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Original Research Article

Efficacy of intermittent peritoneal dialysis in renal causes of acute kidney injury in children

Mashhura Huq[1]*, Shireen Afroz[2], Sabrina Akter[3], Moshrefa Newaz[4], Tahera Nasrin[5], Fahmida Hossain[1]

[1]Department of Paediatrics, Ad-din Women's Medical College, Dhaka, Bangladesh
[2]Department of Paediatric Nephrology, Bangladesh Shishu Hospital and Institute, Dhaka, Bangladesh
[3]Department of Pediatrics, Ad-din Sakina Women's Medical College, Jashore, Bangladesh
[4]Department of Pediatrics, Islami Bank Central Hospital, Dhaka, Bangladesh
[5]Department of Pediatrics, Ibn Sina Hospital, Jashore, Bangladesh

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***Correspondence:**
Dr. Mashhura Huq,
E-mail: mashhurahuq@gmail.com

ABSTRACT

Background: In low-resource settings like Bangladesh, intermittent peritoneal dialysis (IPD) has been identified as the preferred modality for the management of AKI. PD is a safe, simple and inexpensive procedure and has been used in pediatric AKI patients. However, its effectiveness in treatment of renal AKI warrants further exploration. To evaluate the efficacy of IPD in treating pediatric renal AKI patients**.**
Method: This prospective and interventional study conducted in the Department of Paediatric Nephrology at Bangladesh Shishu Hospital and Institute from January 2020 to December 2021. Children aged 1 month to 12 years of either sexes with renal AKI stages 2 or 3 who required PD were included. Each patient had IPD for 72 hours. Every day, the clinical and laboratory markers were measured; on the third day, or 72 hours later, the results were compared.
Results: Majority of patients were from 1-5 years age group and predominantly male. Following 3 days of IPD, clinical parameters (tachycardia, tachypnea and edema) improved significantly. Oedema found in 23 patients before PD, however, 5 patients got a relief from it ($p=0.016$) after PD. The urea reduction ratio in renal AKI patients increased from 19.3 to 40.7 ml/kg/hr days, with urinary output increasing from 0.02 to 0.50 ml/kg/hr at day 3 ($p<0.001$). After PD, there was a significant decrease in creatinine, urea, and potassium levels ($p<0.001$). Besides, a noteworthy improvement of 40.7%, 36.5% and 47.7% were observed in creatinine, urea and bicarbonate levels respectively.
Conclusion: IPD is well-effective in treating renal AKI in children by observing a greater improvement in clinical and laboratory parameters in the patients.

Keywords: Renal acute kidney injury, Intermittent peritoneal dialysis, Oedema, Creatinine

INTRODUCTION

In Bangladesh as well as throughout the world, AKI in children is a serious threat to health. Comprehending the pediatric AKI epidemiology in susceptible populations is crucial. Conditions causing AKI can be classified into pre renal, renal and post renal groups.[1,2] Renal AKI includes a variety of disorders characterized by renal parenchymal damage, including sustained hypoperfusion and ischemia.[3] Haemolytic uremic syndrome (HUS), acute tubular necrosis (ATN) due to bee sting, wasp bite, toxin, drugs and acute interstitial nephritis, post infectious glomerulonephritis (GN), rapidly progressive glomerulonephritis (RPGN), henoch- schonlein purpura (HSP) nephritis, lupus nephritis are the important causes of renal AKI in children.[4] Dialysis is an effective therapeutic modality for the management of AKI.[5]

Available dialysis modalities for AKI management are-intermittent peritoneal dialysis (IPD), intermittent haemodialysis (IHD), and continuous renal replacement therapy (CRRT).[6] Among them, IPD requires minimal equipment and infrastructure, is easy to perform, and remains the favored dialysis option in developing countries where modern facilities are not widely available.[7] In intrinsic renal causes, renal hypoperfusion has been severe enough to injure renal parenchymal cells, particularly tubule epithelium and ARF does not resolve immediately after the restoration of renal blood flow.

Extreme ischaemia can induce bilateral renal cortical necrosis and irreversible renal failure. Acute IPD is currently the best modality for managing AKI due to primary renal disease.[8] Garg et al, in 2020 suggested that IPD is effective in slow correction of solutes and can be used in patients with hemodynamic instability.[9] But they did not focus on the efficacy of IPD in different varieties of AKI. ISN (International society of nephrology) recently set a goal of eliminating preventable and treatable deaths from AKI by 2025, a "0 by 2025" campaign and stressed on making IPD more available in grass root level hospitals to achieve this goal. Many published literatures have shown the incidence, prevalence, etiology, and outcome of AKI in children.

Unfortunately, very little is known about the efficacy of peritoneal dialysis (PD) in children with AKI of different varieties. Therefore, this hospital-based study aimed to observe the efficacy of intermittent peritoneal dialysis in the management of renal AKI in children. This study result would show the importance of optimizing IPD throughout the country in managing most of the renal AKI in an attempt to reduce the mortality and morbidity of children.

METHODS

Children with AKI attending for the treatment between January 2020 to December 2021 in the Department of Paediatric Nephrology unit of Bangladesh Shishu Hospital and Institute were assessed for eligibility as the study population. Blood samples for arterial blood gas, serum creatinine, blood urea nitrogen, serum electrolytes were collected immediately during the first intravenous line insertion.

Patients were diagnosed as renal AKI from history and lab evidence (blood urea nitrogen: creatinine ratio <20:1). Peritoneal dialysis was done at the bedside in all patients. The indications of dialysis were AKI stage 2 or 3 with any ≥1 of the complications such as, oliguria/anuria for ≥12 hours followed by fluid overload refractory to diuretics, severe hyperkalemia refractory to medical management, severe, persistent metabolic acidosis, severe hypernatremia, not controlled by medical management, and uremia. Other investigations like ultrasonography of kub region, electrocardiogram, and chest X-ray were done accordingly. Urinalysis and cultures were performed in the patients after passing urine. They were also screened for Blood culture, ASO titre, complement C3, C4, ANA, anti-ds DNA, pANCA, cANCA, serum IgA and renal biopsy to confirm the underlying cause of AKI when necessary. Peritoneal fluid cytology and culture were done when needed. All patients received supportive therapy. Serum creatinine, blood urea nitrogen (BUN), ABG, and S. Electrolyte were repeated after starting dialysis at day 3 (72 hours).

To see the efficacy clinical and laboratory parameters were compared before (at day 0) and after dialysis (at day 3). Dialysis was continued if oliguria or anuria and azotemia persisted. After completion of 72 hours of IPD, if patient did not respond well, further decision for re-IPD or hemodialysis was taken. The procedure related complications were noted.

Statistical analysis

All the data were entered into the database of IBM SPSS on a personal computer. It was processed and analyzed by using IBM SPSS 26 version for Windows software. For all statistical tests, p value of less than 0.05 was considered statistically significant. The purpose, procedure, importance, and benefit of the study were explained to the parents or local guardians. Proper informed written consent from the parents or local guardian was taken. The ethics of this study were reviewed and approved by the ethical review committee of the hospital.

RESULTS

The study included 27 renal AKI patients, where the maximum was from 1 to 5 years. Most were male (74.1%), and mainly resided in urban areas (77.8%).

Among the 27 patients, 9 (33.33%) had Hemolytic uremic syndrome (HUS) and 7 (25.9%) patients had ATN due to wasp bite.

The main indication of PD was acidosis (96.3%). Other indications of PD were hypernatremia (n=2, 7.4%), volume overload (n=8, 29.6%), uremia (n=15, 55.5%), hyperkalemia (n=5, 18.5%) and pulmonary oedema (n=1, 3.7%).

In this study, the majority (85.2%) of the patients presented with oedema but with only 14.8% having no signs of oedema. Most of the patients (77%) were hypertensive and 66.7% patients had a normal pulse rate. Again, respiratory assessments showed that 73.9% exhibited tachypnea.

IPD significantly reduced oedema (p=0.016), but no significant difference was found in blood pressure (p=0.083). Tachypnea was present in 6 patients compared to 17 before PD (p<0.001).

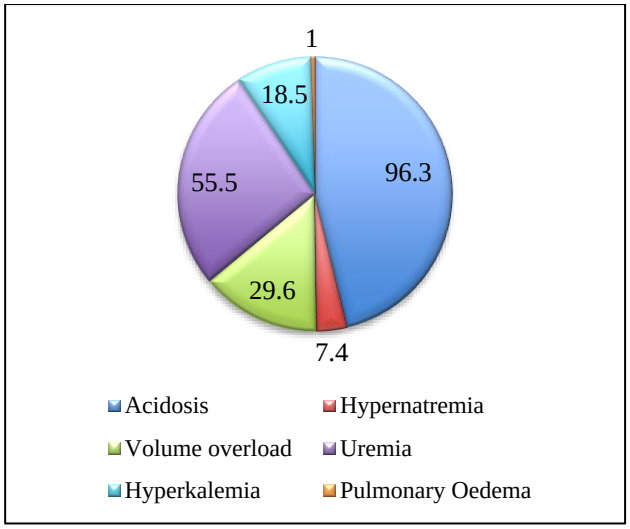

Figure 1: Indications of PD of the patients.

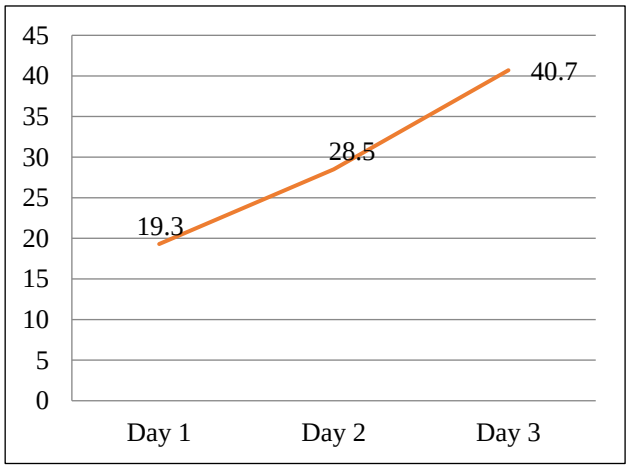

Figure 2: Urea reduction ratio in renal AKI patients.

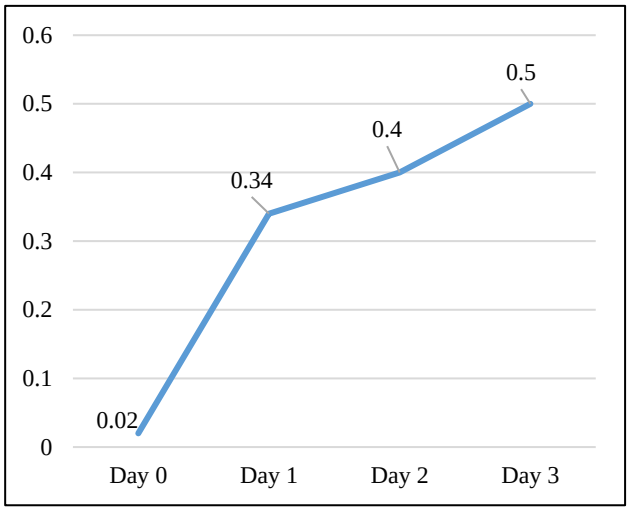

Figure 3: Distribution of patients by urinary output (ml/kg/hr).

There was no significant statistical difference in the median urine output between day 1 and day 2 (p=0.558).

However, by day 3, the median urine output of renal AKI patients was noticebly higher compared to day 2 and day 0 (p=0.003).

Comparison of laboratory parameters of patients in renal AKI showed that after PD, creatinine, urea and potassium level decreased from day 0 to day 3 (p<0.001). The pH, bicarbonate and sodium level significantly increased from day 0 to day 3 (p<0.001, p<0.043).

The urea reduction ratio at day 1 was 19.3 in renal AKI patients. At day 2 and at day 3, the urea reduction ratio was 28.5 and 40.7 respectively.

In patients, at day 0, the median urine output was 0.02 ml/kg/hr which increased to 0.34 ml/kg/hr on day 1, 0.40 on day 2, and finally 0.50 on day 3.

IPD significantly improved renal function in patients, as evidenced by improvements (in percentage) in creatinine, urea, and bicarbonate levels were all 40.7%, 36.5%, and 47.7% higher, respectively.

Table 1: Distribution of patients by socio-demographic characteristics (n=27).

Socio-demographic characteristics	Renal AKI (n=27)
Age	
<12 months	4 (14.8%)
1-5 years	14 (51.9%)
5-12 years	9 (33.3%)
Gender	
Male	20 (74.1%)
Female	7 (25.9%)
Residence	
Urban	21 (77.8%)
Rural	6 (22.2%)

Data were expressed as frequency (percentage).

Table 2: Etiology of renal AKI (n=27).

Causes of renal AKI	Frequency	%
Vascular cause		
Hemolytic uremic syndrome (HUS)	9	33.33
Glomerular cause		
RPGN	3	11.1
PSGN	1	3.7
Acute tubulo-interstitial nephritis (ATN)		
Wasp bite	7	25.9
Drug	3	11.1
Infection	2	7.4
Fish bile poisoning	1	3.7
Pigment nephropathy	1	3.7

Data were expressed as frequency (percentage). RPGN= Rapidly progressive glomerulonephritis, PSGN=post streptococcal glomerulonephritis, ATN=acute tubular necrosis.

Table 3: Distribution of patients by indication of PD.

Indication of PD for renal cause	Frequency	%
Acidosis	26	96.3
Hypernatremia	2	7.4
Volume overload	8	29.6
Uremia	15	55.5
Hyperkalemia	5	18.5
Pulmonary Oedema	1	3.7

Table 4: Baseline clinical parameters of study patients before IPD (n=27).

Clinical features	Renal (27)
Oedema	
Present	23 (85.2%)
Absent	4 (14.8%)
Pulse	
Normal	18 (66.7%)
Tachycardia	9 (33.3%)
Bradycardia	0 (0%)
Blood pressure	
Normotensive	1 (3.7%)
Hypotension	5 (18.5%)
Hypertension	21 (77%)
Respiratory rate	
Normal	10 (37.0%)
Tachypnea	17 (73.9%)

DISCUSSION

The clinical presentation and predominant causes of paediatric AKI vary in different regions of the world.[10] In this study, Hemolytic uremic syndrome (HUS) and Acute tubular necrosis (ATN) due to wasp envenomation were the predominant causes of renal AKI patients. Biljonre et al, ported a higher incidence of HUS and Afroza et al, expressed HUS, wasp envenomation and acute glomerulonephritis to be the common causes of renal AKI.[11,12] Mishra et al, also emphasized Hemolytic uremic syndrome and septicemia as most common causes of AKI in their study.[13,16] The majority of patients were older than 1 year. Among them 14 (51.9%) were from 1-5 years age group and 9 patients (33.3%) were above 5 years of age. An observational study was conducted at Dhaka Shishu (children) Hospital in critically ill patients. They showed among 441 cases of AKI, 67 were between 1 year to 5 years of age and 64 were older than 5 years.[14]

The main indication of PD was severe metabolic acidosis (96.3 %) in our study. We observed that volume overload (n=8, 29.6%), uremia (n=15, 55.5%) and hyperkalemia (n=5, 18.5%) were other common indications of PD in renal AKI. Usually, more than one indication co-existed in a patient at the time of initiation of therapy. Metabolic acidosis was noted as the commonest indication of PD followed by uremic encephalopathy in other studies, showed severe metabolic acidosis (5; 17.2%) and symptomatic fluid overload (8; 27.6%) as the common reasons for initiating PD.[15,16]

At baseline, oedema was more common among the study population. Following 3 days of peritoneal dialysis, noticeable improvement was observed in oedema control in compared to day 1. There was a great improvement in urine output after 24 hours, 48 hours, and 72 hours of peritoneal dialysis. After starting peritoneal dialysis, creatinine, urea, pH, bicarbonate and sodium level improved at 72 hours. Heperkalemia has been corrected significantly. Li et al and Mishra et al, conducted retrospective studies where they found blood urea and serum creatinine values decreased effectively throughout dialysis, indicating effective purification.[7,17]

Table 5: Comparison of clinical parameters of renal AKI patients before and after IPD (n=27).

Before PD	After PD			Total	P value
Pulse					
Normal	Normal	Tachycardia		18	0.004*
	18	0			
Tachycardia	8	1		9	
Total	26	1		27	
Blood pressure					
Normotensive	Normotensive	Hypertensive	Hypotensive	1	0.083
	1	0	0		
Hypotensive	3	2	0	5	
Hypertensive	0	0	21	21	
Total	4	2	21	27	
Respiratory rate					
Normal	Normal	Tachypnea		10	<0.001**
	10	0			
Tachypnea	11	6		17	
Total	21	6		27	

Continued.

Before PD	After PD		Total	P value
Oedema				
	Present	Absent		
Present	17	6	23	0.016*
Absent	0	4	4	
Total	17	10	27	

Data were expressed as frequency (percentage). *p<0.05 = statistically significant, **p<0.001 = highly significant

Table 6: Urine output (ml/kg/hour) values of renal AKI patients (n=27).

Day	Urine output median (IQR)	P value
Day 0 vs Day 1		
Day 0	0.02 (0.00, 0.1)	<0.001**
Day 1	0.34 (0.10, 0.70)	
Day 1 vs Day 2		
Day 1	0.34 (0.10, 0.70)	0.558
Day 2	0.40 (0.06, 0.96)	
Day 2 vs Day 3		
Day 2	0.40 (0.06, 0.96)	0.003*
Day 3	0.50 (0.14, 1.17)	
Day 0 vs Day 3		
Day 0	0.02 (0.00, 0.1)	<0.001**
Day 3	0.50 (0.14, 1.17)	

Data were expressed as median and inter quartile range. Statistical analysis was done by Mann Whitney U test. *p<0.05=statistically significant, **p<0.001=highly significant

Table 7: Comparison of laboratory parameters of patients before and after IPD (n=27).

Biochemical parameters	Mean±SD	P value
Creatinine		
Day 0	6.4 (5.1-9.2)	<0.001**
Day 3	3.8 (1.8-6.5)	
Urea		
Day 0	105.3 (77.0- 123.8)	<0.001**
Day 3	59.9 (33.6-88.8)	
pH		
Day 0	7.2±0.1	<0.001**
Day 1	7.4±0.09	
Bicarbonate		
Day 0	8.4 (4.0-11.3)	<0.001**
Day 1	14.3 (12.2-18.3)	
Sodium		
Day 0	138.7±9.7	0.043*
Day 1	142.8±4.1	
Potassium		
Day 0	4.9±1.1	<0.001**
Day 1	4.1±0.6	

Data were expressed as mean ± SD and median and interquartile range. Statistical analysis was done by Paired t-test and Wilcoxon signed-rank test. *p<0.05=statistically significant, **p<0.001=highly significant

Choudhary et al showed in their study that there was a meaningful improvement in acid-base parameters (pH, bicarbonate, and lactate) and blood urea and creatinine within 24 hours of PD which continued till the end of the procedure.[18] Abdullah, in a retrospective study, continued PD for 3 days and showed the efficacy of PD in terms of reducing blood urea nitrogen and serum creatinine was indicative.[19] In current study, urea reduction ratio also increased in a notable manner from day 1 to day 2 and then day 3. The mean of reduction (in percentage) of creatinine and urea were really lower in patients after PD.

CONCLUSION

The findings of this study showed that intermittent peritoneal dialysis is greatly effective in treating children's renal causes of AKI. By expanding the use of peritoneal dialysis nationwide, we can significantly reduce the mortality and morbidity associated with renal AKI in children in Bangladesh.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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