Original Research Article

Incidence and clinical outcomes of acute kidney injury in patients admitted in MICU

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Abstract

Background: Acute kidney injury (AKI) refers to a syndrome encompassing kidney damage from mild injury to total loss of function that seriously disturbs the homeostasis of fluid and electrolyte balances.

Materials and methods: All patients admitted in Medical intensive care unit of Mahatma Gandhi Memorial Hospital, Warangal from 1st January 2016 to 30th June 2016, who fulfilled the inclusion criteria, are included in this study. Patients admitted in medical intensive care were included in the study and patients admitted in surgical and obstetric intensive units are not included.

Results: We included all patients above 18 years of age in our study. The mean age for development of AKI was 49.2 years (SD = 18) (Range 18-89 years). Most of the patients belonged to 61-70 years (21.4 %) age group. 97 patients in elderly age group (>65 years) had AKI. Sepsis is responsible for 84 (24%, n= 350) cases of AKI. 67% of the study population had co morbidities in our study; most patients had more than one co-morbidities. Oliguria (52.8) is the most common presenting feature followed by Hyperkalaemia (48%) in our study. There is a significant (p= <.0001) association between presence of oliguria and stages of AKI. There is a significant association (p = <.0001) between need for RRT and KDIGO stages of AKI. Outcomes of AKI were put into three categories in our study. Of the 324 patients in whom outcomes were analysed 204 patients had complete recovery. They were discharged in stable condition with normal or near normal serum creatinine values.

Conclusion: Sepsis is the most common cause of AKI in MICU and is associated with significant mortality. Early and aggressive management of sepsis is required to prevent progression of AKI in MICU.

Key words

Acute Kidney Injury, Sepsis, Co-morbidities, Outcome.

Introduction

A uniform definition for Acute Kidney Injury has existed only since 2004, when the Acute Dialysis Quality Initiative (ADQI) proposed the Risk, Injury, Failure, Loss, End-stage kidney disease (RIFLE) criteria for AKI [1]. Since then two modifications of the RIFLE: Acute Kidney Injury Network (AKIN) (2007) [2], and Kidney Disease: Improving Global Outcomes (KDIGO) (2012) [3] have emerged. All of the three modern definitions are based on changes in serum or plasma creatinine and urine output.

In the century that followed Richard Bright's description of kidney disease in 1827 many case studies of acute Bright's disease associated with a variety of aetiologies including infections, toxins, and transfusion reactions were published. However, it was the landmark report by Bywate and Beal in 1941 [4] linking crush injury to the acute impairment of renal function that stands out as the starting point for modern medicine's discussion of acute kidney injury (AKI).

Clinical symptoms may be scarce in the early stages of AKI. As the kidney injury progresses and affects the glomerular filtration rate (GFR) creatinine starts to rise. Oliguria or anuria may develop early, but sometimes the urine output remains intact for quite long. Later in the course of AKI the severely diminished GFR manifests as electrolyte and acid-base disturbances, most often as elevated potassium and acidosis.

Pathogenesis of AKI is still poorly understood. Several different pathways have been proposed and studied; none of which seems to explain the big picture alone. The arising consensus suggests that AKI is a syndrome with several different predisposing factors and mechanisms of pathophysiology. A growing amount of data supports the idea that risk for AKI increases with a growing burden of illness whether chronic or acute [3].

The traditional division of kidney failure to pre- and post-renal causes has been widely abandoned as the complex nature of the kidney injury syndrome has unfolded [3]. Extra renal causes, without actual kidney damage, such as depletion of fluids or urinary tract obstruction naturally still exist but are rare causes for AKI in the intensive care environment. Also, these causes, when identified, are quite easy to treat and usually without long-term damage to the kidney or other organs. In the MICU, AKI is usually multifactorial with both chronic conditions and acute events contributing to the development of kidney injury [5].

Aim and objectives

- To measure the incidence of acute kidney injury in MICU.
- To analyse the causes, clinical profile of acute kidney injury in the MICU.
- To analyse the risk and prognostic factors of acute kidney injury in the MICU.
- To study the impact of acute kidney injury on final outcome of kidney function and morbidity in the patients with acute kidney injury in the MICU.

Materials and methods

A Hospital based prospective observational study was conducted in patients admitted in Medical Intensive Care Unit of Mahatma Gandhi Memorial Hospital, Warangal from 1st January 2016 to 30th June 2016. Ethics clearance was obtained from the Ethics Committee, Kakatiya Medical College.

Informed written consent was obtained from patients or from the closest relative where the patient was too ill to communicate. All investigations that the patients were subjected to were a part of the routine workup done in any critically ill patient.

Inclusion criteria

- All Patients admitted into MICU for various etiologies with normal creatinine values at admission and developed

elevated serum creatinine values subsequently during their hospital stay.

- Patients admitted in MICU with Increase in serum creatinine by >0.3 mg/dl within 48 hours or increase in serum creatinine to X1.5 times baseline, which is known or presumed to have occurred within the prior 7 days.
- Patients who are present in MICU for minimum of 24 hours of hospital admission.

Exclusion criteria
- Patients with established chronic kidney disease.
- Patients with prerenal factors like volume depletion corrected within 24 hours of admission.

The Socio demographical, clinical, laboratory parameters and outcomes were collected using a structured datasheet filled by interviewing the patients (or relatives where the patients were unable to communicate).

Clinical data of symptoms related to primary aetiology of renal failure and its predisposing factors or involvement of other organs were recorded in detail. Past histories of any diseases were elicited.

Laboratory investigations include complete blood count, urine analysis, Blood urea, Serum Creatinine, Serum Electrolytes and USG Abdomen for all the patients.

Wherever necessary LFT, Bleeding profile, 24-hour urinary protein were done.

We measured Serum creatinine, blood urea and serum electrolytes values once every 24 hours in all patients admitted in MICU. The highest Serum creatinine value recorded during hospital stay was taken to classify the patients in to KDIGO stages of AKI.

Collected data were analysed using SPSS version 16.0. Categorical data were expressed as proportions and subgroups and analysed using Pearson Chi-square test.

Results

Incidence of acute kidney injury

Out of 4820 patients admitted in MICU, 350 patients developed acute kidney injury. The incidence of AKI in MICU in our study was 7.2%. The incidence of AKI was greater in males (66%) than females (34%) in our study as per **Table – 1**.

Table - 1: Gender distribution of AKI in study group.

Gender	No. of patients	Percentage
Males	232	66.3%
Females	118	33.7%
Total	350	100%

Majority of patients with AKI belonged to the age group of 61 – 70 years accounting for 21.4% (*n* = 350) of total patients. The median age of the patients was 49 years, lying in the age group of 41-50 years (**Figure – 1**).

97 patients in the geriatric age group (>65 years) had AKI in our study accounting for 27.7% of total cases of AKI. Etiologies of AKI were as per **Table – 2**. Co-morbidities in study group were as per **Figure – 2**.

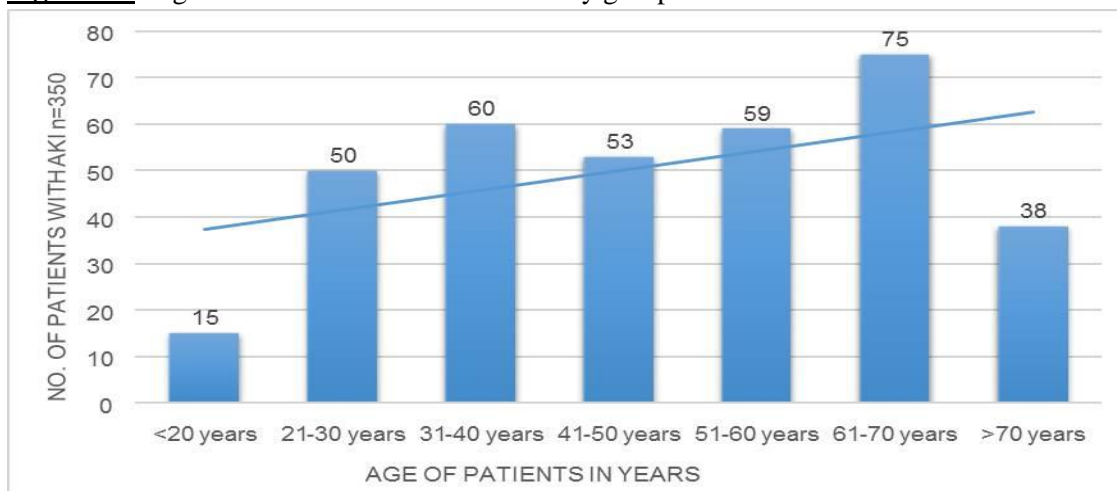### Biochemical parameters in study group

The mean value of serum creatinine in study group was 3.19 mg/dl with SD =1.4. The mean blood urea in study group was 106 mg/dl with SD = 33.
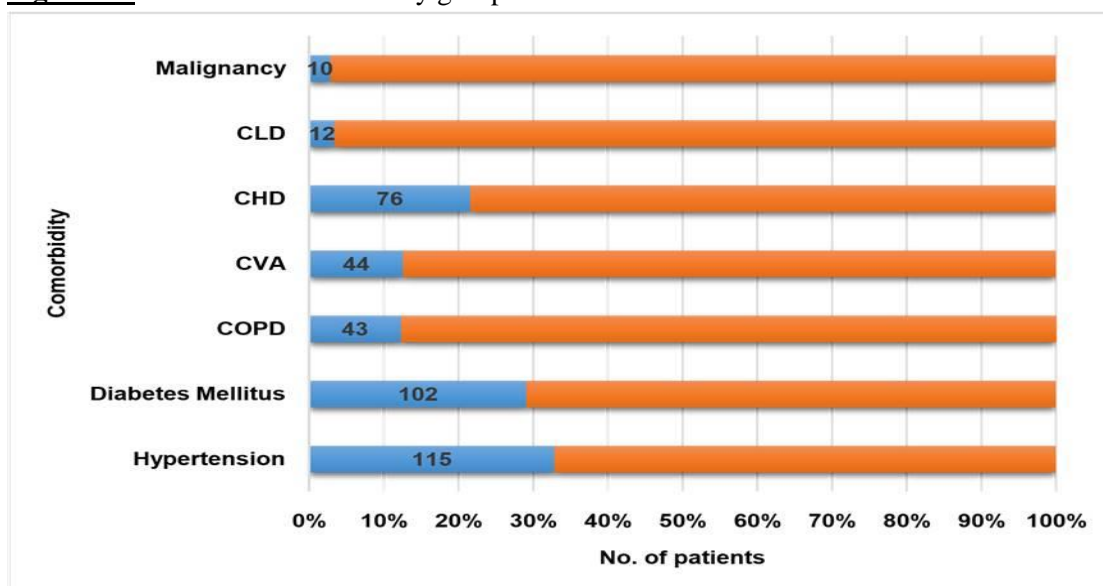
KDIGO staging

We measured serum creatinine values of all patients admitted in MICU and the greatest value was taken to classify the patients in to KDIGO stages of AKI (**Table – 3**).

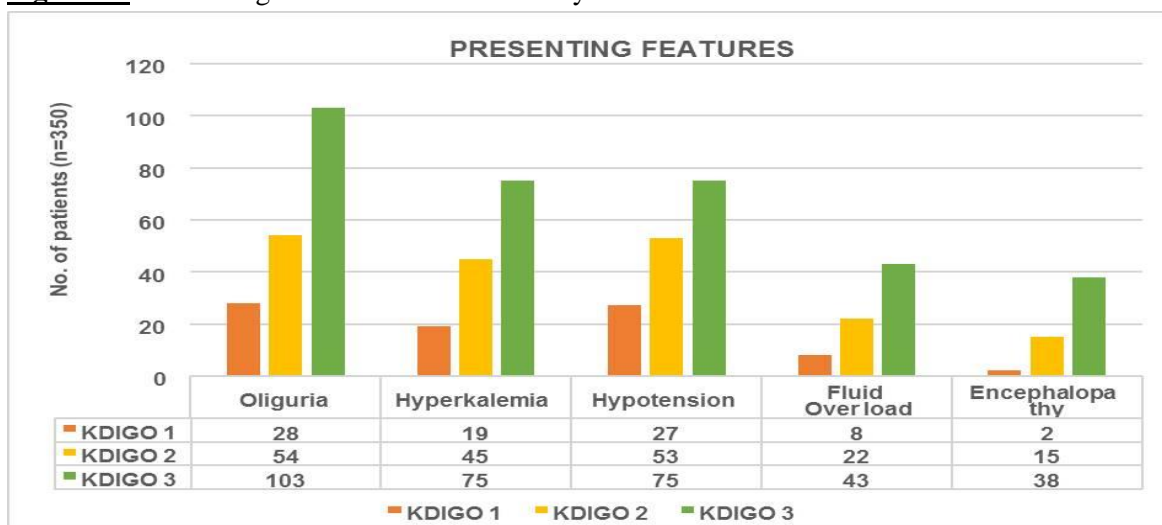Most of the patients belonged to KDIGO stage 3 (142) at admission.

Figure – 1: Age wise distribution of AKI in study group.

Figure – 2: Co-morbidities in study group.

Figure - 3: Presenting features related to renal system.

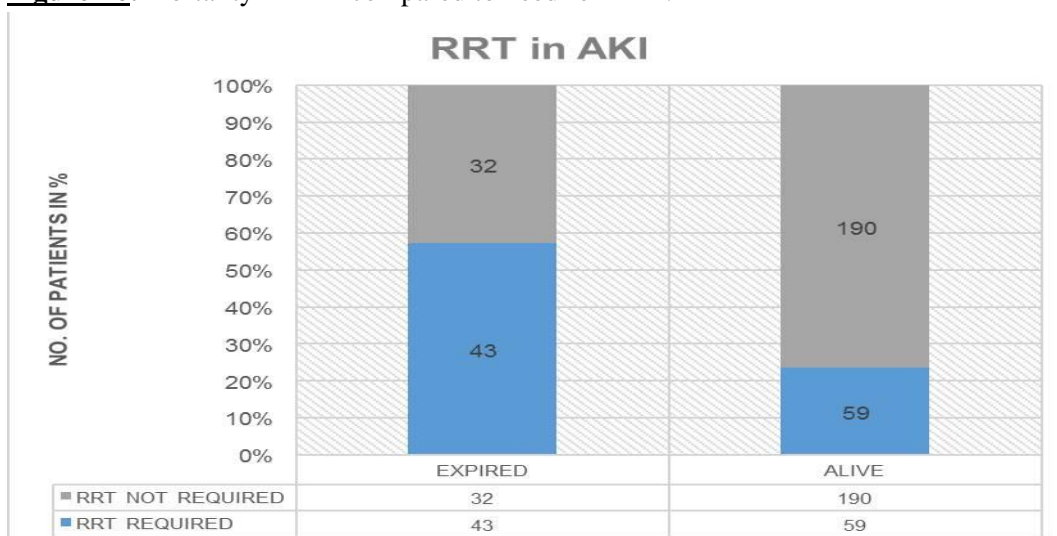|	Oliguria	Hyperkalemia	Hypotension	Fluid Over load	Encephalopathy
KDIGO 1	28	19	27	8	2
KDIGO 2	54	45	53	22	15
KDIGO 3	103	75	75	43	38

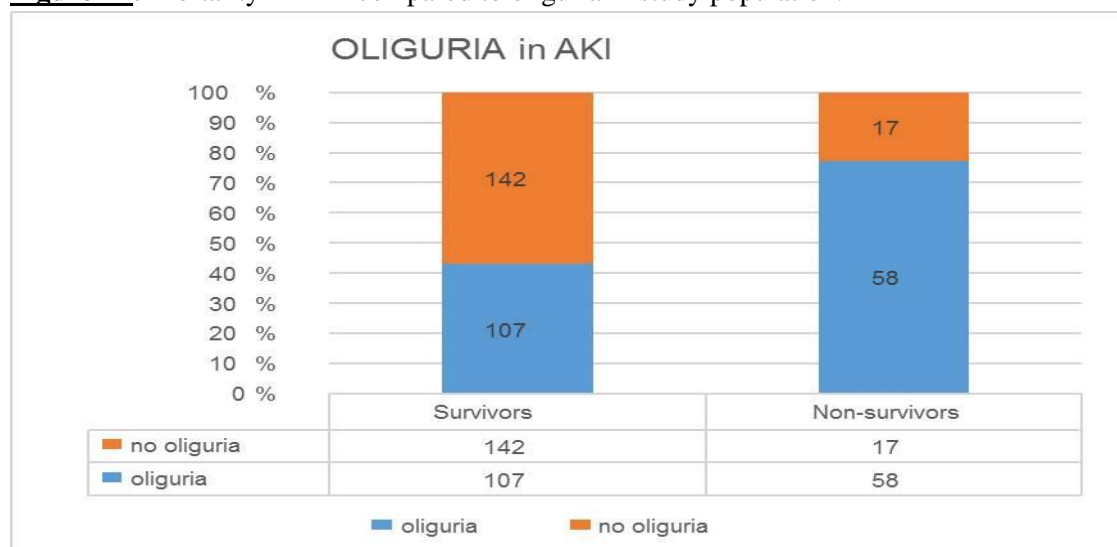**Figure – 4:** Need for RRT in AKI in relation to KDIGO stages.
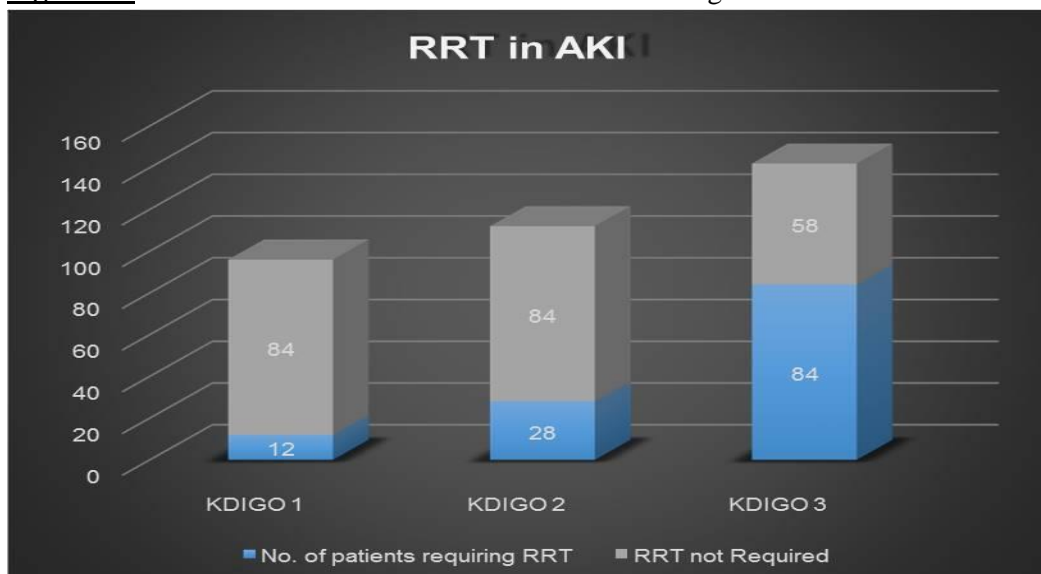
Figure – 5: Outcomes of AKI in study group in relation to KDIGO stages.
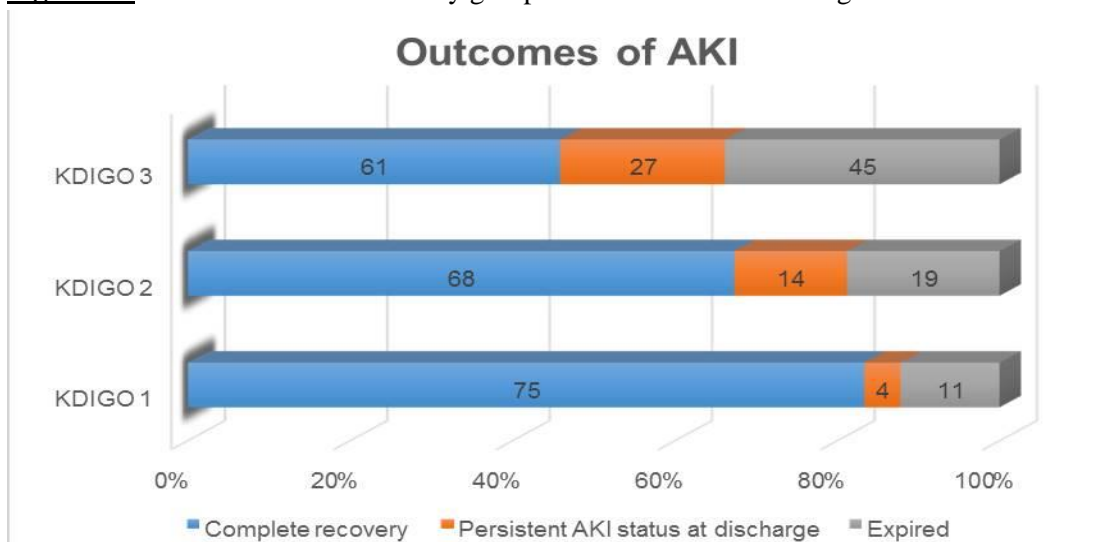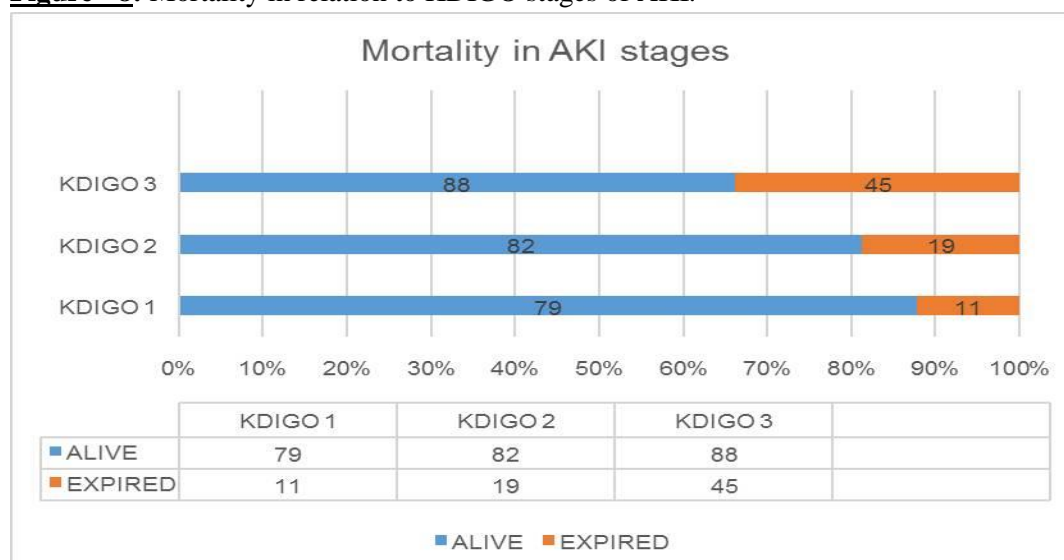

Figure - 6: mortality in AKI compared to need for RRT.

Figure - 7: Mortality in AKI compared to oliguria in study population.

Figure - 8: Mortality in relation to KDIGO stages of AKI.

Of the 324 patients, 75 (23.1%) expired due to their illness, 204 (63%) patients completely recovered their renal function and 45 (13.8%) patients had persistent AKI and were discharged with elevated renal parameters (**Figure – 3, 4**).

There was a significant (p = .00001) correlation between the KDIGO stages and outcomes of patients with AKI.

The crude mortality rate in our study was 23%. There was a significant statistical correlation (P = .0004) between KDIGO stages and mortality in patients with AKI (**Figure – 5, 6**).

75 (83.3%), 68(67.2%) and 61 (45.8%) of patients in KDIGO stages 1, 2 and 3 respectively completely recovered their renal function by the time of discharge from hospital. Stage 3 has worse prognosis compared to stages 1 and 2 [6, 7].

Mortality in AKI in study group [8-12]
Total of 75 (23.3%) patients expired in our study population. We measured only the in-hospital mortality of patients. Survivors and non-survivors are analysed for the significance of various factors effecting outcome (**Figure – 7, 8, Table - 4**).

Table - 2: Etiologies of AKI.

Diagnostic category	No. of patients	%
Sepsis	84	24%
Respiratory causes	62	17.7%
Acute GE	36	9.4%
AFI-no focus	33	9.4%
Malaria	24	6.8%
Poisoning	19	5.4%
Cardiac causes	18	5.14%
Hepatorenal	15	4.28%
Dengue fever	14	4%
Metabolic causes	12	3.4%
Pancreatitis	8	2.2%
Peripartum	8	2.2%
Peritonitis	6	1.7%
Obstructive uropathy	5	1.4%
Snake bite	6	1.7%
Total	350	100%

Table - 3: KDIGO stages in study group.

KDIGO stage	No. of Patients	%
1	96	27.4%
2	112	32%
3	142	40.5%

In our study, 44 of 184 (24%) males and 31 of 118 (21%) females expired. There was no statistical significance (P = .24) of gender regarding mortality in AKI. Age and gender did not show statistically significant difference among survivors and non-survivors.

Mortality rates were 30.26%, 28.8% and 25% in cases of Sepsis, pneumonitis and malaria respectively.

Patients with oliguria and in need for dialystic support had higher mortality (p values <.001 for all three parameters).

The crude mortality rates were 12.2% (11), 19.8% (19) and 31.6% (45) in KDIGO stages 1, 2 and 3 respectively. Higher KDIGO class was associated with significant chance (P = <.001) of death.

Discussion

A total of 4,820 patients were admitted into MICU during the study period; 578 patients had elevated serum creatinine values at admission or during MICU stay. Of the 578 patients, 350 patients met the inclusion criteria for the study.

Of the 578 patients, 228 patients were excluded from the study (104 patients had CKD or ESRD, 24 patients expired in first 24 hours of admission, 32 patients left against medical advice within 24 hours of admission and 66 patients had volume depletion that was corrected within 24 hours of admission).

In our study, the incidence of AKI was 7.2 %. The reported incidence of AKI in the MICU has varied widely ranging between 3.79% and 42.7% [13, 14]. This marked variability may be due to differences in the population involved in the study, type of tertiary care facility available and basic underlying diseases causing AKI. The reason for relatively lower incidence of AKI in our study may be due to the fact that a wide variety of patients are admitted into our MICU, ranging from patients with non-venomous snake bites, poisonings to very critically ill patients with sepsis and meningitis.

Most recent studies used RIFLE or AKIN criteria for defining AKI, old studies done before 2004 did not use standardized criteria to define AKI. We used creatinine criteria of KDIGO to define AKI. We could not use urine output criteria as we found it difficult and unreliable to measure urine output in our hospital setting.

Our results were comparable to other studies in the country regarding sex distribution of AKI cases. There is no statistical significance between Gender and outcomes or Death (p =.24 for Mortality) in our study which is similar to previous studies.

We included all patients above 18 years of age in our study. The mean age for development of AKI was 49.2 years (SD = 18) (Range 18-89 years).

Most of the patients belonged to 61-70 years (21.4 %) age group. 97 patients in elderly age group (>65 years) had AKI.

Etiology of AKI

In our study, sepsis is the most common cause of AKI. This is in correlation with almost all previous studies. Sepsis is responsible for 84 (24%, n= 350) cases of AKI.

The relatively low incidence of sepsis in our study is because of presence of non-infectious etiological factors like poisoning (19), metabolic (12) and peripartum (8) causes of AKI. Further we added a separate category of patients whose primary diagnosis was a respiratory infection, which also included some cases of sepsis. However, sepsis was still the most common cause of AKI in our study, well in accordance with most other Indian studies.

Table - 4: Characteristics of survivors' vs non-survivors in AKI.

AGE		SURVIVORS	NON-SURVIVORS	SIGNIFICANCE
		47.34	60.6	
SEX	Males	138	44	P = .24 Not significant
	Females	111	31	
Oliguria	Present	107	58	P = <.001 significant
	absent	142	17	
KDIGO stage	1	79	11	P = <.001 significant
	2	82	11	
	3	88	45	
RRT	Required	59	43	P = <.001 significant
	No required	190	32	

Respiratory category is the second most common cause (62 cases 17.7%) of AKI which included patients with primary pneumonias and Stroke patients with aspiration pneumonitis.

24 patients with Malaria had AKI with incidence of 6.8%. It is similar to studies done by Eswarappa, et al. [12] (6.4%), Sankarasubbaiyan, et al. [15] (7.8%) and Maulita, et al. [16] (9%).

We had 8 (2.2 %) patients with obstetric causes of AKI, 7 patients were puerperal with Eclampsia (5) and HELLP syndrome (2 cases). All 8 patients recovered renal function completely and there was no mortality. The reported incidence of obstetric AKI in the developed countries is 1-2.8%, while in developing countries it is 9-25%17. Godara, et al. [18] reported an incidence of obstetric AKI of 9.82% in a single centre trial including 580 patients.

Co-morbidities

67% of the study population had co morbidities in our study; most patients had more than one co-morbidities. Hypertension (32.8%) is the most common comorbidity present followed by Diabetes (29.14%), chronic heart disease (21.7%), COPD (12.2%), Chronic liver disease (3.4) and malignancy (2.8) in that order.

Our observations were similar to most other Indian studies in which either Hypertension or Diabetes is the most common co-morbidity present.

Hypertension is the most common co-morbidity present because elderly patients were the majority in study population. Diabetes is one of the important risk factors of Sepsis, CVD and pneumonias and thus an important risk factor for development of AKI.

In study done by Marion Venot, et al. [19], a multicentre study comparing outcomes of AKI in sepsis in diabetes, they found that diabetes

decreased the likelihood of renal function recovery in patients with severe sepsis or septic shock.

Huw, et al. [20] in their study observed that Incidence of Cardio renal syndrome type 1 was 52.56%. In our study, 12 patients of Chronic liver disease developed AKI as a part of hepato-renal syndromes. Variceal bleeding, use of diuretics, Spontaneous bacteria peritonitis were the causes responsible for precipitation AKI (HRS type 1) in chronic liver disease.
Malignancy was seen in 10 cases of which 7 cases were due to sepsis and 3 cases were due to obstructive uropathy due to cervical cancer.

Presenting features in AKI
Oliguria (52.8) is the most common presenting feature followed by Hyperkalaemia (48%) in our study.

There is a significant (p= <.0001) association between presence of oliguria and stages of AKI. Hyperkalaemia (48%), Hypotension (44.2%), Fluid overload (20.5%) and Encephalopathy (15.7%) are all significantly associated with the Stages of AKI. Our results were comparable to other studies Eswarappa, et al. [12]; Prakash, et al. [13].

Treatment options in AKI
In our study, RRT was needed in 124 (35.4%) patients. RRT was needed in 12, 28, 84 patients from KDIGO stages 1, 2 and 3 respectively. There is a significant association (p = <.0001) between need for RRT and KDIGO stages of AKI.

In our study the incidence of dialysis requiring AKI in critically ill patients admitted in MICU was 2.8%. Vaara, et al. [21]; Bouchard, et al. [10] observed similar results.

Requirement of RRT in studies by Prakash, et al. [13]; Maulita, et al. [16]; Korula, et al. [22] and Eswarappa, et al. [12] are 54.35, 17%, 39.1% and 37.25 respectively. Clinical practice has traditionally been predicated on starting RRT

only when a life threatening complication of AKI arises. These indications include severe metabolic acidosis, refractory hyperkalaemia, and fluid overload with pulmonary oedema unresponsive to other forms of treatment [3]. Additionally, sustained oliguria/anuria and complications of uraemia are considered to be conventional indications [3]. However, it has become increasingly clear that, in usual clinical practice, many patients with severe AKI commence RRT well before the development of any conventional indications for RRT. This approach may have conceivable benefits (e.g., removal of uremic toxins and improved volume control) but may also expose patients to the harms of RRT while being resource intensive. In a study by Vaara, et al. [23], comparing conventional versus pre-emptive initiation of RRT found that the 90-day mortality among 105 patients with pre-emptive RRT was 31 (29.5%; 95% CI, 20.8% to 38.2%), and the 90-day mortality among 134 patients with classic RRT was 65 (48.5%; 95% CI, 40.0% to 57.0%). Classic RRT remained associated with a higher risk (odds ratio, 2.05; 95% CI, 1.03 to 4.09) for 90-day mortality after adjusting for multiple confounders, including disease severity and presence of severe sepsis. The frequency of RRT-related complications did not differ.

Outcomes in AKI
Outcomes of AKI were put into three categories in our study. Of the 324 patients in whom outcomes were analysed 204 patients had complete recovery. They were discharged in stable condition with normal or near normal serum creatinine values.

There are only few studies regarding outcomes and dialysis dependence in MICU patients especially in India. Eswarappa, et al. [12] observed complete renal recovery was seen in 61% of patients. In study by Prakash, et al. [13] complete renal recovery was seen in 32.57% of patients. In our study, complete renal recovery was found in 62.5% of patients which is in close similarity with Eswarappa, et al. [12]. Complete renal recovery is less commonly reported in the

literature, however few studies have previously shown that the majority of patients recover sufficient renal function with one study even showing 68.0% of patients recovered completely [24, 25]. The excellent recovery seen in our study might be due to the exclusion of patients with pre-existing renal disease. Schiffl, et al. [26] in their study showed that if critically ill patients with normal renal function prior to the renal insults, survive the precipitating cause of ATN, the overwhelming majority will recover sufficient renal function. In study by Josee Bouchard, et al. [10], a multicentre study comparing outcomes of AKI in multiple centres in developed and emerging countries observed that Survivors from emerging countries were less likely to recover kidney function (52.2% in emerging countries versus 71.7% in developed countries; P<0.001) and more frequently dialysis-dependent at hospital discharge (18.5% versus 5.7%; P<0.001).

Conclusion

KDIGO classification of AKI adds transparency to the management of AKI and is an independent predictor of mortality. Physicians must make every attempt to classify AKI into KDIGO stages and use pre-emptive measures to halt the progression of acute kidney injury.

Sepsis is the most common cause of AKI in MICU and is associated with significant mortality. Early and aggressive management of sepsis is required to prevent progression of AKI in MICU.

Mortality is high in patients needing RRT, so facility for renal replacement therapy is very much essential in MICU.

Critically ill will always be an especially challenging group of patients concerning kidney injury. Presence of multiple co-morbidities and presence of multiple factors involved in kidney injury make management of AKI in MICU a challenging ordeal.

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