A Recent Experience About Pediatric Acute Dialysis in our Center

Merkezimizdeki Pediatrik Akut Diyaliz Deneyimleri

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ABSTRACT

OBJECTIVE: Acute renal failure is a life-threatening event in critically ill children. The dialysis modality depends on the clinical status of the patient and technical opportunities. We aimed to assess the renal replacement therapies (RRT) performed in children admitted to our center in a four-year period.

MATERIAL and METHODS: We retrospectively evaluated the data of children who received RRT in intensive care units in our center between January 2004 and September 2007. The anthropometric values, etiological factors, dialysis details, laboratory findings, medications, involvement of organs or systems other than kidneys and outcome of the patients were recorded.

RESULTS: There were 18 children (M/F:11/7) meeting the criteria aged between 3 days and 17 years. Seven of the patients were premature and three of them were very low-birth-weight infants Two patients received continuous hemodiafiltration, two received intermittent hemodialysis and the rest of them received peritoneal dialysis. The most frequent cause for RRT was increased serum creatinine levels. The mean duration of care in ICU before RRT initiation was 6.67±5.01 (0-18) days. The mean duration of continuous RRT in patients except the two who received intermittent hemodialysis was 154.31±102.29 (40-396) hours. The mortality rate was 83% (15/18) and the three survivors received short-term peritoneal dialysis, one of whom additionally received intermittent hemodialysis due to vancomycin toxicity. Two of them needed no pressors. Each patient had complications associated with the type of dialysis modality and catheters, but none solely leaded to mortality. All three very low-birth-weight infants received peritoneal dialysis via peripheral venous catheters.

CONCLUSIONS: Peritoneal dialysis is still an encouraging, simply performed RRT modality for acute renal failure, especially in small children. It is even accessible in very low-birth-weight infants through simple catheters. Sharing latest clinical experiences may encourage its use when other techniques are not available.

KEY WORDS: Acute renal failure, Renal replacement therapy, Children Intensive care, Renal failure

ÖZ

AMAÇ: Akut böbrek yetmezliği yoğun bakım hastalarında hayatı tehdit eden bir problemdir. Tercih edilecek diyaliz biçimi, hastanın klinik durumu ve teknik imkanlara bağlıdır. Bu çalışmada dört yıllık periyodda merkezimizde çocuklara uygulanan akut renal replasman tedavileri (RRT) değerlendirilmiştir.

GEREÇ ve YÖNTEMLER: Ocak 2004–Eylül 2007 tarihleri arasında Merkezimizde akut RRT alan çocukların verileri retrospektif olarak değerlendirildi. Antropometrik değerler, etiyolojik faktörler, diyaliz ile ilgili detaylar, laboratuvar bulguları, ilaç tedavileri, diğer organ tutulumları ve hastaların izlem sonuçları kaydedildi.

BULGULAR: Kriterlere uyan 3 gün–17 yaş arasında 18 hasta (E/K:11/7) mevcut idi. Hastaların yedisi prematüre ve üçü çok düşük doğum ağırlıklı idi. İki hastaya devamlı hemodiyafiltrasyon, iki hastaya aralıklı hemodiyaliz ve geri kalan hastalara periton diyalizi uygulanmıştı. RRT gerektiren en sık neden serum kreatinin değerlerinin artması idi. Hastaların RRT öncesi yoğun bakımda kalış süreleri 6,67±5,01 (0-18) gün idi. Aralıklı hemodiyaliz alan iki hasta dışındaki hastaların devamlı RRT alım süreleri 154,31±102,29 (40-396) saat idi. Mortalite oranı %83 (15/18) olup, sağ kalan üç hasta kısa süreli periton diyalizine alınmış, ikisinin pressör ihtiyacı olmamıştı. Bu hastalardan biri vankomisin aşırı dozu nedeni ile periton diyalizine ek olarak hemodiyalize alınmıştı. Tüm hastalarda diyaliz tipi

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ya da kateter ile ilgili problem yaşanmış olup bunların hiçbiri mortaliteye neden olmamıştı. Periton diyalizi düşük doğum ağırlıklı bebeklerin tümüne periferik venöz kateterler yolu ile uygulanmıştı.

SONUÇ: Periton diyalizi özellikle küçük çocuklarda halen akut böbrek yetmezliğinde sıkça ve kolaylıkla uygulanabilen bir RRT yöntemidir. Düşük doğum ağırlıklı yenidoğanlarda bile basit kateterler uygulanabilmektedir. Son klinik deneyimler, özellikle diğer tekniklerin kısıtlı olduğu durumlarda periton diyalizi kullanımını vurgulamak amacı ile paylaşılmıştır.

ANAHTAR SÖZCÜKLER: Akut böbrek yetmezliği, Renal replasman tedavisi, Çocuk yoğun bakım, Böbrek yetmezliği

INTRODUCTION

Acute renal failure (ARF) frequently occurs in critically ill children and infants. It may present as an isolated failure or as a part of multiorgan dysfunction syndrome (MODS) with a higher mortality rate (1,2). Once ARF occurs, early institution of renal replacement therapy (RRT) is required to improve survival rates (3). The optimal modality of choice may be established by understanding the underlying causes of ARF and MODS and recognition of the local expertise with respect to the personnel and equipment resources (4). Intermittent RRT can be performed with standard hemodialysis (HD) (5). Continuous RRTs include peritoneal dialysis (PD) and extracorporeal arterio-venous and veno-venous techniques (3). Every RRT modality has its own advantages and disadvantages (1,6). Intermittent HD has a high efficiency but cannot be used in hypotension. PD, a cheaper and simpler technique that is universally available, can be administered in hypotension and requires no anti-coagulation or vascular access, but has a moderate dialysis efficiency volume control. Continuous hemodiafiltration (CHDF) modalities have high efficiency, volume control and can be used in hypotension, but require anti-coagulation (1,2,7). In a study of the choice of RRT in children with ARF, it was demonstrated that the use of PD, HD, and CHDF among pediatric nephrologists was 30%, 20% and 40%, respectively (5). There is also an increasing trend towards CHDF techniques in recent reports of pediatric and infantile patients (2,8-10). However, current studies have not lead to a consensus about the optimal ARF therapy for children in intensive care units (ICUs) (1,2).

The choice of modality may be restricted with financial and technical issues in developing countries. We therefore aimed in this study to demonstrate the options of RRT in our country. Although there are recent publications about RRT in the pediatric ICU from our country (11,12), we analyzed the different RRT modalities administered in children in the ICUs of our hospital with additional limited CHDF experience and neonatal RRT.

MATERIAL and METHODS

Data of patients receiving RRT in any intensive care unit (pediatric ICU, neonatal ICU, cardiovascular ICU and anesthesia ICU) in Dokuz Eylul University Hospital under the consultation of the pediatric nephrology department with an age range of 1d - 18 years between January 2004 and September 2007 were evaluated retrospectively.

The data consisted of age, gender, height and body weight in addition to details about intensive care, including primary disorders requiring intensive care (post-operative period due to cardiac or other problems, metabolic, hepatorenal, sepsis, etc.), Pediatric Logistic Organ Dysfunction (PELOD) and Pediatric Risk of Mortality III (PRISM III) scores at first admission to ICUs, extrarenal organ-system involvements and survival. Data about RRT included blood urea nitrogen (BUN as mg/dL), serum creatinine (Scr as mg/dL) and glomerular filtration rate (GFR as mL/min/1.73 m^2) at the time of RRT initiation, previously indicated primary reasons for RRT initiation [oliguria (urine output < 1cc/kg/hour), anuria (urine output <0.5 cc/kg/hour), rising levels of BUN and serum creatinine levels to at least double that of the normal levels for age, electrolyte imbalance, inborn errors of metabolism (13)], inotropic or diuretic use before RRT, days in PICU until RRT initiation, dialysis modality (CHDF, intermittent HD or PD), type of the catheter used for dialysis, duration of dialysis, problems encountered during dialysis and reasons to terminate RRT.

PELOD scores were calculated to determine organ dysfunction (14) and the severity of illness was scored by PRISM III (15).Organ-systems other than the kidneys were evaluated and MODS was defined as at least one organ system affected due to the underlying primary disease process leading to acute renal failure (10,13). GFR was calculated by the Schwartz formula (16). The type of the catheters used for RRT [jugular/femoral catheter, branule (peripheric venous catheter), Cook acute PD catheter, Tenckhoff (surgically placed) peritoneal catheter] and the complications (fluid retention, overfiltration, leakage, catheter revision, peritonitis, catheter obstruction or clotting) were also noted. The intravenous catheters used for CHDF or HD and Tenckhoff PD catheters were inserted by surgeons. Acute PD catheters were inserted by the pediatric nephrologists.

In CHDF, PD solution (1.36% Baxter Dianeal solution) was used as dialysate solution with a flow rate of 1000 mL/hour and 0.9% saline with interchangeably added 1g Ca-gluconate/75 mEq $NaHCO_3$ per liter was used as replacement fluid with a flow

rate of 25cc/kg/hour. $MgSO_4$ was also infused from another line. Blood flow rates ranged from 50 to 100cc/hour. Anti-coagulation treatment, potassium replacement and ultrafiltration rates were arranged with regard to the current values. The priming volume (if needed) and the number of sets changed during the dialysis were also recorded.

Intermittent HD was performed via dialyzers with a surface area that was ¾ of body surface area and standard dialysis solutions with appropriate potassium and calcium content. The duration and the number of dialysis cycles were recorded for patients receiving intermittent HD.

PD was usually initiated with small volumes (10cc/kg) of 1.36% glucose solutions with a 10-min filling period, 30-min dwell period, and 20-min emptying period. Since the body weights of the patients were relatively lower and the cycle volumes were mostly smaller than the minimum needed for the automatic cyclers, we used manual circuits that required a higher medical and nursing support. We routinely used PD solutions including lactate and added 500 U/L heparin and 250 mg/L cefazoline to the solutions if no systemic antibiotic had been prescribed. Potassium content added to the solutions was arranged due to the serum potassium concentrations ([K]). No potassium was added if the serum [K] was > 6 mEq/L, 2 mEq potassium per 1L dialysis solution was added if the serum [K] was 4-6 mEq/L, and 4 mEq potassium per 1L dialysis solution was added if the serum [K] was <4 mEq/L (17). The dialysate glucose concentrations were increased to 2.27% or even 3.86% when the targeted ultrafiltration levels could not be reached. Dwell volumes were gradually increased up to 40cc/kg if tolerated in a few days. The filling volumes and glucose concentrations of PD fluids were noted for each patient.

RESULTS

There were 18 children (M/F:11/7) requiring RRT in ICUs of our hospital between the mentioned dates. There were 5 adolescent patients between 14 and 17 years of age. Two of them received CHDF (veno-venous), two intermittent HD, and one PD. The rest of all patients received PD.

Table I: The data of very low birth weight infants.

Baby no	BW (grams)	GA (weeks)	BoW at IOD (grams)	Age at IOD (days)	MODS
I	504	25	593	10	(+)
II	690	24	750	6	(+)
III	468	28	725	23	(+)

BW: birth weight, GA: gestational age, BoW: body weight, IOD: initiation of dialysis,
PD: peritoneal dialysis, MODS: multiorgan dysfunction syndrome.

Table II: The clinical data and outcomes of all patients.

P	Age (years)	G	Disorders requiring IC	PELOD	PRISM III	EOSI	Sur
1	14	F	CVS	41	26	5	Ex
2	14.5	M	HRS	31	13	4	Ex
3	17	M	HRS	10	9	0	Ex
4	14	M	Sepsis	10	13	0	Ex
5	10/365	F	Prematurity	31	22	4	Ex
6	6/365	M	Prematurity	21	12	2	Ex
7	23/365	F	Prematurity	40	23	2	Ex
8	5/365	M	GS (intestinal)	32	25	3	Ex
9	8/12	F	Asphyxia	41	41	4	Ex
10	1	M	CVS	10	7	0	Ex
11	16/365	M	Prematurity	21	14	3	Ex
12	14	M	CVS	30	27	3	Ex
13	3/365	F	CVS + GS (colostomy)	41	10	4	Ex
14	39/365	M	CVS	41	20	5	Ex
15	4.5	F	CVS	30	10	2	Ex
16	10/365	M	GS (urogenital)	10	2	0	√
17	13/365	M	IEM	20	5	2	√
18	25/12	F	CVS	22	17	4	√

P: patient, **G:** gender, **IC:** intensive care**, PELOD:** Pediatric Logistic Organ Dysfunction, **PRISM III:** Pediatric Risk of Mortality, **EOSI:** extrarenal organ-system involvement, **Sur:** survival.

F: female, M: male, CVS: cardiovascular surgery, HRS: hepatorenal syndrome, GS: general surgery, IEM: inborn errors of metabolism, ex: exitus, √: survivor

There were 5 patients between 1 month-5 years of age and one of these patients received HD along with PD. Eight of the patients were newborns, seven of which were premature and three of which were very low-birth-weight (VLBW) infants (<1000g). Clinical data of the three VLBW infants are shown in Table I. None of the newborns was younger than 48 hours of age, so Scr levels reflected their own levels rather than maternal Scr levels.

The primary reasons leading to intensive care, PELOD and PRISM III scores, the number of extrarenal organs or systems involved and survivals of the patients were summarized in Table II. 72% (n:13) had respiratory, 56% (n:10) had cardiovascular, 78% (n:14) had neurological, 28% (n:5) had hepatic, 83% had renal (n:15) and 22% (n:4) patients had hematological problems (Figure 1). In three of the patients, renal involvement was negative with regard to the PELOD score, which solely evaluates Scr levels (14). These three patients had normal Scr levels and received RRT due to hypernatremia, oligoanuria and inborn metabolic disorder, respectively.

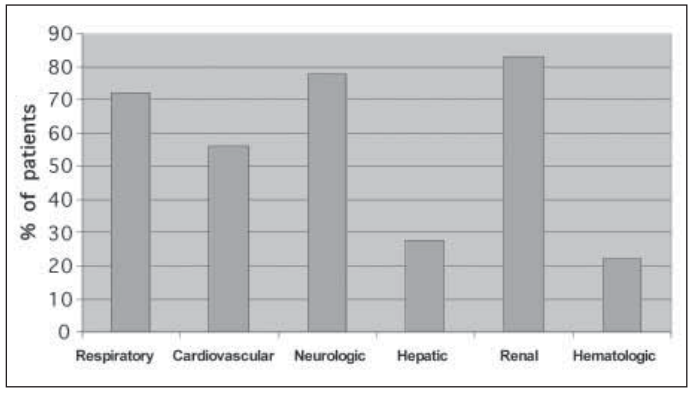

***Figure 1:** Organ/system involvement rates in our patients.*

Table III: The laboratory and clinical details of RRT.

P	BUN	Scr	GFR (mL/ min/ 1.73 m²)	OA	E. imb	>x2 Scr	In	D	TBD (days)	DM	CT	DD (hours)	DP
1	135	1,9	43.42	(+)	(-)	(-)	(+)	(+)	8	CVVHDF	Femoral	77	IV, VII
2	57	2,2	46.77	(+)	(-)	(+)	(+)	(+)	3	CVVHDF	Jugular	88	VII
3	144	8,06	15.28	(-)	(+)	(+)	(-)	(+)	13	HD	Femoral	16 cycles	VI
4	108	2,3	45.65	(+)	(-)	(+)	(+)	(+)	0	HD	Femoral	9 cycles	-
5	75	2,2	4.50	(+)	(+)	(+)	(+)	(+)	10	PD	Branul	40	I
6	62	2,6	4.06	(+)	(-)	(+)	(+)	(+)	6	PD	Branul	121	III,V
7	17	1,7	5.24	(+)	(+)	(+)	(+)	(+)	8	PD	Branul	95	III
8	34	1,7	9.317	(+)	(+)	(+)	(+)	(+)	1	PD	Cook	45	I
9	64	1,7	18.52	(+)	(+)	(+)	(+)	(+)	1	PD	Cook	121	I,III
10	66	1,70	15.88	(+)	(+)	(+)	(+)	(+)	0	PD	Cook	230	I,IV,V
11	80	0,6	28.50	(+)	(-)	(-)	(+)	(+)	15	PD	Cook	118	-
12	46	1,1	98.63	(-)	(+)	(-)	(+)	(-)	7	PD	Tenckhoff	109	I,II
13	47	2,35	6.319	(+)	(-)	(+)	(+)	(+)	4	PD	Tenckhoff	396	I,V
14	69,5	1,06	20.37	(+)	(-)	(+)	(+)	(+)	8	PD	Tenckhoff	226	V
15	81	2,33	20.06	(+)	(+)	(+)	(+)	(+)	17	PD	Tenckhoff	103	I,IV
16	8,7	3,62	4.10	(-)	(-)	(+)	(-)	(+)	10	PD	Tenckhoff	161	III
17	10	0,5	45	(-)	(-)	(-)	(-)	(-)	5	PD	Cook(x2)+ Tenckhoff	353	II,IV
18	106	2,9	14.22	(+)	(-)	(+)	(+)	(+)	4	PD +HD	Tenckhoff+ Femoral	186	I

P: patient, **BUN:** blood urea nitrogen, **Scr:** serum creatinine, **GFR:** glomerular filtration rate, **OA:** oligoanuria, **E.imb:** electrolyte imbalance, **>x2 Scr:** at least two-fold increase in serum creatinine level, **In:** inotropic usage, **D:** diuretic, **TBD:** time before dialysis, **DM:** dialysis modality, **CT:** catheter type, **DD:** duration of dialysis**, DP:** dialysis problems

CVVHDF: continious venovenous hemodiafiltration, HD: hemodialysis, PD: peritoneal dialysis, I: fluid retention, II: overfiltration, III: leakage, IV: catheter revision, V: peritonitis, VI: reversible occlusion, VII: clot formation in the sets,

Only three of the patients survived. One was dialyzed upon metabolic abnormality (MSUD), the second had major cardiac operation and additional iatrogenic vancomycin (VNC) intoxication and received both PD and HD in ICU, and the third had obstructive uropathy (posterior urethral valve) and surgical correction. They all received PD and none of them needed chronic PD.

The mortality rate was 83% and the high level was thought to be associated with the primary disorders requiring intensive care and associated problems. Four of the patients were premature neonates (three with VLBW), two had hepatic insufficiency, one had neutropenic sepsis and aspergillosis, one had candida sepsis, one infant was found suffocated in her bed and was near-dead when admitted, five of the patients had multiple congenital heart diseases, one neonate had abdominal surgery. Three of the patients had cardiopulmonary arrest before RRT initiation. The PELOD and PRISM III scores of the survivors and non-survivors were 17.33±6.42 vs. 28.67±11.72 and 8.0±7.9 vs. 18.13±9.25, respectively.

The laboratory and clinical findings regarding RRT are detailed in Table III. The reason for initiation of RRT was oliguria in 8, anuria in 6, electrolyte imbalance in 8 (hypernatremia in 2, hyponatremia in 3, hyperkalemia in 2, and hyponatremia + hypokalemia in 1), and at least two-fold high Scr levels in 14 patients (some had multiple causes). Three patients did not need inotropic agents and two of them survived). All received diuretics (any combination of furosemid, aldactone, and mannitol) except the two patients with adequate urine output (one with MSUD and the other with hepatorenal syndrome).

The mean duration of ICU stay before initiation of RRT was 6.67±5.01 (0-18) days. The mean duration of continuous RRT in patients except the two who received intermittent HD was 154.31±102.29 (40-396) hours. The patients receiving intermittent HD had 16 and 9 dialysis cycles. The reason for the termination of the dialysis was patient death in 11, improvement in renal functions and/or urine output in four, regain of electrolyte balance in one, metabolic improvement in one and a technical problem in 1 of the patients.

Internal jugular (n:1) or femoral (n:3) double lumen venous catheters were used in four patients for CHDF and HD. The femoral catheter was occluded in one patient and a new catheter was inserted to the opposite side. Of the 14 cases receiving PD, infantile size (15.25 inch, 38.9cm), double-cuffed Tenckhoff catheters (Quinton Swan Neck, Infantile Curl Cath, Tyco Healthcare, Mansfield, USA) were inserted with surgical techniques in six patients. 5 FG Cook catheters were placed percutaneously by the Seldinger method in five infants weighing 3.8-8 kg. In two of the patients, they were replaced by Tenckhoff catheters during the course of PD. In three VLBW babies, 18 FG branules with manually made holes of 1mm diameter were used (Figure 2).

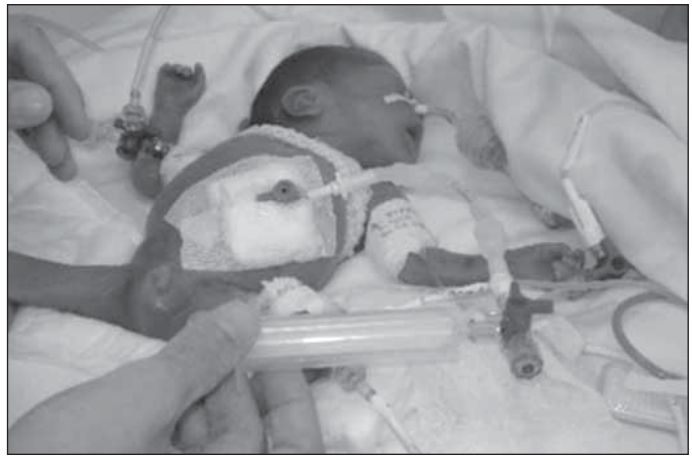

Figure 2: *A 750g infant dialyzed (Baby II = Patient 6) via a 16 FG branul with manually made holes of 1mm on it.*

Although becoming the most popular treatment of choice in critically ill children in recent years, CHDF was discontinued for the last 18 months of the study period in our hospital. Thus, only two of our patients could receive CHDF (Patients 1 and 2). The first one was a 14-year-old girl. She had a major cardiac surgery and had intracranial bleeding. She was dialyzed for 77 hours and during that period, she had clots in filters for four times and her femoral catheter was changed due to flow problems. The second patient was a 14,5-year-old boy with Budd-Chiari disease and atrio-mesenteric shunt. CHDF was performed for 88 hours and he had clots in filter and sets for three times during dialysis period.

After CHDF was suspended in our hospital, intermittent HD was performed in two of our patients who had convenient coagulation pattern for vascular access insertion and sufficiently high blood pressure levels providing dialysis through the pump (Patients 3 and 4). One of the patients was a 17-year-old boy with hepatorenal syndrome and his blood pressure was 110/90 mmHg at the initiation of HD. The other one was a 14-year-old boy with neutropenic fever and aspergillosis on the basis of non-Hodgkin lymphoma. His blood pressure at the initiation of HD was 126/79 mmHg.

Only one of our patients received HD along with PD (Patient 18). She had undergone cardiac surgery and received PD on her 4th post-operative day because of anuria and high levels of Scr. She was accidentally prescribed high doses of VNC for her lung infection and her BUN level was 97 mg/dL and Scr level was 3.8 mg/dL at that time. Serum free VNC level reached >80 μg/mL on the fourth day of the treatment. Her body weight was 10kg and neither a suitable venovenous hemodiafiltration membrane nor a high-flux membrane could be found for her. She was prescribed a HD program with a classical F3 (0.4 m^2) hemodialyser along with her PD for 2 hours in the first day and for 6 hours in each of the following three days. HD was stopped when serum free

VNC level decreased to 16 μg/mL Her urinary flow increased four days later, Scr levels decreased and PD was also stopped. No hearing loss was detected in the follow-up.

DISCUSSION

ARF requiring RRT frequently occurs in ICUs. The incidence of such cases is increasing among children because of the broadening of the indications, although ARF itself is an uncommon condition in children (4,18). In the past, ARF in children was most commonly associated with cardiac surgery, sepsis, and burns, while hematologic and oncologic complications, bone marrow transplantation, and pulmonary failure have become more common in recent years (19-21). Although our series reflects a recent four-year period, all but one of our patients had classical causes of ARF and only one patient had neutropenic fever and sepsis as a complication of oncological malignancy.

Children with ARF were traditionally treated with PD before 1995, but there has been a changing trend in the modality of acute dialysis in children and extracorporeal techniques are being increasingly used in pediatric ICUs, especially in children with MODS (3,8). In developing countries, the number of trained personnel and healthcare sources are limited. In our hospital, we had sufficient technical equipment and experienced nurses for institution of extracorporeal RRT, but we had to discontinue performing this technique both in critically ill children and adults due to hospital policy and insurance problems.

CHDF has the advantage of slow and controlled ultrafiltration, which minimizes the risk of hypotension and provides a more stable hemodynamic state (8,22,23). However, intermittent HD has the disadvantages of intermittent clearance, hypotension and further aggravation of renal injury and is not always a convenient option when adult hemodialysis units take care of the critically ill children (8,22,23). In contrast to the above theoretical advantages of CHDF, a previous study demonstrated that PD was safer than extracorporeal methods among children aged between 1 day and 15.5 years (24). In another study comparing the periods of RRT before and after the use of CHDF, no significant improvement in mortality was demonstrated and this was thought to be associated with the fact that more critically ill patients, especially patients with MODS were dialyzed with CHDF (8). Indeed, PD has its own advantages like being a continuous choice of therapy, eligibility in hemodinamically unstable patients and requiring no anticoagulation or vascular access (25). Acute PD catheters may be inserted at the bedside under sedation. Chronic PD catheters may be inserted at the operating room or at the bedside in ICUs (1). After assessment of an access providing a free flow in and out of the abdomen, the cycling of the prescribed volume of dialysate solution can be performed automatically or manually (26). We usually preferred manual PD systems since modification of the machine for acute dialysis catheters or small cycle volumes was not available.

Pressor requirement during the course of ARF treatment is a risk factor for mortality in children (4,21,27). All of our patients except for three needed inotropic agents. Fifteen of the 18 patients could not survive and two of the three survivors did not need inotropics. It is well known that concomitant MODS in children with ARF usually increases mortality rate to 60-100% even when treated with CHDF (19,27,28). Our two patients receiving CHDF also had MODS and could not survive. Our mortality rate was 83% and the high level was thought to be associated with the primary disorders requiring intensive care and individual additional medical problems.

Two of the three survivors of our series also had MODS and all three received PD. So, we believe that PD is still a helpful modality in critically ill children with MODS. Moreover, acute PD is a relatively inexpensive and technically more feasible modality of dialysis when compared to CHDF in developing countries (8). Thus, we have performed PD in most of our patients.

PD was complicated with dialysate retention, overfiltration, replacement requirement, and peritonitis in our patients. The uncommon experience in the study was the use of PD in premature infants including three VLBW neonates, the smallest one with a body weight of 593g and recovery of a patient from VNC intoxication under PD with the additional use of classical HD.

ARF in preterm infants is usually secondary to prenatal, perinatal, and/or postnatal conditions such as placental insufficiency, congenital cardiac anomalies, respiratory failure, necrotizing enterocolitis or cardiac surgery. These medical and surgical conditions result in poor renal perfusion and consequent renal failure (7,29-31). The most common indications for dialysis are anuria, intractable acidosis, hyperkalemia, and/or progressive azotemia (30,32). The indication for dialysis was primarily anuria in six of the premature neonates, and increased Scr levels in one neonate with obstructive uropathy.

The frequency of ARF among VLBW infants is 6-8% (30,31). Peritoneal dialysis is the treatment of choice in VLBW infants due to its relatively easy access and technical simplicity, but there are few cases reported in the literature (31-34). Technically, the large peritoneal surface area to body weight ratio increases the dialysis efficiency, but increased peritoneal membrane permeability due to sepsis or peritonitis and poor cardiac output may decrease the efficacy (30,31,33,34). Moreover, providing an access for PD in VLBW infants was more difficult than in older infants. These babies have inelastic abdominal walls leading to a high incidence of leakage in both acutely or surgically inserted catheters (31). In our VLBW infants, we used peripheral venous catheters with manually made holes, since we had no other catheters of convenient size. This was a historical but effective method for peritoneal catheterization (33). We had dialysis fluid

retention in one, leakage and fungal peritonitis in one and leakage requiring revision in one of these VLBW infants (Table 1).

VNC is a commonly prescribed drug in critically ill children. It is rapidly removed by the kidneys in healthy individuals, while its overdose is a severe problem in patients with renal failure leading to hearing loss (35). HD with traditional membranes and PD are believed to be ineffective in removing VNC both because of its high molecular weight and protein binding (36). Charcoal hemoperfusion, high-flux membranes, and continuous RRT modalities are efficient in VNC toxicity (35,37,38). In our patient, the latter two choices of treatment could not be administered, since we could not obtain membranes of appropriate sizes. At the end of 4 cycles of HD with a traditional membrane along with continuous PD, serum free VNC levels decreased to normal levels. This may prove to be beneficial regarding treatment choices in case of technical limitations.

CONCLUSIONS

Although CHDF is the preferred treatment modality of choice for patients in ICU with regard to the hemodynamic stability it provides, it is not always easy to achieve required technical or financial support, especially in developing countries. In this study, we reported our cases with ARF mostly treated with PD and coincidentally, most of them were newborns or toddlers. We obtained sufficient metabolic control and moderate fluid balance in these patients. We also shared our experience about three VLBW infants receiving PD via a very simple catheter. In conclusion, we may say that PD is still an applicable and useful modality of choice for ARF in the management of critically ill children and VLBW infants even with MODS.

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