Respiratory, CVS, CNS and hematological	31 (38.8%)

AKI=Acute kidney injury, CVS=Cardiovascular system, CNS=Central nervous system

Table 3: Factors influencing outcome in patients with AKI (survivors vs non-survivors)

Survivors non-survivors significance
(*n*=47) (*n*=77)
Age (mean±SD) 43.30±17; 12 45; 80±13.99; *t*=0.587
P=NS
Sex, No. (%)
χ^2=1.244
Male 71; 32 (66.7%) 39 (51.40%) *P*=NS
Female 53; 15 (33.0%) 38 (48.60%)
Comorbid condition
Present (67) 16 (33.3%) 51 (65.7%) χ^2=5.533
Absent (57) 31 (66.7%) 26 (34.3%) *P*<0.05
Urine output
<400 ml/day (82) 23 (47.6%) 59 (77.1%) χ^2=5.103
>400 ml/day (42) 24 (52.4%) 18 (22.9%) *P*<0.05
Sepsis
Present (39) 06 (15.38%) 33 (84.6%) χ^2=26.809
Absent (85) 41 (48.23%) 44 (51.76%) *P*<0.001
Basic diagnosis
Medical (63) 38 (81.0%) 25 (32.46%) χ^2=0.409
Surgical (42) 7 (14.3%) 35 (45.45%) *P*=NS
Obstetric (19) 2 (4.8%) 17 (22.07%)
Ventillation
Needed (84) 20 (23.8%) 64 (94.3%) χ^2=29.888
Not needed (40) 27 (76.2%) 13 (5.7%) *P*<0.001
Multi organ system failur with MOSF (79)
Two (17) 7 (14.89%) 10 (12.98%) χ^2=40.32
Three (31) 31 (40.25%) *P*<0.001
Four (31) 31 (40.25%)
Without MOSF (45) 40 (85.10%) 5 (6.49%)
Dialyzed (*n*=84)
Peritoneal dialysis (55) 13 (27.65%) 42 (54.45%) χ^2=6.477
IHD (29) 10 (21.27%) 19 (24.67%) *P*<0.05
Nondialyzed (*n*=40) 24 (51.06%) 16 (20.77%)
APACHE IV scores 60.57±10.96; 110.31±15.93; *t*=12.604
P=0.00
Total duration of stay 14.85±1.87; 20.80±3.88; *t*=6.546
P<0.05

AKI=Acute kidney injury, MOSF=Multi organ system failur, NS=Not signifcant, IHD=Ischaemic heart disease, APACHE= Acute physiology and chronic health evaluation

was an important predictor of mortality. Mortality was 100% in those with three or more organ system failure. The therapeutic parameters (i.e. ventilation and dialysis), associated co-morbidities, oliguria, and sepsis were also associated with higher mortality in patients with AKI in ICU.

DISCUSSION

AKI in the ICU has been a scourge and continues to be a cause of high mortality and morbidity. Incidences of AKI in ICU patients have been reported to be from 7% to 36% by Nash *et al*.,[1] In present study AKI occurred in 21.6% patients. In our study mean age was lesser 44.87 ± 15.14 years compared to other studies. Symptoms and signs of extra-renal organ dysfunction were the commonest feature of diseases at admission to ICU. Mehta *et al.,* had shown that co-morbidities were associated with higher mortalities in AKI in ICU set up.[4] Co morbid conditions like hypertension, diabetes and coronary artery disease were common among these patients and were associated with higher mortality 65.7% compared to patients without these conditions. Uchino *et al.,* had shown that sepsis is the most important cause of mortalities in AKI in ICU 47.5%.[5] Our study also revealed a high incidence of sepsis 69.64% in patients developing AKI followed by hypotension, nephrotoxic medications and volume depletion.[4] UO was an independent predictor of mortality. In our study, patients with UO <400 ml/day had higher mortality (77.1%). Similarly, need for ventilation was associated with higher mortality of 94.3%. Mehta *et al.,* had shown that dialysis requirement increase mortalities.[4] Mortality remained high despite providing dialysis support, as 72.61% patients died, reflecting severity of underlying disease process. Ostermann *et al.,* had shown that MOSF were associated with worst outcome. There was progressive increase in mortality as the number of organ dysfunction increased.[6] Higher APACHE IV score (110.31 ± 15.93) was observed in patients who died. Mortality of AKI has remained high despite advancement of supportive care as reported in various studies to be ranging from 32%-90%. In our study, death occurred in 62.1% patients which were similar to reported by others. Out of various factors analyzed age, sex and basic disease responsible for ICU admission, had no effect on outcome. Co-morbid conditions, sepsis, UO, need for ventilation, renal replacement therapy, number of organ system failure, APACHE IV scores and duration of ICU stay increased mortality in ICU patients.

CONCLUSION

AKI in the setting of ICU is associated with increasing co morbidities, high incidence of sepsis, and mortality. Sepsis and MOSF are major causes of mortality in these patients. These findings call for early detection and aggressive management of sepsis and its associated complications so as to bring down the mortality in patients admitted to ICU.

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