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Original Article

Incidence of Acute Kidney Injury in 1 - 14 years old Critically ill Children in a Tertiary care Center

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Abstract

Introduction: Acute Kidney injury (AKI) is associated with poor outcomes in critically ill hospitalized children. There are very few studies on incidence of AKI based on urine output criteria of KDIGO (Kidney Disease: Improving Global Outcome) and time lag between the fall in urine output and rise in serum creatinine. This study was therefore aimed at determining the same.

Methods: A prospective study was conducted in the Department of Paediatrics of a tertiary care hospital. 171 critically ill children between one to 14 years who were admitted in PICU were enrolled. Hourly urine output and eight hourly serum creatinine levels were measured and incidence of AKI was calculated along with lag time between fall in urine output and rise in serum creatinine. Outcome of children with AKI was also studied. Data analysis was done using SPSS software version 25.0 and Microsoft excel 2007.

Results: The mean age + SD of children in the study was 5.5 years ± 3.76 with a range of one to 14 years, with 62.6 % of them being boys. The incidence of AKI in the study population was 14.62%. The mean lag time between fall in urine output and rise in serum creatinine was found to be 13.21 hours. AKI had a significant association with mortality, use of nephrotoxic drugs, inotropes and mechanical ventilation.

Conclusions: A significant number of critically ill children develop AKI and its occurrence portends a poor outcome. Utilization of the KDIGO reduced urine output criteria as a marker of AKI allows for early detection and intervention.

Introduction

Acute kidney injury (AKI) is a clinical syndrome in which a sudden deterioration in renal function results in the inability of the kidneys to maintain fluid and electrolyte homeostasis. The etiology and epidemiology of AKI is varied. Various studies in different parts of India have reported an incidence of 0.6% to 45%.[1-7] Other than the renal causes; sepsis, infections, nephrotoxic medications and ischemia are the predisposing conditions leading to AKI. [8-11]

AKI in critically ill children bears a poorer prognosis in the PICU (Paediatric Intensive Care Unit) setting. Use of creatinine in the diagnosis of AKI however is problematic as it requires almost 50% loss in renal function before its levels rises. The most widely used laboratory finding to make the diagnosis of AKI remains an elevated serum creatinine. However, serum creatinine is often a delayed and imprecise test as it reflects GFR (Glomerular Filtration Rate) in individuals at steady state with stable kidney function and does not accurately reflect the GFR in a patient whose renal function is changing.[12]

There are not much paediatric studies about the lag time between fall in urine output

and the rise in creatinine levels. In critically ill adult patients, a study was done comparing the creatinine and urine criteria of RIFLE (Risk, Injury, Failure, Loss of function, End stage renal disease). In this study 53% of the patients with AKI would have been diagnosed at least one day earlier if the RIFLE urine criteria had been applied. The study concluded that the use of serum creatinine criteria alone underestimates the incidence and grade of AKI and also delays the diagnosis of AKI.[13]

With this background, the present study was planned to determine the incidence of AKI as diagnosed by Kidney Disease: Improving Global Outcome (KDIGO) reduced urine output criteria in critically ill children without any underlying renal condition and to estimate the mean lag time between fall in urine output and rise in serum creatinine.

Methods

A cohort study was conducted in the Department of Paediatrics of a tertiary care teaching hospital in western India over a period of 18 months from October 2018 to April 2020. All critically ill children aged one to 1 - 14 years admitted to PICU were included in the study. Children with chronic kidney disease including congenital anomalies of kidney and urinary tract were excluded. Children with deranged baseline creatinine on admission were also excluded. Written informed consent from parents was taken. Relevant data was obtained from the parental history and case records. A baseline creatinine was measured in the study population, followed by measurement of hourly urine output by catheterization. The children in whom catheterization was not indicated, urine was measured in every void if they were toilet trained and diaper weights were taken in children who are not toilet trained. Written informed consent was taken from parents. If there was fall in urine output to < 0.5 ml / kg / hour during any six6 hours duration, serum creatinine was measured then and every eight[8] hourly thereafter. Serum creatinine was repeated every 12 hourly or as per their clinical progression in children not developing decreased urine output. The children in whom catheterization was not indicated, urine was measured in every void with a measuring can if they were toilet trained and diaper weights were taken in children who are not toilet trained. If they did not pass urine for six hours, they were included in the AKI category, and further managed with catetherisation. The time lag if any between AKI diagnosed by decrease in urine output and by rise in serum creatinine was measured. Outcome of children with AKI diagnosed by KDIGO reduced urine output criteria were also documented.

Data analysis performed by using SPSS (Statistical Package for Social Sciences) version 25:0. Quantitative data variables expressed by using mean and standard deviation (SD). Qualitative data variables were expressed by using frequency and percentage. Chi - square test was used to find the association between occurrence of AKI and its outcomes. Mann - Whitney U test was used to compare the length of stay with occurrence of AKI. A p value of < 0.05 was considered as significant. The study was approved by Institutional Ethic Committee. The management was done as per the PICU protocol irrespective of study participation.

Results

The study population consisted of 171 children ranging from one to 14 years. 63% were boys & 37% were girls. 50. 9% cases belonged to age group less than five years, 35. 7% and 13.4% from age group six to 10 years and > 10 years respectively.

Children in the study were classified into broad diagnostic categories. The highest percentage of cases were respiratory disorders (22%), followed by neurological (13%), post - operative (9.5%), gastrointestinal disorders (9.5%) and hematological disorders (8%). Other cases in the study population included cardiovascular, autoimmune, neurosurgical, metabolic and MODS (Mmultiorgan dysfunction syndrome). Amongst respiratory group there were cases including pneumonia, pleural effusion, empyema, bronchiolitis and acute exacerbation of asthma. Neurological subgroup cases included cases of status epilepticus, febrile encephalopathy, GBS (Guillain - Barre Syndrome). Hematological cases included febrile neutropenia in cases of ALL (Acute Lymphocytic Leukemia), AML (Acute Myelogenous Leukemia) and sequestration crises in a case of sickle cell anemia. 48% of the study population had pre-existing comorbidities. In the study population (renal comorbidities were excluded), the most common were neurological comorbidities (18.71%) followed by hematological (8.19%) and cardiovascular cases were 7%. Other less common pre - existing co-morbidities also included endocrinological cases, respiratory, autoimmune cases and hemato-oncological cases.

14.62% % (25/171) developed Acute Kidney Injury (AK) as per the urine output criteria of KDIGO. If the incidence was measured only by the creatinine criteria of KDIGO, then the

incidence would have been 13.45%. Two patients in the study AKI would have been missed in two patients if the creatinine criteria of KDIGO was used alone. The observed fall in urine output was noted around eight to 24 hours post admission. The mean lag time between fall in urine output and rise in serum creatinine was found to be 13.21 hours (Include SD).

Figure 1 shows the trend of rise and fall in creatinine in the AKI patients. The creatinine levels started rising around eihght to 16 hours post the recorded fall in the urine output below 0.5 ml per kg per hour for six hours. The creatinine values peaked to a maximum level at around 64 hours post the fall in urine levels. Recovery of creatinine values to baseline occurred in around 136 to 152 hours. Figure 2 shows the trend of fall and recovery of urine output in children with AKI. The fall in urine output was observed to be around eight to 24 hours post admission and the recovery of urine output was observed to be around 72 to 96 hours.

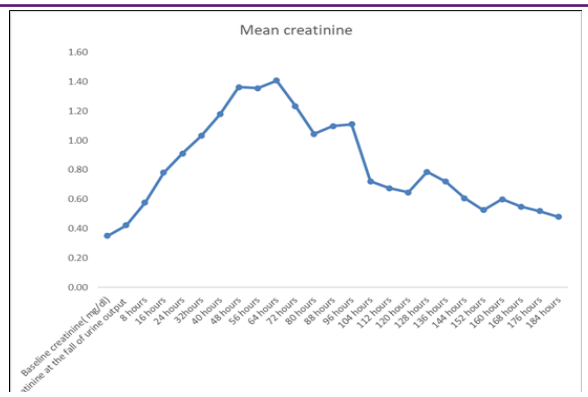

Figure 1: Trend of creatinine in children with AKI

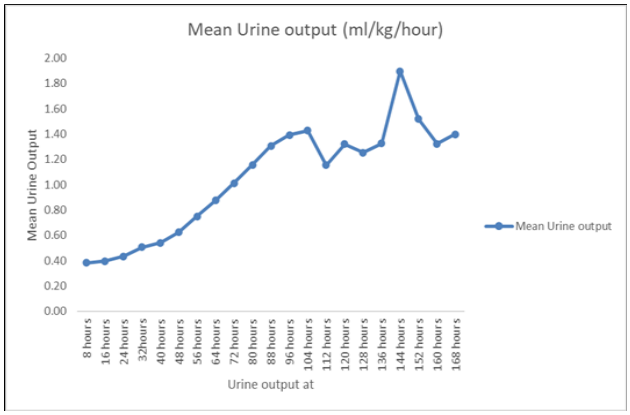

Figure 2: Trend of urine output in children with AKI

We looked at association of AKI with age, gender, any specific diagnostic category or pre-existing co-morbidity and use of nephrotoxic drugs. We found a significant association with use of nephrotoxic drugs. In the study population the most common nephrotoxic drug which was administered was amikacin (39%) followed by vancomycin 23%.

Table 1 shows that amongst the patients with AKI, statistically significant association was seen with mechanical ventilation, the use of inotropes and mortality . On analysis of outcomes in the AKI patients, association with inotropes was seen in 56% of cases, mechanical ventilation in 24% of cases and mortality was seen in 52%. Amongst 171 children of the study population, 20 died, out of which 13 had AKI. This shows a significant statistical association of AKI with mortality ($p < 0.001$).

Outcomes	AKI (Urine output criteria of KDIGO)		Total	p-value
	Yes	No		
Mechanical ventilation	6	7	13	0.001*
Inotropes	14	16	30	< 0.001*
Mortality	13	7	20	

Table 1: Association of AKI with mechanical ventilation, inotropes and mortality

No significant association of AKI was seen with length of stay in the hospital in this study.

Discussion

Paediatric AKI presents with a wide range varying from an isolated mild elevation in serum creatinine to renal failure with anuria arising due to multiple etiologies in various clinical settings.[14-23] The present study was aimed at determining the incidence of AKI based on the urine output criteria of KDIGO in critically ill children with no previous renal comorbidities.

Our study shows an incidence of 14.62% developed AKI in the children admitted to PICU. Several studies worldwide showed variable incidence ranging from 25.1% to 82% depending on various inclusion criteria and profile of patients admitted to the PICU.[5] The incidence in different parts of India varied through different studies. Previous Indian studies report varied incidence ranging from 6.96% - 45.1%.[1, 4 -7] If we used the creatinine component of the KDIGO criteria alone, we would have missed two cases of AKI in the study population (Primary diagnosis of these cases were enteric fever and acute gastroenteritis with severe dehydration) and the incidence would have been 13.4% (23/171).

In this study the mean lag time between fall in urine output and rise in serum creatine was calculated in children with AKI and was observed to be[13.21] hours with a standard deviation of 5 [17]. There are very few studies in the past which have determined time lag in these settings. One study determining AKI using RIFLE criteria in critically ill adult patients documented a time lag of 24 hours. It was emphasized in this study that the with the use of RIFLE urine criteria, AKI could be diagnosed around one day early and significant mortality could be prevented.[13] Early identification of patients at risk for severe AKI and adverse outcome can influence physician's decision-making with regard to the implementation of the critical care bundle for AKI. Thus, the use of urine output criteria rather than the serum creatinine criteria as a marker for making clinical decisions and modification of drugs will be a better measure to prevent the grave complications of AKI.

The association of AKI was studied with the use of nephrotoxic drugs, inotropes, mechanical ventilation and mortality. A previous paediatric study showed that the use of three or more nephrotoxic drugs accentuates the risk of AKI as well as the patient morbidity.[24] AKI has been associated with poor outcomes in critically ill paediatric patients. A prospective Indian paediatric study in children of age group one month to 18 years showed that 40 % of children with AKI needed vasopressor support and 48 % of them required mechanical ventilation.[1] This study showed a significant association of occurrence of AKI with the use of nephrotoxic drugs and with association of inotropes and mechanical ventilation. According to previous Indian studies, mortality in AKI patients ranged from 37% to 46 %.[1,4] In this study, mortality in AKI patients was 52%. Hence our study also revealed poorer outcomes in patients developing AKI as compared to the non-AKI group.

Limitations

The present study had few limitations. This was a single-center study, including limited number of patients from varied group of diagnostic categories and comorbidities. Hence, we recommend studies on larger sample of children with specific risk factors and conditions.

Conclusions

AKI incidence in this study involving critically ill children aged one to - 14 years admitted in PICU (without any previously detected renal comorbidities) accounted to 14.62 % (25/171). Urine output criteria of KDIGO detected AKI around 13 hours before the rise of serum creatinine making it a more reliable guide than the serum creatinine levels for drug modification in critically ill patients to prevent AKI. Mortality was statistically significant in children with AKI (52%) as compared to the non-AKI group (4.8%). The incidence of AKI seemed to have a statistically significant association with use of nephrotoxic drugs, inotropes, and mechanical ventilation.

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