



## Clinico pathological spectrum of acute kidney injury in children admitted to tertiary care centre

Abhijeet Trivedi<sup>1</sup>, Atul Deokar<sup>2</sup>, N C Joshi<sup>3</sup>

<sup>1</sup> Specialist Pediatrician, Aster Hospital, Dubai, United Arab Emirates

<sup>2</sup> Pediatric Nephrologist, Nanavati Max Superspeciality Hospital, Mumbai

<sup>3</sup> Department of Pediatrics, Nanavati Max Superspeciality Hospital, Mumbai, Maharashtra, India

### Abstract

**Background:** Acute kidney injury (AKI) is a frequently encountered clinical entity in children and imposes significant morbidity and mortality. In a resource limited healthcare facilities the treatment of AKI is challenging task for pediatricians and it has been associated with wide range of adverse outcomes. The main aim of the present study was to evaluate the clinicopathological profile and outcome of AKI.

**Methods:** This prospective study was carried out on 30 children admitted to pediatric medical wards over a period of 2.5 years. Children aged 1 day to 12 years diagnosed with AKI irrespective of the underlying cause were included. Detailed medical information of the children was recorded and the baseline investigations were noted. Clinical and etiological profile of were also obtained.

**Results:** In this study, the incidence of AKI was higher among the children with age group between 1 month- 5 years (63.3%). The major cause of AKI was due to acute tubular necrosis (ATN) encompassing 80%. Further, 33.3% of children were managed by dialysis and most of them underwent peritoneal dialysis. Mortality was observed in 7 out of 30 children (23.3%) and the main risk factor was dialysis, hypertension and dehydration.

**Conclusion:** The main cause of AKI in the present study was acute tubular necrosis. Dialysis, hypertension and dehydration are the main predictors of mortality.

**Keywords:** acute kidney injury, children, acute tubular necrosis, mortality, dialysis, dehydration

### Introduction

Acute kidney injury (AKI) is defined as the drop or sudden loss of kidney function and is characterized by accumulation of waste products, loss of fluid and electrolyte balance, and alteration of acid-base homeostasis [1]. Studies showed that the development of acute kidney injury (AKI), defined as an acute increase in serum creatinine level ( $\geq 1.5x$  of baseline Scr or increase of 0.3 mg/dl of Scr in 48 hours), increases the risk of adverse outcomes in hospitalized patients [2]. The international kidney disease and critical care community recently proposed replacing the traditional term 'acute renal failure' (ARF) with AKI because the latter closely reflects the pathophysiological nature of the disease. AKI is characterized by a reversible increase in blood concentration of creatinine and nitrogenous waste products as well as by the inability of the kidney to properly regulate fluid and electrolyte homeostasis. Renal injury can be divided into prerenal disease, renal disease including vascular insults, and postrenal disease [3]. It is a common condition in critically ill newborns hospitalized in neonatal intensive care units (NICUs), and it is considered an independent risk factor that increases mortality, length of stay, and health care costs. There is increasing evidence that the incidence and awareness of pediatric AKI is rising. In infants and children undergoing cardiac surgery, the incidence varies from 30% to 50% [4]. Additionally, it is common in pediatric intensive care units (ICUs) and has an incidence of 10% to 35%.<sup>5</sup>The etiology of AKI in children is multifactorial and recent studies have shown that the major causes of AKI were cardiac surgery, sepsis, blood cancer, and respiratory failure of varied etiology [6]. In children, the main risk

factors for developing AKI are administration of nephrotoxic medications, veno-occlusive disease in association with hepatorenal syndrome, severe sepsis with shock, cardiopulmonary bypass (CPB) surgery, use of vasopressor along with invasive ventilation, FO, stem cell transplants and tumor lysis syndrome.<sup>7</sup> In this backdrop, the present study was conducted to study the incidence, etiology, risk factors and outcome including predictors of fatality of acute kidney injury in pediatric medical wards.

### Materials and methods

This was prospective study conducted on 30 children suffering from acute kidney injury, who were admitted to the pediatric medical wards over a period of 2.5 years. Patients from day 1 to 12 years of age were included in the study.

### Inclusion and exclusion criteria

Children aged one month to 15 years, diagnosed with AKI irrespective of the underlying cause were included. Known cases of chronic kidney disease (CKD) or those with congenital anomalies of kidneys and urinary tract were excluded.

A detailed history of the presenting symptoms and their duration with special attention to oliguria was noted. A preceding history of gastro-enteritis, bacillary dysentery and other infections, ingestion of drugs like aminoglycosides and analgesics were specifically taken into account. A physical examination was carried out with

special attention to state of hydration, blood pressure, acidotic breathing, nutritional status, signs of congestion, pallor and neurological status.

Various laboratory investigations were carried out on each patient. These included haemoglobin, complete blood count with peripheral smear and routine urine analysis, urine culture was done where relevant. Arterial blood gases, blood urea nitrogen, serum creatinine and serum electrolytes were done serially where possible. Other specialised investigations like ultrasonography, micturating cystourethrography and kidney biopsy were undertaken as and when indicated in order to aid the diagnosis. The details of history, physical examination and investigations which were done are mentioned in the protocol attached.

Patients were treated with diuretics and associated factors like hypertension, dehydration, electrolyte imbalance, acidosis, infection and malnutrition were simultaneously managed. Those who failed to improve or deteriorated inspite of conservative management were taken up for peritoneal dialysis. Early dialysis (within 48 hours of oligoanuria) was undertaken in haemolytic uremic syndrome. During dialysis, supportive measures were continued till the patients responded, in the form of rise in urine output and improvement in biochemistry.

**Statistical analysis**

SPSS v 24 was used for the data analysis. Qualitative data were expressed as frequency and percentages. Quantitative variables were represented as mean and standard deviation. Chisquare test was performed comparing the outcome of children as per pRIFLE criteria. A p value <0.05 was considered as statistically significant.

**Results**

In this study, the incidence of AKI was higher among the children with age group between 1 month- 5 years (63.3%) followed by 20% in the 5 years-12 years and 16.6% in newborns. Meanwhile, the incidence of AKI was higher in male children as compared to female children (70% vs 30%).

The causes of AKI in the present study were displayed in table 1. The acute tubular necrosis (ATN) was the major cause of AKI constituting around 80%, followed by acute glomerulonephritis (6.6%), hemolytic uremic syndrome (HUS) in 6.6% and urinary tract infection (UTI) in 6.6% of children respectively.

**Table 1:** AKI causes in the present study

Cause	No of cases	Percentage
ATN	24	80%
AGN	2	6.6%
HUS	2	6.6%
UTI	2	6.6%

The incidence of oliguricrenal failure was higher as compared to non- oliguricrenal failure among the children (80% vs 20%). Further, majority of the children were normotension (50%), 30% had hypotension and 20% had hypertension. Regarding dehydration status, majority of children were normally hydrated (70%) and 30% of the children had dehydration. The results were shown in table 2.

**Table 2:** Clinical features among the AKI children

Clinical features	No of Cases	Percentage
Oliguricrenal failure	24	80%
Non- oliguricrenal failure	6	20%
Blood pressure status		
Normotension	15	50%
Hypertension	6	20%
Hypotension	9	30%
Hydration status		
Normally hydrated	21	70%
Dehydration	9	30%

Regarding the potassium level, 60% of the children had normokalemia, 16.6% had hypokalemia and 23.3% had hyperkalemia.

Regarding treatment modality, majority of the children were approached using conservative management as compared to management with dialysis (66.6% vs 33.3%) respectively. The results were shown in table 3.

**Table 3:** Treatment modality among the AKI children

Age	Total no of cases	No. of cases treated conservatively	No. of cases treated with dialysis
Newborn	5	4	1
1mth-5yrs	19	11	7
6yr-12yr	6	5	2
Total	30	20(66.6%)	10(33.3%)

In this study, among the 10 children who underwent dialysis, majority of the children were subjected to peritoneal dialysis (5 cases), peritoneal dialysis followed by hemodialysis in 3 cases, Hemodialysis in 2 cases and Plasmapheresis in 1 case respectively.

In this study, out of 30 AKI children the mortality was observed in 7 cases. The age wise distribution of mortality was shown in table 4. Meanwhile, out of 7 died children 4 cases were males and 3 were females. Further, all the 7 cases of mortality were due to acute tubular necrosis

**Table 4:** Mortality among the AKI children

Age	No. of cases	Mortality	Percentage
Newborn	5	2	40%
1 mth-5 yrs	19	5	26.31%
5 yrs-12 yrs	6	-	
Total	30	7	23.3%

The mortality pattern of AKI cases was shown in table 5. Among the 7 died cases, 3 cases had normotension and 4 cases had hypotension, 3 cases were dehydrated and 4 cases were normal hydrated and in treatment modalities 4 cases were died in conservative management and 3 cases died in dialysis. Overall the mortality was higher in hypotension, dehydrated and dialysis underwent children.

**Table 5:** Mortality pattern among the AKI children (n=7)

Clinical features	No of Cases	Percentage
Blood pressure status		
Normotension (15 cases)	3	20%
Hypertension (6 cases)	-	-
Hypotension (9 cases)	4	44.4%
Hydration status		
Dehydrated (9 patients)	3	33.3%
Normally hydrated (21 patients)	4	19.04%
Management		
Conservative (20 cases)	4	20%
Dialysis (10 cases)	3	33.3%

## Discussion

AKI in children leads to significant morbidity and mortality and imposes economic burden to the parents and caretakers<sup>[8]</sup> Thus early identification of risk factors for AKI can prevent the disease and also aids in accurate diagnosis and treatment<sup>[9]</sup> In a recent study conducted in India, the prevalence of AKI is 25.2%<sup>[10]</sup>. A meta-analysis including studies across the world, reported a pooled incidence of AKI in children of 33.7%<sup>[11]</sup> In our study, the prevalence of AKI was higher in children aged ranging between 1 month to 5 years constituting about 63.3%. Similarly in a study done by Bharat et al. maximum cases of AKI were seen in 1–5 years of age<sup>[12]</sup>. Male preponderance is observed in the present study with 70% of children are males. Our results are in line with the study done by Anigilaj et al<sup>[13]</sup> where 51.2% children are males.

In the present study, the major etiological cause of AKI is acute tubular necrosis constituting around 80% followed by acute glomerulonephritis and hemolytic uremic syndrome. Previous study shows that, AKI children who underwent biopsy displayed normal glomeruli with evidence of ATN and interstitial edema<sup>[14]</sup> Interstitial edema leads to reduced GFR and renal tubules compression and thus elevates the hydrostatic pressure in Bowman's space<sup>[15]</sup> However, mounting studies has reported that sepsis is the major etiological cause of AKI<sup>[16]</sup>. A high incidence of hemolytic uremic syndrome (HUS) has been reported in different studies<sup>[17]</sup>. In another study conducted in Turkey, hypoxic ischemic injury and sepsis were leading causes of AKI<sup>[18]</sup> In an Indian study, glomerulonephritis and snake bite are the two major causes of AKI in 70% of the children<sup>[19]</sup>. In our study, 20% of the AKI children had hypertension and 30% displayed hypotension. Similarly, in a study done by Kraut et al.<sup>[20]</sup> there has been a significant association between AKI and hypertension. The dehydration rate in the present study was 30% among the AKI children. A study done by Marzuillo et al.<sup>[21]</sup> shows that dehydration displayed significant association with the development of AKI. We have observed dialysis rate of 33.3% among the AKI children and majority of the children had undergone peritoneal dialysis. In a study done by Nawaz et al.<sup>[10]</sup> 6.6% children had undergone dialysis and majority of the children were subjected to peritoneal dialysis. The mortality rate in the present study is 23.3%. The mortality rate of AKI has been reported from 10% in uncomplicated AKIs to 80% in those who required renal replacement therapy.<sup>[22]</sup> In Nawaz et al.<sup>[10]</sup> study the mortality is reported as 28.5% in AKI children and the mortality was higher in stage 3 AKI patients.

## Conclusion

In the present study, children with age less than 5 years were mostly affected with AKI. Acute tubular necrosis was the most common etiological cause for AKI. The mortality rate was 23.3% in this study and the main prognostic factors are hypotension, hypertension, dehydration and dialysis. Thus the prognosis of AKI is definitely improved with appropriate approach, newer diagnostic modalities, and with proper treatment of symptoms and cause.

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