

Acute Renal Failure in Children Below 12 Years Causes, Clinical Presentation and Management

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ABSTRACT:

BACKGROUND:

Acute renal failure (ARF) is a common condition in hospitalized patients, characterized by a rapid fall in glomerular filtration rate (GFR), carries a high morbidity and mortality, often preventable, so rapid recognition and treatment may prevent irreversible loss of nephrons.

OBJECTIVE:

To find out the cause of acute renal failure in children and to study the clinical presentation and management modalities and sequel.

METHODS:

A prospective study done in Central Teaching Hospital for children from January 2006 to December 2006. 120 patients aged 1month- to 12 years who were diagnosed and treated as cases of acute renal failure were collected & analyzed. And the distribution of patients according to (age, sex, type of presentation, laboratory finding, type of management and sequel) were done.

RESULTS:

From hundred twenty patients, there were 77 male and 43 female with 1.7:1 ratio distributed into 93 infant, 14 preschool and 13 school age group. The main type of presentation was acidosis, oliguria & dehydration. The main causes were gastroenteritis, sepsis and obstructed uropathy in infancy and preschool children, glomerular disease in school age group. 97 need conservative treatments and 23 need urgent peritoneal dialysis (PD) with mortality rate 5.15%, 30.51% respectively.

CONCLUSION:

Acute renal failure occurred more in infancy and most of them were prerenal acute renal failure can be handled with conservative treatment; peritoneal dialysis is a good choice for treatment of acute renal failure not resolved by conservative therapy.

KEY WORDS: acute renal failure, peritoneal dialysis

INTRODUCTION:

Acute renal failure (ARF) is, as the name implies, a rapidly progressive loss of renal function, generally characterized by:

1-oliguria (decrease urine production, quantified as less than 400 ml per /m² day in adults, less than 0.5ml/kg/hr in children or less than 1 ml/kg/hr in infants)

2-body water and body fluids disturbances; and electrolyte's derangement.

So acute renal failure is characterized by a rapid fall in glomerular filtration rate, clinically manifest as an abrupt and sustained rise in urea and creatinine. Life threatening consequences include volume overload, hyperkalaemia, and metabolic acidosis. Acute renal failure is both common and costly and carries a high morbidity and mortality.

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As it is often preventable, identification of patients at risk and institution of appropriate preventive measures are crucial. In incipient or established acute renal failure rapid recognition and treatment may prevent irreversible loss of nephrons. Acute renal failure resulting in retention of nitrogenous (urea and creatinine) and non-nitrogenous waste products⁽¹⁾. ARF may occur as isolated failure of the kidneys alone, with other organ systems functioning normally, or in association with multiple organ failure. The mortality of the latter group is considerably higher, especially with the growth in pediatric intensive care. For example, the mortality in neonates and infants is 51% after cardiac surgery for congenital heart defects, but only 3%–6% for children with intrinsic renal disease such as hemolytic uremic syndrome (HUS) in developed countries⁽²⁾.

PATIENTS AND METHODS:

A prospective study done in Central Teaching Hospital for children from January 2006 to December 2006.

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All patients with suspicion of acute renal failure who admitted to emergency department had detailed history, complete physical examination; all needed laboratory investigations and imaging study.

To define patient with RF we depend on, the Acute Dialysis Quality Initiative (ADQI) group published the RIFLE classification of ARF, based on changes from the patient's baseline either in serum creatinine level or glomerular filtration rate (GFR), urine output (UO), or both. ⁽³⁾

The RIFLE classification of ARF is as follows:

Risk (R) - Increase in serum creatinine level X 1.5 or decrease in GFR by 25%, or UO <0.5 mL/kg/h for 6 hours

Injury (I) - Increase in serum creatinine level X 2.0 or decrease in GFR by 50%, or UO <0.5 mL/kg/h for 12 hours

Failure (F) - Increase in serum creatinine level X 3.0, decrease in GFR by 75%, or serum creatinine level > 4 mg/dL; UO <0.3 mL/kg/h for 24 hours, or anuria for 12 hours

Loss (L) - Persistent ARF, complete loss of kidney function >4 wk

End-stage kidney disease (E) - Loss of kidney function >3 months

To estimate the GFR we depend on Schwartz GJ formula ⁽⁴⁾ $GFR = K \times \text{height} / P \text{ Cr}$

Where is K=constant value and P Cr is plasma creatinine

BUN/CR ratio (both in mg/dl) ⁽⁵⁾ also calculated

1- Normal ratio: suggests intrinsic renal disease in setting of oliguria

2- >20: suggests prerenal azotemia, or GI bleeding.

3- <5: suggest liver disease, starvation, inborn error of metabolism

One hundred twenty patients collected within this period

All these patients divided according to

1- Age (infants, toddler & preschool and school age)

2- Sex

3- Type of presentation as acidosis, oliguria or anuria, polyuria fit, dehydration, vomiting and hypertension

4- GFR

5- Laboratory finding as blood urea, serum creatinine, serum sodium serum potassium, serum calcium, bicarbonate level, blood PH, GFR level, and imaging study.

6- Also according to underlying causes.

7- According to management modalities either conservative or PD.

Conservative treatment such as intravenous fluid replacement, antibiotics and other supportive measure.

RESULTS:

Most of patients were infant (93) 77.5% follow by toddler & preschool with (14)11.7% & only (13) cases 10.8% at school age group. From all these cases 77 male & 43 female with M/F ratio 1.7:1.

The types of presentation vary in different age group. 97 patients (80%) presented with acidosis, 93 patients (77.5%) with oliguria & 53 patients (44%) presented with dehydration, mainly in infant age group while hypertension is present in 9 patients (7.5%) mostly in school age group. Fits, vomiting, anuria or polyuria are presented in very small number of cases as shown in table 1.

Table 1: Distribution of patients according to clinical presentation

presentation	Infant 1 st year	Toddler & preschool 1 – 6 year	School 6 – 12 year	total	%
Acidosis	76	11	10	97	80
Oliguria	71	12	10	93	77.5
Dehydration	42	9	2	53	44
Hypertension	0	1	8	9	7.5
Fit; encephalopathy	6	2	1	9	7.5
Vomiting	12	0	0	12	10
Anuria	4	0	0	4	3.3
polyuria	0	0	1	1	0.8

GFR estimation by Schwartz formula shown that most of our patients 94 (78%) had GFR between 10-50ml/min as shown in table 2.

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Table 2: Distribution of patients according to Glomerular filtration rate levels

	< 10ml/min	10-50ml/min	50-70 ml/min
Infant	20	73	0
Toddler&preschool	0	14	0
School age	0	7	6
total	20 (16.6%)	94 (78.4%)	6 (5%)

The RIFLE classification of ARF applied on our patients and 25 patients (21%) with second grade (injured) as shown that 84 patients (70%) with grade three (failure) shown in table 3.

Table 3: Distribution of patients according to The RIFLE classification

	Risk	Injured	failure
Infant	1	22	70
Toddler&preschool	4	3	7
School	6	0	7
total	11 (9%)	25 (21%)	84 (70%)

The BUN/creatinine ratio is measured. The infant age group 66 patients (70%) had ratio > 20 and 26 patients had ratio 5 – 20, this mean that the prerenal ARF is

common in infant age group. But in school age group the ratio 5 – 20 is commoner, this mean that the intrinsic renal disease is commoner in this age group as shown in table 4.

Table 4: Distribution of patients according to BUN/Cr ratio

BUN/CR Mg/mg	Less than<5	5-20	>20
Infant	1	26	66
Toddler&preschool	0	6	8
School age	1	8	4
Total	2	40	78

The measurement of bicarbonate show that 83 patients (69.2%) had serum bicarbonate between 10 – 20 meq/l, 33 patients (27.5%) had serum bicarbonate below 10 meq/l while only 4 patients (3%) had normal range of bicarbonate.

The level of serum potassium is important in patients with ARF & regard as a one of indicator for dialysis especially if associated with ECG changes, there were 68 patients (58%) of cases had normal serum potassium, 37 patients (30%) had hyperkalemia & only 15 patients (12%) had hypokalemia.

Measurement of the serum sodium shown that there were 16 patients (13%) had hyponatremia, 70 patients (59%) had isonatremia & 34 patients (28%) had hypernatremia from them 31% of infants had serum sodium more than 150meq/l

while only 28% in toddler& presch. age group &7% in school age group.

The measurement of serum calcium showed that 55 patients (45.8%) had hypocalcemia, 51 patients (42.5%) had normal serum calcium, & only 14 patients (11%) had hypercalcemia.

The ultrasound finding showed that 102 patients (85%) had normal size kidney, 16 patients (13.3%) had hydronephrosis& hydroureter &only 2 patients (1.7%) had single kidney.

The causes of ARF vary also according to age. In infant age group GE, Sepsis & obstructive uropathy are the most common causes, but in pre school group, GE is the most common cause and in school age group the glomerular disease (NS, AGN) are the most common causes as shown in table 5.

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Table 5: Distribution of patients according to the underlying causes of renal failure

	Infant	Toddler & preschool	School
GE	47	8	0
Sepsis	29	0	0
HF	2	1	0
HUS	2	1	0
G6PD def.	0	0	1
Nephrotic syndrome	1	2	7
Acute GN	0	0	2
Obstructive uropathy	12	2	2
RTA	0	0	1

The way of handling of patients with ARF divided into two lines of treatment either conservative or dialysis. Conservative treatment (CON) used in 97

patients with failure (death) only in 5 patients (5.15%) & PD treatment used in 23 cases with death in 7 patients (30.51%) as shown in table 6.

Table 6: Distribution of patients according to management modalities

	CON				PD			
	success	%	death	%	success	%	death	%
Infant	77	79.38	4	4.12	16	69.5	6	26.08
Tod & preschool	10	9.3	0	0	4	17.39	1	4.43
School age	10	9.3	1	1.03	3	13.04	0	0
total	97	100	5	5.15	23	100	7	30.51

DISCUSSION:

A prospective study for children below 12 years with ARF, how admitted during a study period of one year. Most of cases were infant (77.5%), as what reported in other studies, Gokcay et al⁽⁶⁾ in Turkey found that infant constituted (79%) of the patients with ARF, while Srivastava RN et al⁽⁷⁾ in new delhi found that the spectrum and outcome of ARF were studied in 205 child aged between 1 month and 12 year, there were 145 boys and 60 girls (2.4: 1), 23% of patients were below 1 year and 49% between 1 – 4 year.

Jamal A et al⁽⁸⁾ in Pakistan found that the mean age presentation was 4.5 years with 56.7% of patients under the ages of 5 years. Also Arora P et al⁽⁹⁾ in India found that there were 51.9% of patients aged below 4 years.

Regarding the sex, our study showed male predominance, with M:F ratio 1.7: 1, similar to what reported by Jamal A et al⁽⁸⁾ that male predominance was noted in all ages with an overall M:F ratio 2.3: 1. Arora P et al⁽⁹⁾ found that there were 39 boys and 13 girls with ratio 3: 1, so also with male predominance.

The type of presentation vary in different age group but most of the infants cases presented with acidosis (80%), oliguria (77.5%) & dehydration in (44%) while hypertension mostly in school age

group (7.5%), or other presentation like fits, vomiting, anuria or polyuria are very rare. Arora P, et al⁽⁹⁾ in India found that all patients had severe renal involvement with anuria in 53.6% and oliguria in 46.4% at presentation also in Shah BV et al,⁽¹⁰⁾ found that the most common presenting feature was oligo-anuria (94.1%). So the type of presentation vary & affected by the cause of renal failure, the age of patients & the severity of renal failure.

The causes of ARF vary also according to age and according to the country with GE & Sepsis in infant & pre school group while glomerular disease (NS, AGN) in school age group in this study while Vivian M. Reznik et al⁽¹¹⁾ reported that the cause of the acute renal failure was primary renal disease in 17/50 children, cardiac disease in 19/50, and trauma/sepsis in 14/50. Acute gastro-enteritis, acute glomerulonephritis and hemolytic-uremic syndrome were the most common causes of ARF in study of Shaha BV et al⁽¹⁰⁾. Other different study like Kaballo BG et al⁽¹²⁾ in sudan found that Acute tubular necrosis (ATN) was diagnosed in (56%) patients. Jamal A et al⁽⁸⁾ in Pakistan found that the most common cause leading to ARF in younger age group was found to be hemolytic uremic syndrome [25(54.34%)] followed by

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septicemia [7(15.21%)]. In older patients renal calculus disease was the most common [22(30.13%)], Arora P, et al⁽⁹⁾ in India found that the hemolytic uremic syndrome (HUS) was the commonest cause of ARF (30.8%) followed by acute tubular necrosis (ATN) in 28.84% and acute glomerulonephritis in 19.23% & R COUNAHAN et al⁽¹³⁾ found that their was 72 episodes of acute renal failure were treated in 70 children aged up to 16 years. The commonest causes were renal hypoperfusion (31 cases), haemolyticuraemic syndrome⁽¹²⁾, glomerulonephritis⁽⁹⁾, septicaemia⁽⁵⁾, and congenital abnormalities⁽⁶⁾.

The way of handling of patients with ARF divided into two lines of treatment either conservative or dialysis. Conservative treatment used in 97 with failure only in 5 patients (5.15%) & PD treatment used in 23 cases with failure in 7 patients (30.51%) most of them in infant age group so the important and significant risk factor for mortality was age & the youngest patients showed a higher mortality rate. Most published studies of acute kidney failure in early life are small series of fewer than 25 patients, yet the mortality rate is high as In debra M. et al 2003 study, neonates and infants, aged 1 day to 1 year, represented 57% of the total nonsurvivor group. Debra M. Williams⁽¹⁴⁾, in China hospital reported that the the mortality was 6.25% for patients in nephrology department, but 65.51% in ICU ($p < 0.001$), and was 21.6% for patients in community-acquired ARF (CA-ARF), but 63.1% in HA-ARF ($p < 0.001$). Wang Y et al⁽¹⁵⁾, reported that the mortality rate of patients with acute renal failure was 28%.

The RIFLE classification of ARF applied on patients show 84 patients (70%) with grade three (F) (failure) follow by second grade (I) (injured) with 25 patients (21%) & last 11 patients (9%) with risk grade similar to these result to some instant found in Eric AJ Hoste et al⁽¹⁶⁾ found in his study that acute kidney injury occurred in 67% of intensive care unit admissions, with maximum RIFLE class R, class I and class F in 12%, 27% and 28%, respectively. While J. A. Lopes, et al⁽¹⁷⁾ for studying rifle criteria for acute renal failure his patients were categorized on serum creatinine or urinary output, or both and the criteria that led to the worst classification were used. A total of 126 patients were evaluated, according to the RIFLE criteria, 14.3% of all the patients were in the class R for ARF, 8.7% in the class I and 12.7% in the class F

The measurement of BUN/creatinine ratio is important & can help us to categorize patients to prerenal, intrinsic renal disease & liver disease. So

most of cases are prerenal (65%) especially in infant age group (70%) while (61%) of school age group from intrinsic renal disease. as we know that the causes of acute renal failure can be broadly grouped into three major categories. These are decreased renal blood flow (pre-renal causes; 40-70% of cases), direct renal parenchymal damage (intrinsic renal causes; 10-50% of cases,) and obstructed urine flow (post-renal or obstructive causes; 10% of cases.) Rachel Hilton BMJ⁽¹⁸⁾.

Metabolic acidosis which is a sign of ARF can be measured either with blood PH or with serum bicarbonate level.

The measurement of bicarbonate show that most of cases lies on are between 10-20 (69%) follow by (28%) lies below 10 while only 3% within normal range of bicarbonate

In ARF patients, the compensatory responses are inadequate both at a respiratory level and at a metabolic level. Understanding these abnormalities might assist physicians in making the correct physiological diagnosis and, perhaps, in avoiding unnecessary investigations or incorrectly targeted therapeutic interventions (acid-base status) Hanna JD et al⁽¹⁹⁾.

About serum potassium, renal failure is the most common cause of hyperkalaemia seen in the emergency department. In this study there was 58% of cases with normal serum potassium & 30% with hyperkalemia & only 12% with hypokalemia & hyperkalemia can be explain by presence of ARF but hypokalemia need to explain & this can occurred through GIT losses also Cremer and Bock et al⁽²⁰⁾ describe acute renal failure arising in several patients with known prolonged hypokalaemia where there was no obvious precipitant such as volume depletion or rhabdomyolysis so ARF can be occur in prolong hypokalemia.

Measurement of the serum sodium is important especially in dehydrated patients which affect the type of treatment used also the decision of time to start dialysis. their was 1/3 of infants⁽²⁹⁾ 31% had serum sodium more than 150 meq/l while only 28% in toddler & preschool age group & 7% in school age group & this affected by the causes of acute renal failure which affected by the age of the patients. R COUNAHAN et al⁽¹³⁾ found that only 7/72 patients were hypernatraemic 150 numol (mEq)/l, while 9/72 had plasma sodium concentrations below 125 meq/l & all other cases had normal sodium level which explain by the causes of ARF

About serum calcium: there was. (44%) with normal Ca⁺ level. (45%) with hypocalcemia & only (11%) with hypercalcemia.

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The ultrasound finding in patients with acute renal failure in this study showed that only 13%⁽¹⁶⁾ had hydronephrosis & hydroureter & only 1.6%⁽²⁾ had single kidney while R COUNAHAN et al (13) found that congenital abnormalities (6/72)(8%) resulting in ARF were posterior urethral valves (4/72 cases), dysplastic kidneys (1/72 case), and obstruction of vesicoureteric junction in a single kidney (1/72 case)

From this study we conclude that ARF occurred more in infancy age group with male predominance & most of the cases presented with acidosis, oliguria & dehydration. the main causes were GE (prerenal) in infancy & preschool age group & GN (intrinsic renal disease) in school age group, 3/4 of cases need conservative treatment & 1/4 need dialysis with failure rate 5.15%, 30.51% respectively. There was hyperkalemia, hypernatremia & hypocalcaemia in 1/3 of cases & only 13.33% had obstructed RF.

So ARF more occurrence in infancy age group need to pay attention in this age group and most of ARF are prerenal can be handle conservatively, other modality is peritoneal dialysis, and hemodialysis and hemofiltration other modes of dialysis, Should available in each nephrology and dialysis centers.

CONCLUSION:

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