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Original article

Incidences and clinical outcomes of acute kidney injury in PICU: A prospective observational study

Shweta Pathak[1*], S Shashank Pandey[2], Monica Lazarus[3], Abhay Mudey[4], Ashish Nagrale[5]

[1]Consultant Pediatrician , Department of Pediatrics, Shital Chhaya Hospital Pvt Ltd Jabalpur, [2]Consultant SCH Jabalpur, [3]Assistant Professor, NSCB Medical College, Jabalpur (M.P).

ABSTRACT

Introduction: Acute Kidney injury (AKI) is a common and a serious complication among patients admitted to the PICU. The incidence and outcome of AKI in PICUs is largely unknown hence this study was done to evaluate the incidence, severity and outcome of AKI in a tertiary level Pediatric intensive care unit. **Materials and Methods:** We screened all patients admitted to the PICU. We excluded patients who had chronic kidney disease and were on renal replacement therapy, and those whose duration of PICU stay was shorter than 48 hours. Standard demographic, clinical and investigational data was obtained prospectively from all the patients. AKI was defined based on the modified pRIFLE (pediatric Risk, Injury, Failure, Loss and End stage kidney disease) criteria. **Results:** Out of 114 patients; 50 patients developed AKI and 64 did not develop AKI and served as controls; 23 patients (20.1%) developed pRIFLEmax R AKI; 15 (13.1%) pRIFLEmax I and 12 (10.5%) pRIFLEmax F AKI. Patients with PRISM scores over 10 on day 1 were more likely to develop AKI ($p < 0.01$). Patients with AKI were at higher risk of death, significantly longer PICU stay, prolonged duration on mechanical ventilation and need for dialysis ($p < 0.05$). **Conclusion:** The incidence of AKI in PICU is very high (43.7% in our study) and it is associated with significant morbidity and mortality.

KEYWORDS: Acute kidney injury, pRIFLE, PICU.

INTRODUCTION

The reported mortality from AKI is still as high as 60% in critically ill children [1]. Most of the reported clinical studies of pediatric AKI focus on patients requiring renal replacement therapy (RRT), who have clearly experienced severe renal injury However, recent studies demonstrate that even a modest rise in serum creatinine (SCr) is a risk factor for mortality in adult and pediatric patients[1,2].

The AKIN acute kidney injury diagnosis criteria is defined as "an abrupt (within 48 hours) reduction in kidney function currently defined as an absolute increase in serum creatinine of more than or equal to 0.3 mg/dl, a percentage increase in serum creatinine of more than or equal to 50% (1.5-fold from baseline), or a reduction in urine output (documented oliguria of less than 0.5 ml/kg/h for more than 6 hours) [3].This definition considers the patient's baseline function and changes in clinical markers within a 48-hour.

In 2004, the Acute Dialysis Quality Initiative proposed a multidimensional AKI classification system in adults termed the Risk, Injury, Failure, Loss, End-Stage Kidney Disease (RIFLE) criteria to promote a consistent AKI definition to compare findings across studies and populations [4].

Acute kidney injury (AKI) plays a major role in the clinical outcomes of critically ill patients. It is estimated that AKI affects approximately 35% of intensive care patients and 4% to 7% of all hospitalized patients [5]. Although creatinine level and urine output are not highly sensitive indicators of glomerular filtration rate (GFR), they are readily available, clinically tested and verified, and therefore used in most definitions.

This study was performed considering the paucity of data available on the incidence and outcome of AKI in Indian children and taking into account the retrospective nature of previous studies. This study was done to evaluate the Incidence and outcome of AKI in Pediatric intensive care unit by using modified pRIFLE criteria.

MATERIALS AND METHODS

This was a Prospective study that validated Pediatric modified RIFLE (pRIFLE) criteria [2] for defining AKI in critically ill children done over a period of 1 year at Narayana Hrudayalaya Multispecialty Hospital, Bangalore, India. The study was approved by the institutional ethics committee. Informed consent was obtained from the parents prior to inclusion of subjects into the study.

Table 1: Current pRIFLE Criteria Used for Diagnosis of Acute Kidney Injury. [2]

pRIFLE Stages	eCCl	Urine Output
R- Risk	eCCl>25%	<0.5ml/kg/h for 8h
I – Injury	eCCl>50%	<0.5ml/kg/h for 16h
F –Failure	eCCl>75% or <35ml/min/1.73m2	<0.3ml/kg/h for 24h
L- Loss	Persistent failure > 4 weeks	
E- ESRD	Persistent failure > 3 months	

Note: GFR = Glomerular filtration rate, [Cr] = serum creatinine concentration, eCCl = estimated creatinine clearance determined by the Schwartz formula: eCCl = CLCR = (k x Ht) / Serum Cr., where Ht height/length is in cm, serum creatinine in mg/dl and k is a constant (k = 0.55 for all children except infants and k=0.45 for Infants),ESRD = End stage renal disease.

Patients aged 1 month to 14 years, admitted to the Pediatric intensive care unit (PICU), were eligible for enrollment. Patients with known renal disease or previous chronic disease were excluded. Patients with less than two SCr levels or those with no urine specimens were also excluded from the study. Patients were enrolled within 48 hr. of admission in the PICU and followed up until they get discharged from the hospital.

The demographic variables collected were age, gender and weight. Clinical data included primary diagnosis, Length of Stay in PICU, PRISM III score (severity of illness/mortality risk measure)was calculated at the day of PICU admission, Need for mechanical ventilation, Duration of mechanical ventilation, Sepsis suspected or proven by positive culture, tissue stain, or polymerase chain reaction test (Patients were classified as having sepsis if they fulfilled consensus criteria for systemic inflammatory response syndrome, infection, sepsis, severe sepsis or septic shock as determined from PICU admission/discharge summaries and laboratory values .

Serum creatinine (SCr) values and urine output (in ml/kg/hour 8th hourly) were recorded on day 1, 2, 3, 5, 7 and possibly day 10 of PICU stay. Estimated creatinine clearance (eCCl) was calculated using the Schwartz formula (eCCl =K Ht/ Sr Creatinine). Patients were classified daily by pRIFLE criteria for AKI, using the changes in eCCl from baseline eCCl and decrease in urine output (UOP). The pRIFLE criteria for AKI classified patients' grade of AKI based on changes in eCCl and UOP: pRIFLE R ('Risk') denotes a ≥25% decrease in eCCl or UOP < 0.5ml/kg/h for 8h; pRIFLE I ('Injury') denotes a ≥50% decrease in eCCl or UOP < 0.5ml/kg/h for 16h and pRIFLE F ('Failure') denotes a 75% decrease in eCCl from baseline renal function or UOP < 0.3ml/kg/h for 24h or anuria for 12h.

First occurrence of AKI using pRIFLE criteria (based on either urine output or calculated eCCl whichever worst) was noted, and the worst pRIFLE stratum (pRIFLE max) attained in the first 10 days of study enrolment was also recorded. Patients were classified into two groups AKI and No AKI by using modified pRIFLE criteria then followed up till they get discharged or died subsequently these two groups were compared by using univariate analysis.

Statistical Methods: Descriptive statistical analysis has been carried out in this study. Results on continuous measurements are presented on Mean±SD (Min-Max) and those on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. Chi-square/Fisher Exact test has been used to find the significance of study parameters on categorical scale between two groups [12, 13, 14].

RESULTS

Out of 157 patients, 114 enrolled in the prospective pRIFLE validation study had urine specimens and SCr available for analysis. 25 patients were excluded because they had less than two SCr levels drawn and 18 patients had no urine sample available. Out of total 114 Patients 50 developed AKI and 64 patients (56.2%) did not develop AKI during the study period and served as controls; 23 patients (20.1%) developed pRIFLEmax R AKI; 15 (13.1%) pRIFLEmax I and 12 (10.5%) pRIFLEmax F AKI [Table 2] .

Patients were classified into 2 groups i.e. AKI and No AKI and baseline characteristics in both the groups were compared. There were 35 male patients in AKI and 41 in Non AKI group. The mean (SD) age of entire cohort was 4.2(4.8) years range (1month -16 years).Mean age of children in AKI group was 2.2 (2.6), whereas mean age in Non AKI group was 4.96(5.02). The mean (SD) weight of entire cohort was 16(17.8) years range (10-36kg).Mean weight of children in AKI group was 11.2 (12.6), whereas mean weight in Non AKI group was 17 (18.02). We found that Age <1 year, Weight<10kgs and Gender were almost similar in two groups and found to be stastically insignificant [table 3].

Table2: Classification of Patients according to modified pRIFLE criteria

Classification	Number of patients (n=114)	Percentage
No AKI	64	56.2
AKI	50	43.8
Risk	23	20.1
Injury	15	13.1
Failure	12	10.5

Table 3: Comparison of baseline characteristics in two groups by Univariate Analysis

S.N	Baseline Variables	AKI (n=50)		No AKI (n=64)		P value
		Number	Percentage	Number	Percentage	
1	Age in years					
	≤ 1 years	20	40.0	14	21.9	0.124
	>1 years	30	60.0	50	78.1	
2	Gender					
	Male	35	70	41	64.1	0.505
	Female	15	30	23	35.9	
3	Weight					
	<10 kg	20	26.6	17	26.6	0.128
	>10 kg	30	73.4	47	73.4	

The duration of PICU stay was significantly longer (>4days) among patients with AKI (82%) compared with no AKI (59.6%) AKI. (P value <0.01) [Table 4]. A PRISM score greater than 10 within the first 24 hours of PICU admission was seen in a total of 38 patients (76%) in AKI group and 32 patients (50%) in No AKI group. (P Value <.01) [Table 4]. There were 50% patients in AKI group required ventilator support for >4days whereas in No AKI group only 22% patients were on ventilator for >4 days. (P Value <.01) [Table 4].

Table 4: Correlation of severity variables of two groups by Univariate analysis

S.N	Baseline Variables	AKI (n=50)		No AKI (n=64)		P value
		Number	Percentage	Number	Percentage	
1	Length of Stay in PICU ≥4 days	41	82.0	38	59.4	0.009
2	PRISM III score >10	38	76.0	32	50.0	0.005
3	Duration of mechanical ventilation > 4days	25	50.0	14	21.9	0.002
4	Sepsis	22	34.4	14	28.0	0.467

The overall duration of stay in the hospital was almost similar in two groups as depicted in the [Table 5]. Renal replacement therapy in the form of haemodialysis (intermittent renal replacement therapy) was done in 10% of the patients in AKI group which was statistically significant. (P value<0.05) Total mortality in our study was 11%. 16 % in AKI and 5 % in No AKI group hence there was a statistically significant association between the presence of AKI and mortality. (P value<0.05) [Table 5].

Table 5: Correlation of outcome variables of two groups by Univariate analysis

S.N	Baseline Variables	AKI (n=50)		No AKI (n=64)		P value
		Number	Percentage	Number	Percentage	
1	Length of stay in the Hospital ≥7 days	36	72.0	50	78.1	0.451
2	Need for Dialysis	5	10.0	0	0.0	0.014*
3	Mortality	8	16.0	3	4.7	0.042*

DISCUSSION

Our single-center study evaluates the role of various factors in the development of AKI in PICU. This study shows that the incidence of AKI in PICU is 43.3 % which is comparable with the other studies. Cerda J et al reported that AKI affects approximately 35% of intensive care patients and 4% to 7% of all hospitalized patients. [5] Similarly; AKI is associated with significantly longer PICU stay, resulting in a significant burden in terms of cost of care. This is of particular importance in a resource limited setting, as PICU beds are limited and in great demand. Our findings are similar to studies in other countries. A similar but larger study in Italy showed that around half the patients admitted to ICU showed some form of AKI, and 65% of patients in ICU developed AKI at some stage during their stay, a figure very close to that seen in our study [1, 10].

As expected, sicker patients were more likely to develop AKI; those with PRISM scores greater than >10 were more likely to develop AKI. In our study we found no correlation between age, weight and gender with the incidence of AKI. The reason for this difference is unclear, but could potentially be due to the fact that over 75% of our patients belonged to a younger age group.

Potential limitations of our study include the relatively small sample size of 114; another potential concern is the use of an assumed baseline eCCl of 100 ml/min/1.73m2 for patients without a known baseline creatinine, in about one-fourth of the patients. The potential danger of this assumption would be to misdiagnose a patient with AKI based on a relative decrease in eCCl if in fact the patient had chronic kidney disease. Whether or not such misdiagnosis would lead to unnecessary evaluation or treatment is currently not known, but clinicians should exercise caution when classifying patients with AKI using pRIFLE, or any system using eCCl change, when a baseline creatinine level is unknown.

CONCLUSION

The incidence of AKI is high(43.7% in our study) in patients admitted to PICU, and the development of AKI is associated with significantly longer PICU stay, prolonged need for mechanical ventilation, need for dialysis .Patients with PRISM scores over 10 on day 1 were more likely to develop AKI. Age, gender and weight do not appear to influence the incidence of AKI in our study. We conclude that the incidence of AKI is high in PICU and it is associated with poor outcome and reduced survival.

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*Corresponding author: Dr. Shweta Pathak
E-Mail: drsp83@gmail.com