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An Assessment of Acute Kidney Injury Development, Identification & Correlation of Risk Factors with Various Stages of RIFLE and Outcome of In-Patients at a Tertiary Care Teaching Hospital

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ABSTRACT

INTRODUCTION: Acute Kidney Injury (AKI) is a common and serious problem in clinical medicine characterized by an abrupt decrease in renal function resulting in accumulation of nitrogenous waste products and inability to regulate fluid, electrolyte and acid-base balance in the body.
OBJECTIVES: This study aims to evaluate the incidence of AKI development in hospitalized patients according to RIFLE criteria and assesses the co-relation between risk factors and the stages of AKI development.
METHOD: A prospective cross sectional observational study was conducted among Acute Kidney Injury patients for a period of about 6 months. RIFLE Criteria was used to assess the patients. Data was analysed using SPSS v.20. Pearson's chi square tests; correlations and linear regression analysis were used to analyse the data collected.
RESULT: A total of 207 patients participated in this study. Majority were females with an age group of 50 and above. The incidence of Acute Kidney Injury according to RIFLE criteria was, Risk 25(12.1%), Injury 55(26.6), Failure 79(38.2%), Loss 44(21.3) ESRD 4(1.9%).58 patients (28.0%) had 1-4 risk factors ,138 patients(66.7%) had 5-8 risk factors while 11 patients (5.3%) had <8 risk factors. Co-morbidities (CVS disorders, T2DM, Sepsis and other infections) and Length of Hospital stay were found to have highly a significant co-relation with all stages of RIFLE.
CONCLUSION: The study concludes that AKI is often under-recognized despite its prevalence and clearly shows the need for its earlier diagnosis. This study helps to determine the possible risk factors to avoid morbidity and progression to ESRD.

Keywords: [Acute Kidney Injury, Risk Factors, RIFLE criteria]

INTRODUCTION

Acute Kidney Injury (AKI) is a common and severe problem in clinical medicine.[6] It is characterized by a sudden decline in renal function within hours to days, resulting in the accumulation of nitrogenous waste products and an inability to regulate fluid, electrolyte, and acid-base balance. AKI is also known as Acute Renal Failure (ARF).[6] The majority of AKI cases occur in hospitalized patients for other medical conditions. Up to 7% of hospitalized patients experience AKI, which can increase to over 30% in those who are terminally ill. [6]AKI is a common complication in critical care patients admitted to intensive care units, with an incidence of 20-50%.[3] Currently, more than 13 million people worldwide suffer from AKI each year, with significant geographic variations among

countries, regions, and economies.[1] Various factors such as age, gender, co-morbidities, past medical and medication history, length of hospital stay, current medications, postsurgery, and the need for mechanical ventilation contribute to the development of AKI.[8]

To diagnose AKI accurately, the Acute Dialysis Quality Initiative developed the RISK, INJURY, FAILURE, LOSS and END stage kidney failure (RIFLE) classification in 2004. RIFLE defines three grades of severity of AKI (R, I, F) and two outcome variables (L, E). The distinctive feature of RIFLE is its assessment of three graded severity of renal dysfunction based on individual variation in serum creatinine, reflecting modifications in GFR or the duration and severity of the decline in urine output from the baseline.[6]

The study aims to determine the incidence of AKI development in hospitalized patients according to RIFLE criteria and assess the correlation between risk factors and stages of AKI development. There has been a fourfold increase in the incidence of AKI in the past 15 years, with a higher proportion of severe AKI requiring dialysis. ARF in critically ill patients has a mortality rate of at least 50% and is often associated with the failure of one or more non-renal organs. Despite recent advances in dialysis delivery and the development of sophisticated continuous renal replacement therapy, AKI continues to have a grim prognosis.[1] Early diagnosis of AKI and the identification of potential risk factors are crucial to preventing morbidity, progression to ESRD, and the burden of RRT, improving patients' quality of life, and reducing economic loss.

MATERIALS & METHODS

The prospective observational study was conducted from March 2022 to August 2022 at SSIMS&RC, a tertiary care teaching hospital, Davangere.207 were enrolled from ICU, Emergency, General ward over a period of 6 months. The study population consisted of individual aged 18 year or older who underwent serum Creatinine testing during hospitalization for a duration exceeding 24 hrs. Patients who were under 18 years of age,had a history of CKD, were receiving renal replacement therapy, were pregnant, or had genetic kidney disease and who refused to give informed consent were excluded from the study. Informed consent was taken in a predesigned consent form. The collected data was analyzed using an appropriate statistical method.

The statistical package for social sciences (SPSS) software version 2.0 was used to pool and evaluate all of the data extracted. Continuous data were tested for normality. A normally distributed data was expressed as Mean ± Standard deviation. For categorical variables, the Pearson Chi-square test was used to determine the correlation of patient characteristic such as social and hospital parameters, past medical and medication history, current therapy, length of hospitalization, other relevant risk factors. The statistical significance was assumed at $p < 0.05$ in this study. Using linear regression analysis, the predictability of various factors was determined. The findings that was observed was compiled and presented graphically or tabulated

RESULT

The study included 207 patients who met the inclusion criteria. The incidence of Acute Kidney Injury according to RIFLE criteria was analyzed. Out of the total participants, 12.1% belonged to RISK, 26.6% to INJURY, 38.2% to FAILURE, 21.3% to LOSS, and 1.9% to ESRD. The majority of the patients were in the FAILURE stage of AKI, followed by the INJURY stage.

Table1: Distribution of study participants according to RIFLE.

STAGE OF AKI	FREQUENCY	PERCENTAGE
RISK	25	12.1
INJURY	55	26.6
FAILURE	79	38.2
LOSS	44	21.3
ESRD	4	1.9

Figure 1:

Distribution of baseline characteristics:

The study analyzed social parameters such as age, gender, residence, and BMI. Females comprised the majority of participants (59.4%) and most were above 50 years of age (73.4%). Normal weight and overweight patients were more common, with only 8 classified as obese. Rural areas were home to a greater number of patients (58.9%) compared to urban areas (41.1%).

Regarding hospital-related parameters, Emergency department admissions accounted for 48.3% of AKI patients, while 37.7% were admitted to the ICU and only 14% were in the General ward. Elevated serum creatinine levels were observed in 34.8% of patients within 1-5 days, 52.7% within 6-10 days, and 12.6% after 11-15 days. The majority of patients (52.7%) were admitted for 8-15 days, while 44.9% stayed in the hospital for more than 15 days.

Statistical distribution of Risk factors among the study participants

Table 2:

PARAMETER	MEAN	STANDARD DEVIATION
Age	56.9	1.22
Number of co-morbidities	2.11	1.207
Length of hospital stay	14.5	1.20
Day of serum Creatinine rise	7.02	1.2
Total number of risk factors in each patient	5.44	1.2

The study found that the average age of participants was 56.9±1.22 years, and their hospital stay averaged almost 14 days. Patients had at least 2 comorbidities and 5 risk factors on average, and serum Creatinine levels rose over a period of 7 days. These findings underscore the severity and complexity of renal impairment and the need for a comprehensive approach to its management, including regular monitoring of serum Creatinine and identification and management of relevant risk factors.

DISTRIBUTION OF RISK FACTORS AFFECTING STAGES OF AKI

Upon conducting logistic regression analysis, it was observed that the number of days of hospital stay, number of co-morbidities, and total number of risk factors in each patient were highly significant determinants with p-values of 0.00. Additionally, variables such as gender (p-value 0.0010), BMI (p-value 0.013), ward (p-value 0.008), and residence (p-value 0.001) were also found to significantly influence the stages of AKI.

Table 3:

PARAMETER	STAGE OF AKI					TOTAL	P VALUE
GENDER	RISK Frequency (%)	INJURY frequency (%)	FAILURE frequency (%)	LOSS frequency (%)	ESRDfrequency (%)		
Male	12(10%)	27(22%)	43(35%)	37(30%)	4(3%)	123	0.001*
Female	13(15%)	28(33%)	36(43%)	7(8%)	0	84	
AGE							
< 50 years	6(11%)	11(20%)	28(51%)	8(14%)	2(4%)	55	0.126
>50 years	19(12%)	44(29%)	51(34%)	36(24%)	2(1%)	152	
BMI							
Normal	17(16%)	27(25%)	30(20%)	31(29%)	1(1%)	106	0.013*
Overweight	6(6%)	26(28%)	45(48%)	13(14%)	3(3%)	93	
Obese	2(25%)	2(25%)	4(50%)	0	0	8	
RESIDENCE							
Rural	13(11%)	20(16%)	55(45%)	32(26%)	2(2%)	122	0.001*
Urban	12(14%)	35(41%)	24(28%)	12(14%)	2(2%)	85	
LENGTH OF HOSPITAL STAY							
1-7 days	5(100%)	0	0	0	0	5	
8-15 days	12(11%)	30(27%)	42(38%)	23(21%)	2(2%)	109	0.00**
>15 days	8(9%)	25(27%)	37(40%)	21(23%)	2(2%)	93	
WARD							
ICU	5(6%)	15(19%)	34(44%)	23(29%)	1(1%)	78	
Emergency	12(12%)	31(31%)	34(34%)	21(21%)	2(2%)	100	0.008*
General Ward	8(28%)	9(31%)	11(38%)	0	1(3%)	29	
NUMBER OF CO-MORBIDITIES							
0	4(17%)	2(8%)	18(75%)	0	0	24	
1	3(8%)	16(4%)	10(26%)	10(26%)	0	39	
2	6(10%)	11(18%)	21(34%)	22(36%)	1(2%)	61	0.00**
3	7(12%)	17(29%)	23(40%)	10(17%)	1(2%)	58	
4	522%)	9(39%)	7(30%)	2(9%)	0	23	
5	0	0	0	0	2(100%)	2	
DAY OF SERUM ELEVATION							
1-5 days	14(19%)	14(19%)	29(4%)	15(21%)	0	72	
6-10 days	7(6%)	38(35%)	44(40%)	16(15%)	4(4%)	109	0.00*
11-15 days	4(15%)	3(11%)	6(23%)	13(50%)	0	26	

On analysing social parameters in study participants, the male to female ratio was 123 to 84, and the majority of both male and female participants had FAILURE stage of AKI. The p-value was 0.001, indicating the significance of gender with AKI stages. Patients above the age of 50 were predominantly affected by AKI and had a higher likelihood of being in the FAILURE or INJURY stage. Normal BMI patients were more likely to have the LOSS stage, whereas overweight and obese patients had a higher probability of being in the FAILURE stage. The rural patients had a higher percentage of FAILURE stage, whereas INJURY stage was more prevalent in urban areas, and the p-value was 0.001.

Patients with longer hospital stays were more likely to develop FAILURE stage AKI compared to those with shorter stays. Patients admitted to the Emergency and ICU were more likely to develop AKI, especially the FAILURE stage. Patients with more comorbidities were also more likely to develop AKI, particularly in the FAILURE stage. The majority of patients showed an increase in Creatinine level within 6-10 days, with most of them in the FAILURE or INJURY stage. A delayed diagnosis of increased Creatinine levels is a significant risk factor for AKI.

Distribution of co-morbidities in different stages of AKI

Table4:

CO- MORBIDITIES	STAGES OF AKI								TOTAL
	RISK		INJURY		FAILURE		LOSS		ESRD	
	Frequency	P value	Frequency	P value	Frequency	P value	Frequency	P value	Frequency	
CVS disorders	14	0.010*	36	0.000**	47	0.000*	23	0.001*	2	122
T2DM & associated complication	11	0.027*	24	0.001*	35	0.00*	21	0.001*	2	93
Sepsis	3	0.341	4	0.21	13	0.013*	8	0.050*	1	29
CLD	0	0	10	0.028*	23	0.002*	10	0.050	1	44
Infections	16	0.006*	29	0.00*	48	0.00*	26	0.00*	2	121
NSAID abuse	1	0.00*	2	0.00*	13	0.00*	4	0.00*	0	20
Others	1	0.00*	3	0.00*	11	0.00*	6	0.00*	0	21

Table 4: pertains to the distribution of comorbidities across different stages of Acute Kidney Injury (AKI), wherein various comorbidities including CVS disorders, infections, T2DM, sepsis, NSAID abuse, and other comorbidities have been studied.

CVS disorders are predominantly observed in the FAILURE stage of AKI, followed by the INJURY stage. Similarly, infections and surgery are found to be the second most prevalent comorbidities in AKI patients, with a significant majority of patients observed in the INJURY stage. The co-occurrence of T2DM and its related complications is also noted in the INJURY stage of AKI.

The majority of patients with other co-morbidities, such as CLD, Sepsis, NSAID abuse, and other conditions like seizures, accidents, bipolar disorder, migraine, COPD, and arthritis, were observed in the INJURY and FAILURE stages of AKI.

The study also revealed that the distribution of comorbidities across different stages of AKI exhibited a statistically significant correlation. Specifically, CVS disorders and infections were found to have a significant association with all stages of AKI. Moreover, chronic liver disease was positively associated with the FAILURE stage of AKI, while NSAID abuse was found to be a critical and significant risk factor for all stages of AKI.

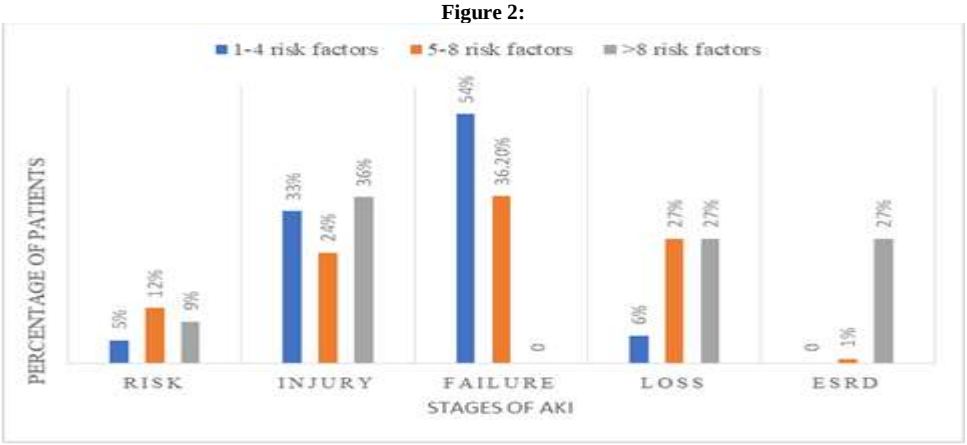
Distribution of Total number of risk factors in each stages of AKI.

Table 5:

PARAMETER	STAGE OF AKI					TOTAL	p- VALUE
	RISK	INJURY	FAILURE	LOSS	ESRD		
	f (%)	f (%)	f (%)	f (%)	f (%)		
NUMBER OF RISK FACTORS IN EACH PATIENT							
1-4 risk factors	8(5%)	18(33%)	29(54%)	3(6%)	0	58	
5-8 risk factors	16(12%)	33(24%)	50(36.2%)	38(27%)	1(1%)	138	
>8 risk factors	1(9%)	4(36%)	0	3(27%)	3(27%)	11	0.00**

A notable proportion of patients with renal impairment exhibited 5-8 risk factors, with the majority of them being observed in the FAILURE stage (36.2%) followed by the LOSS (27%) and INJURY (24%) stages. The significance of these risk factors was underscored by their correlation with all stages of AKI, thus highlighting the importance of assessing a patient's potential risk factors with a p-value of 0.00.

Figure 2:



Distribution of Outcome in AKI patients

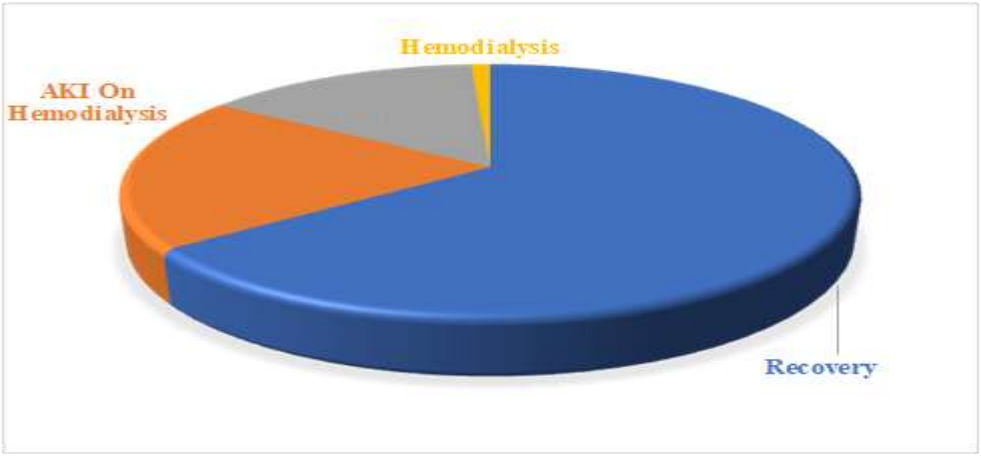
Table6:

OUTCOME	FREQUENCY	PERCENTAGE
Recovery	134	64.7 %
AKI On Hemodialysis	41	19.8 %
Progressed to CKD/ on Hemodialysis	30	14.5 %
Death	1	1 %

Among the total of 207 patients, the proportion of individuals who had recuperated was 64.7%, whereas 19.8% of patients were undergoing hemodialysis, 14.5% had progressed to chronic kidney disease, and 1% had passed away. Despite

the fact that a substantial number of patients with AKI developed into CKD or required hemodialysis, a majority of the patients recovered from the condition.

Figure 3:



DISCUSSION

Acute kidney injury (AKI) is a common and exorbitant clinical syndrome that affects nearly one quarter of all hospitalized patients around the world. The study was conducted at SSIMS&RC for a period of 6 months from March 2022 to August 2022. During the study period, a total of 207 AKI patients above the age of 18 from ICU, emergency, and general wards were monitored prospectively.

Predominant proportion of study participants who developed AKI was found to be male 123(59%). With a p-value of 0.001, gender was found to be a significant risk factor for AKI emergence. Majority of the patients were aged above 50 -152(73%). It is consistent with a study conducted in the United Kingdom by S Finlay, B Bray, AJ Lewington, et al [8], in which 31 elderly patients (56.4%) and 32 male patients (52.3%) who participated in the research developed AKI. Overweight patients were deemed to be at an increased risk of developing AKI according to our study and it is similar to the findings of Sunmi Ju, M.D., Tae Won et.al [2] where the overweight group had significantly ($p<0.001$) higher incidence of AKI (36.3%) than the underweight (9.8%) or normal group (15.0%).

Compared to the general ward, patients in the emergency and intensive care units had a higher risk of renal damage. Ward of admission has a direct correlation to the development of AKI (p-value 0.008). This study was found to be similar of that conducted by Paulo Roberto Santos, Diego Levi Silveira Monteiro [7], and Md. Yousuf Khan, P. Deepa et al [3]. Both of these researches indicate that more than 30% of patients in ICU had AKI. Most patients reported an increase in serum creatinine level within 6-10 days of their hospital stay. AKI is independently associated with increased length of hospital stay. According to a study by Salma Mohammed Magboul, Bashier Osman et al [4], 41 patients (39%) that had a minimum of 6 days of hospital stay was associated with increased incidence of acute kidney injury. It's reasonable to conclude that a patient's length of hospital stay was crucial with p-value of 0.00.

The most prominent co-morbid condition in AKI patients were CVS problems (58.93%) followed by infections and surgery (58.45%). T2DM and its complications (44.92%) were seen in a sizable number of people. The results of our study are consistent with Italian researchers Giuseppe Filiberto Serraino and Michele Provenzano et.al[5] that kidney impairment and cardiovascular disease(80,50.6%) are inextricably linked ($p<0.001$). Patients who had at least two or three co-morbid

conditions exhibited an increase in the incidence of AKI. The study conducted by S Finlay, B Bray, AJ Lewington et al[8] clearly reports a correlation between AKI and a number of risk factors, where patients with ≥2 risk factors had a 7.1-fold increased risk of having AKI compared to those with ≤1 risk factor with a p-value <0.001.

CONCLUSION

The analysis on AKI patients sheds light on the potential risks and contributing factors to the development of AKI in hospitalized patients. The study emphasizes the importance of early identification of AKI to prevent its progression to CKD or requiring dialysis. It identifies various risk factors, including age, gender, Length of hospital stay co-morbidities. The study emphasizes the need for health education and raising awareness about AKI among caregivers and patients to help identify and manage patients at risk. Early identification, prevention, and management of AKI are essential to improve the quality of life of AKI patients. Therefore, a collaborative effort among healthcare professionals, patients, and caregivers is necessary to prevent and manage AKI effectively.

Declaration by Authors

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