

Renal Functional Reserve by Measuring the Creatinine Clearance in Children : Previously Diagnosed and Improved after Acute Renal Failure

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Abstract

Background : Acute Renal Failure (ARF) is a life threatening condition causing significant morbidity and mortality in children. Many studies on adult ARF survivors showed that renal insufficiency persisted after an attack of ARF. Children may be more susceptible to this injury due to immaturity and ongoing growth of the kidney.

Objective : This study was conducted to assess the renal functional reserve or detect any sign of renal injury in children after an episode of Acute Renal Failure

Methods : This prospective study was carried out in the Renal and Dialysis unit, Dhaka Shishu Hospital in 2007, January. Thirty patients were enrolled in this study by searching data held in the study centre.

Results : Thirty (30) patients were selected in this study. Among them 46.7% was in the group > 5-10 years, only 10.0% was in age group < 1 year and more than 10 years respectively. Male were 63.3%, female were 36.7%. Causes of acute renal failure were diarrhoea with dehydration 43.3%, septicaemia 20.0%, Haemolytic Uraemic Syndrome (HUS) 20%, Acute Glomerulo Nephritis (AGN) 10.0%, Henoch Schonlein Purpura (HSP) 3.3% and hepato renal syndrome 3.3%. During follow up Glomerular Filtration Rate(GFR) of the patients were in stage 1 in 76.7% cases, 10.0% in stage 2, 6.7% in stage 3 stage and in stage 4 & 5 3.3% cases. 23.3% patients were found with GFR between stage 2 to stage 5, who had ARF due to HUS and HSP. The incidence of hypertension and proteinuria was found in 13.3% cases of HUS.

Conclusion : The progressive nature of acute renal failure which may cause chronic kidney disease is an important observation.

Introduction

Acute Renal Failure is defined as sudden loss of the ability of the kidneys to excrete excess water, regulate electrolytes and acid base status and eliminate waste products from the body. It occurs in 2-3% of children admitted in all paediatric tertiary hospitals and as many as 8 % of infants in the neonatal intensive care units.¹ Recent studies in developed countries have shown, that ARF in children now a days result from complications of systemic disease such as multi-organ failure.² In the developing countries ARF still results from gastroenteritis and glomerulonephritis.³ A study in Bangladesh has shown that acute Tubular Necrosis, Haemolytic Uraemic Syndrome and septicemia are also the common causes of ARF.⁴ Optimal medical management and dialysis can reverse the derangements caused by ARF. Despite all these, mortality of ARF is still very high. In developed

countries, recent studies report in hospital death rates of about 30-46%.⁵ In the developing countries mortality rates approaches to 40-60%.³ Only a few studies report on long-term outcome and degree of residual renal impairment in the surviving patients and these studies are limited to few renal conditions. Many studies on adult ARF survivors showed that renal insufficiency persisted after an attack of ARF. The paediatric population, likewise, has not been studied so extensively.

Children may be more susceptible to this injury. Therefore follow up of a child who had an episode of Acute Renal Failure is needed to detect any deterioration of renal functional reserve which will alert the clinicians to design appropriate monitoring programs for such children.

Methodology

This prospective study was carried out over one year in the Renal and Dialysis unit, Dhaka Shishu Hospital in 2007, January. Thirty patients admitted with ARF and discharged after recovery, were enrolled in this study by searching data held in the study centre. Patients with Chronic kidney disease or with evidence of any congenital structural renal disease or obstructive uropathy were excluded. Parents signed a formal consent after explaining the benefit and purpose of the study. Patient's data such as age, sex, medical history and findings of physical examinations, laboratory data on admission and discharge were collected from their files. During follow up after 4 month of discharge the blood pressure (BP) was measured. Hypertension in a child was considered when BP value is > 95th percentile corresponding to age and sex. Investigations such as: S.Creatinine, Creatinine clearance (Crcl) and Urine R/M/E to evaluate the renal injury or renal functional reserve were done. Creatinine clearance (Crcl) is a convenient method for GFR assessment. Timed urine collection (24hour) is required. A blood sample for measuring the S. Creatinine around the mid collection period is needed.²

$$\begin{aligned} \text{Crcl} &= \frac{\text{UxV}}{\text{P x T x } 1.73\text{m}^2} \\ &= \text{ml/min}/1.73\text{m}^2 \end{aligned}$$

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(U= urine creatinine (mg/dl)

V=24 hour urine volume (ml)

P= S. creatinine (mg/dl)

T=1440(number of minutes in 24 hours)

Statistical analysis

Result was expressed as mean \pm standard deviation (SD) and frequency distribution. Percentages were calculated to find out the proportion of the findings. Further statistical analysis was done by computer software devised as the statistical packages for social scientist (SPSS). The results were presented in Tables, Figures, and Diagrams etc. For statistical significance difference and correlation test was done. A probability 'p' value <0.05 ($p < 0.05$) was considered as significant.

Results

A total of 30 patients were selected in this study. Out of which 19 were male, 11 were female and the age range was 1 month to 12 years. It was found that among the patients, highest percentage (46.7%) was in the group $> 5 - 10$ years, 33.3% in 1 to 5 years and only 10.0% was in age group < 1 years and more than 10 years respectively (Fig. 1)

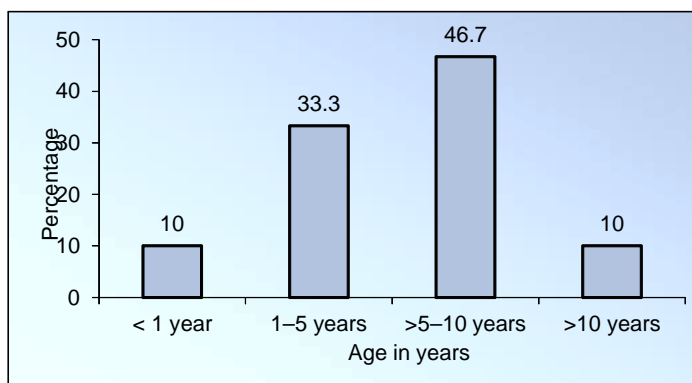


Fig 1: Age distribution of the patients

The male patients were 63.3%, female were 36.7% were female. Female male ratio was 1:1.7 (Fig 2).

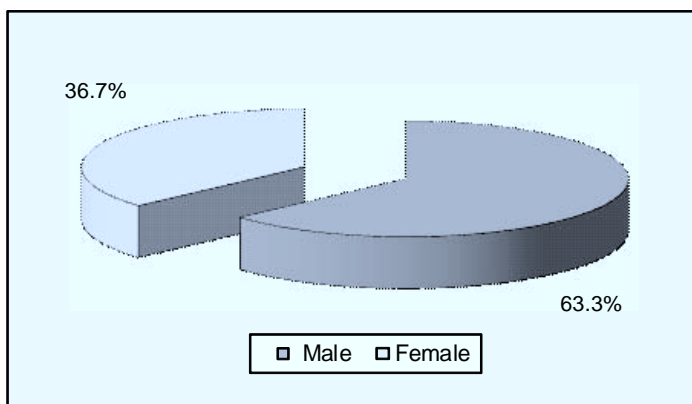


Fig 2: Sex distribution of the patients

Causes of acute renal failure were diarrhoea with dehydration 43.3% septicaemia 20.0%, HUS 20%, AGN 10.0%, HSP 3.3% & hepato renal syndrome 3.3% (Fig 3)

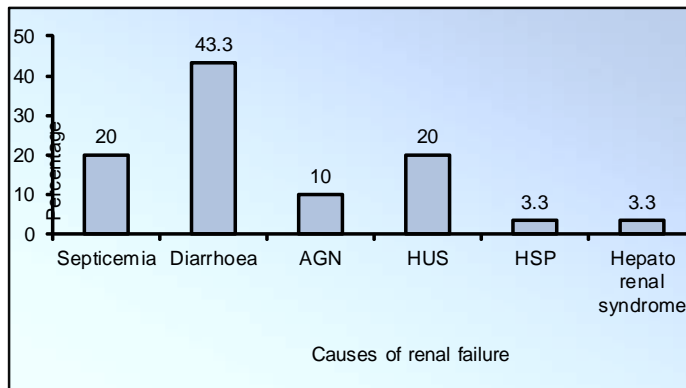


Fig 3: Causes of renal failure of the patients

The mean serum Creatinine was 233.3 ± 127.2 mmol/L ranging from 120 to 550 ml/min of the study subject during admission in the hospital (Table 1)

Table 1: Serum Creatinine of the study patients during admission with ARF

Serum Creatinine mmo/L	No.	%
>110 - <200	4	13.3
200-300	6	20.0
>300 - < 500	12	40.0
> 500	8	26.7
Mean \pm SD	233.3 \pm 127.2	
Range (min, max)	120,550	

Most of the patients were found in stage 1 (76.7%) followed by stage 2 (10.0%), stage 3 (6.7%) and stage 4 & 5 was (3.3%). 7 patients (6 HUS & 1 HSP) whose GFR was found between stage 2 to stage 5 had ARF due to HUS and HSP (Table 2)

Table 2: Status of GFR of the study patients during follow up

Stage	No.	%
1 (90 ml/min/1.73 m ²)	23	76.7
2 (60 - 89 ml/min/1.73 m ²)	3	10.0
3 (30 - 59 ml/min/1.73 m ²)	2	6.7
4 (15 - 29 ml/min/1.73 m ²)	1	3.3
5 (<15 ml/min/1.73 m ²)	1	3.3
Total	30	100.0

HUS(20.0%) and HSP(3.3%) are found as the cause of reduced GFR in the study patients (Table 3).

Table 3: Cause of reduced GFR of the study patients

	No.	%
HUS	6	20.0
HSP	1	3.3
Total	7	20.3

The incidence of hypertension and proteinuria was found in 13.3% cases of HUS

Table 4: Incidence of hypertension and proteinuria found in the HUS patients

	No.	%
Hypertension and proteinuria	4	13.3
No hypertension and proteinuria	2	6.7
Total HUS Patients	6	20.0

Correlation seen between serum creatinine and GFR:

Serum Creatinines of 30 cases during follow up are expressed in mmol/l and their GFR expressed in ml/min/1.73m². A significant negative correlation was found between Serum Creatinine and GFR (ml/min/1.73m²)

The value of Pearson's correlation coefficient was -0.880 and it is significant (p<0.001). Therefore, there was a linear negative association between Serum Creatinine and GFR (ml/min/1.73m²) in the study population.

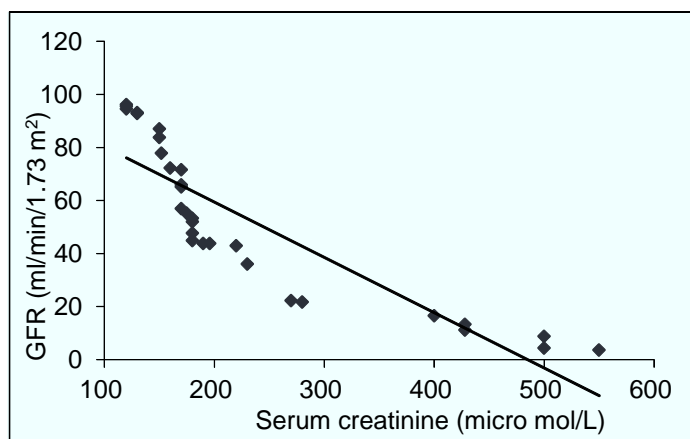


Fig 4: The scatter diagram shows significant relationship ($r=-0.880$) between serum creatinine (mmol/l) and GFR ml/min/1.73m²

Discussion

ARF is a serious complication of many diseases and may follow a number of medical or surgical therapies. The cause of ARF in children has changed substantially over recent decades. In developed countries, data showed that paediatric ARF has changed from primary renal disease to renal involvement secondary to other systemic illness. The most common causes of ARF in hospitalized children are renal ischemia (21%), nephrotoxic medications (16%) and sepsis (11%). Primary renal disease accounted for only 7% cases.³ In the developing countries ARF results mainly from infectious diseases including dehydration following gastroenteritis^{3,6}. A striking observation of this study was that 43.3% had acute renal failure due to diarrhoea with dehydration, 20% due to septicaemia, and 20% due to HUS, 10% due to AGN, 3.3% due to HSP and 3.3% due to hepato renal syndrome.

A study conducted in Children and Young People's Kidney Unit, Nottingham city hospital, UK to see the outcome of children after ARF showed that 49% maintained their normal renal function after an episode of ARF, 20% died, 8% developed CRF, 7% children had developed hypertension and proteinuria.⁷ In one of the first large series published on long term outcome of HUS, it was showed that of 124 patients almost half had persistent signs of renal disease and 18% progressed to ESRD⁸. O'Reagan et al reported that 30% of 37 children with HUS had significant impairment of GFR⁹. Another study showed that after 5 years 23% children surviving HUS developed renal sequels

such as proteinuria, hypertension and had reduced glomerular filtration rate.¹⁰ Patients with chronic renal insufficiency show a linear fall of creatinine clearance with time.¹¹ In this study we found that 23.3% patients who had reduced GFR: 10% had mild reduction of GFR, 6.7% moderate reduction, 3.3% severe and 3.3% progressed to ESRD. Patients who had decreased GFR, 20% were due to HUS and 3.3% was due to HSP. 13% cases of HUS also have renal sequels such as hypertension and proteinuria. This study also showed that these 26.7% patient all had S. Creatinine > 500 mol/l during their admission for which they had undergone peritoneal dialysis. A correlation between S. Creatinine and decreased GFR is seen in this study. The higher the level of S. Creatinine was during admission the incidence of decreased GFR is more.

Conclusion

Several studies on paediatric patients after ARF clearly illustrated that ARF in the paediatric patient is a significant risk factor for later morbidity and mortality. Therefore additional studies with children who suffered an episode of ARF due to any renal cause are needed to detect future risk for renal disease. Such children should under go regular follow up and measurement of creatinine clearance within the first few years at least annually for several years after the initial insult.

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