

# Peritoneal Dialysis in Neonates: A Five-Year Experience

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## ABSTRACT

**Background:** Peritoneal dialysis is an applicable method for children and even neonates. Moreover, it allows the quiet excretion of fluid and soluble substances without hemodynamic instability. Peritoneal dialysis can be continued easily in hospitalized infants. However, the question is whether peritoneal dialysis is an effective procedure to replace hemodialysis in neonates or not?

**Methods:** The population of this study included all neonates who were admitted to the Neonatal Intensive Care Unit of Children's Medical Center Hospital, Tehran, Iran, and underwent peritoneal dialysis during 2012-17. The data were collected using a questionnaire. Subsequently, the underlying diseases, complications, and laboratory changes were determined before and after peritoneal dialysis.

**Results:** In total, 29 neonates who underwent peritoneal dialysis were evaluated in this study. Peritoneal dialysis was performed on 58.6% and 41.4 % of the cases for congenital metabolic disorder and extra body fluids, respectively. Moreover, electrolyte disorders and uremia were observed in 13.7% and 13.8% of the total cases, respectively. Several indications were seen in some infants. Dialysis failure was seen in 79.3% of the cases, most of which were due to dialysis catheter obstruction; however, the mean changes in potassium, sodium, urea, creatinine, acidosis, ammonia, and phosphorus were significant 72 h after dialysis.

**Conclusion:** This study showed that peritoneal dialysis faced several failures in newborns; however, metabolic disorders, electrolyte imbalance, uremia, and extra body fluid were resolved. Moreover, it is considered a vital and effective way for the treatment of newborns, especially in low-resource countries in which hemodialysis cannot be performed easily.

**Keywords:** Newborn, Peritoneal dialysis, Renal dialysis

## Introduction

Acute renal failure is one of the serious problems of newborns admitted to neonatal intensive care units (NICUs), which is treated by conservative therapy; however, some cases require dialysis. Hemodialysis is an appropriate method for these patients; nonetheless, due to some difficulties, the tendency for peritoneal dialysis is increased (1). In peritoneal dialysis, body water excess is removed by an osmotic gradient due to the high concentrations of dextrose in the fluid of dialysis, and the extraction of extra material is facilitated by diffusion from peritoneal capillaries to dialysis fluid. This method is technically easy and can be used continuously in hospitalized infants when needed (2).

In addition, the lack of no need for vascular access and no use of anti-coagulants increase its acceptability (3). Although the insertion of the small size catheter for the newborns is still a problem (1), it is a simple method used for newborns (4), compared to hemodialysis, which can be performed without the need for high-tech facilities. Accordingly, it is a good choice in low-resource countries (5, 6). With this background in mind, the question is whether peritoneal dialysis is an effective procedure to replace hemodialysis in neonates or not?

## Methods

The study population of this analytical cross-

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sectional study included all neonates admitted to the NICU of Children's Medical Center Hospital, Tehran, Iran, and underwent peritoneal dialysis from 2012 to 2017. The data were collected by reviewing the patients' medical files, dialysis forms, and nursing reports. The inclusion criteria were all neonates who had been hospitalized in the NICU of the Children's Medical Center Hospital, Tehran, Iran, during the mentioned period and needed peritoneal dialysis during treatment. On the other hand, the neonates with incomplete information and peritoneal dialysis cases in Cardiac Surgical Ward were excluded from the study. The decision for peritoneal dialysis was performed by a neonatologist, and it was confirmed by a pediatric nephrologist. The demographic characteristics of the infants and the mothers, such as maternal age, type of delivery, maternal care, gender, gestational age, birth weight, mean of admission time, causes of peritoneal dialysis, patient's age at the start of dialysis, pre-dialysis neonates weight, number of days of dialysis, potential dialysis problems, and patients' laboratory tests before, 12, and 72 h after dialysis were evaluated in this study.

Catheterization and dialysis processes were performed by a pediatric nephrologist in the NICU. In order to insert the catheter, a 0.5-1cm incision was performed 1 cm below the umbilicus after sterilization and lidocaine injection. Moreover, the hard catheters (peritocat; 1.5 2.7 200 mm peritoneal dialysis catheter, B. Braun Melsungen AG, Melsungen, Germany) were placed using a blind technique. Subsequently, the catheters were directed to the pelvis, and the peritoneal dialysis catheters were circularly sutured. Dialysate consisted of commercially available lactate based solution (Samen Pharmaceutical Co, IRAN).

The standard peritoneal dialysis solution contains 1.5 meq/L magnesium, 3.5 meq/L calcium, 35 meq/L lactate, 132 meq/L sodium, 102 meq/L chloride, and 15.0 Gm/L dextrose-H<sub>2</sub>O with total osmolality of 347 mosm/L.

Moreover, additional heparin (500 IU/L) and antibiotic (cefazolin 500 mg/L) were added to the dialysis fluid followed by potassium chloride based on the patient's blood potassium level.

Laboratory tests included the analysis of sodium, potassium, serum blood urea nitrogen, creatinine, calcium, blood gases, ammonia, phosphorus, and lactate. All of the lab tests were carried out at the laboratory of the Children's Medical Center Hospital, Tehran, Iran.

Dialysis complications included catheter obstruction defined as 1) a failure in the drainage

of the dialysis fluid without effective response to irrigation, 2) the peritonitis defined as  $\geq 100$  white blood cell/mm<sup>3</sup> with polymorph nuclear  $> 50\%$ , 3) positive smear or culture of peritoneal fluid, 4) leakage as wetness around the catheter site, 5) hemorrhage as bleeding in the peritoneal fluid that continued after multiple cycles, and 6) ascites as fluid accumulation in the peritoneal cavity which was created after dialysis and did not exist before.

### Statistical Analysis

The sample t-test was used to analyze the numeric data, and a p-value less than 0.05 was considered statistically significant.

### Ethical Considerations

This study was performed based on the ethical principles of the Helsinki declaration and was approved by the Ethics Committee of Tehran University of Medical Sciences, Tehran, Iran (ID:9311165012).

### Results

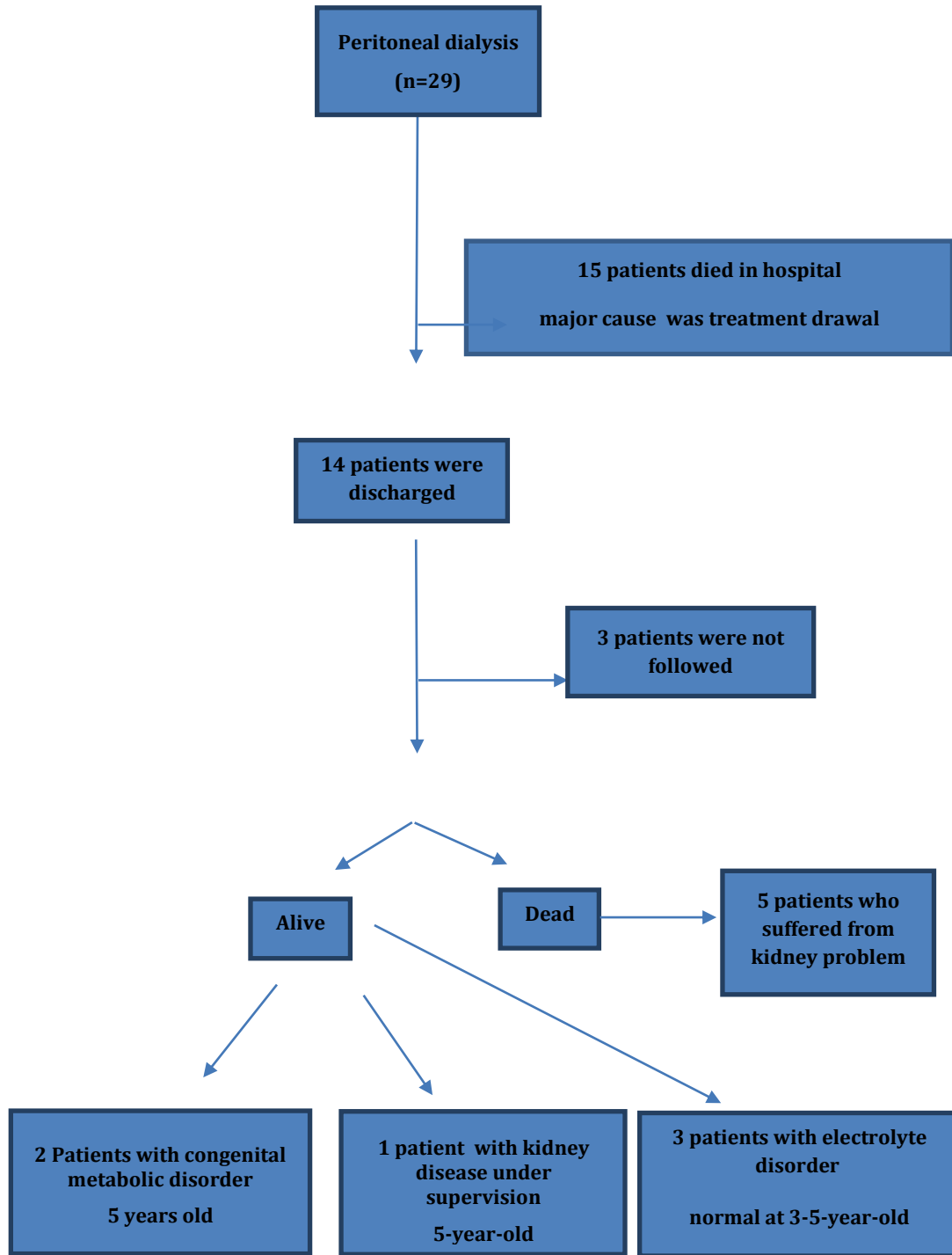
Out of 2460 infants admitted to the NICU of Children's Medical Center Hospital, Tehran, Iran, during 2012-17, 29 neonates underwent peritoneal dialysis during treatment. It is worth mentioning that the majority of the neonates were male (n=17, 58.6%). Moreover, 89.7% and 10.3% of the cases were term and preterm, respectively. Table 1 tabulates the demographic characteristics.

The underlying diseases in 58.6% of the dialysis patients were congenital metabolic disorders; moreover, its leading cause was hyperammonemia and 41.4% was due to severe fluid overload. In addition, electrolyte disorder and uremia were observed in 13.7% and 13.8% of the whole cases, respectively, and the hyperkalemia was the leading cause of electrolyte abnormality.

Several indications were observed in some of the newborns. In total, 79.3% of the cases suffered from dialysis failure of which catheter obstruction was the main reason (51.7%). Peritonitis involved 7 cases (24.1%) and Klebsiella species were the most common organisms. There was no correlation between the cause of dialysis and infection. The incidence rate of mortality was 51.7%, and 14 neonates (48.3%) were discharged. The leading cause of mortality was congenital metabolic disorders due to withdrawal from the treatment and parents' unwillingness to continue the study (Follow-up chart 1).

**Table 1.** Demographic characteristics

Variables	Mean	Maximum	Minimum	Standard deviation
Age(days)	7.28	15	2	3.5
Birth weight(gr)	3135	4250	1370	± 604.5
Pre-dialysis weight(gr)	3090	4530	1650	±780
Duration of dialysis(days)	9.2	26	1	± 3.5
Maternal age(years)	27.8	39	19	± 5.9



Follow-up Chart 1.

## Discussion

The results of this study showed the effectiveness of peritoneal dialysis despite the high rate of catheter malfunction (1). The leading cause of mortality was metabolic disorders due to withdrawal from the treatment and parents' unwillingness to continue the study because of low income and treatment high expenses. The best outcome was related to patients who had electrolyte disturbances due to feeding or care problems. Kidney problems were the worst outcome, and their survival rate was about six months. The cause of mortality was poor control of the disease at home. Therefore, there is a need to design a plan for home treatment until the neonates get ready for transplantation. The patients who survived and had congenital metabolic diseases suffered from neurodevelopmental delay despite a good response to dialysis that was related to delay in diagnosis.

Therefore, an accurate metabolic screening is required in our country, Iran. This study showed a high rate of dialysis failure (79.3%); however, the therapeutic goals in order to correct acidosis, electrolyte problem, hyperammonemia, hyper uremia were achieved in this study (Table 2). The catheter malfunction was a major problem; nonetheless, it did not disturb the goal of the treatment. Stojanović et al. conducted a study on 6 newborns who underwent peritoneal dialysis. They revealed that the small size of catheters for the newborn was an important problem for catheter insertion; however, peritoneal dialysis was a choice method in acute renal failure treatment among newborns (1). Moreover, Kara et al. studied 52 neonates who underwent peritoneal dialysis for 8 years. The complication was seen

in 59.6% of the neonates; however, this method was also effective in this study. In total, 76.9% of the neonates died due to underlying disorders. On the other hand, delay in initiating dialysis affected the mortality rate.

During follow up, out of 12 survivors, 10 patients had complete remission (7). The mortality rate in a study conducted by Hawkins was due to the primary causes as in the present study (8).

Pela demonstrated that peritoneal dialysis might be an appropriate device for eliminating plasma ammonia levels in metabolic disorders, which is in line with the results of this study. They described the earlier catheter administration accompanied with better results (4). The leading cause of peritoneal dialysis during a five-year experience in Mashhad, Iran, was the inborn error of metabolism as in our study, and the mortality rate was high due to underlying causes (40%). Khatami et al. described that continuous venovenous hemodialysis was more effective than peritoneal dialysis; however, it required specialized centers for performance. Therefore, peritoneal dialysis is an appropriate treatment for acute renal failure and metabolic toxicity, especially in neonates (9). Sadowski et al. recorded 33 infants less than 5 kg that underwent hemodialysis within 10 years. They introduced hemodialysis as a valuable alternative treatment when peritoneal dialysis was not appropriate (10). In the same line, Yildiz noted that peritoneal dialysis in hypernatremia renal failure was the preferred method of treatment. They described that the cost of this method is about one-third of that of hemodialysis and one-quarter of that of continuous arteriovenous hemodiafiltration (11) as Özlü showed (12).

**Table 2.** Mean changes before and after dialysis

Variable	The mean pre-dialysis	The mean changes 12 hr after dialysis	The mean changes 72 hr after dialysis	P value
Sodium meq/dl	149 ± 24.6	145 ± 20	140 ± 12	0.03
Potassium meq/dl	5.4 ± 1.6	4.4 ± 1.3	3.7 ± 0.7	0
BUN mg/dl	59.1 ± 71	46.4 ± 54	17.3 ± 19.8	0.01
Cr mg/dl	2.2 ± 2.3	2.1 ± 2	1.4 ± 1.1	0.02
PH	7.2 ± 0.13	7.3 ± 0.13	7.38 ± 0.11	0.01
PCO <sub>2</sub>	30.8 ± 10.4	34.5 ± 14	41.9 ± 23	0.08
HCO <sub>3</sub>	14.4 ± 6.5	16.6 ± 5.4	23.4 ± 6.6	0
base Excess	-10.2 ± 8.7	-8.5 ± 5.8	-1.03 ± 5.4	0
Ammonia micromol/l	549.6 ± 434	364.8 ± 281	232.9 ± 216	0.04
mg/dl Lactate	41.6 ± 27.3	48.6 ± 27.2	36.2 ± 15.7	0.12
Ca mg/dl	7.9 ± 0.9	8.3 ± 1.6	8.5 ± 1.4	0.24
P mg/dl	7.2 ± 0.13	7.3 ± 0.13	7.3 ± 0.11	0.001

## Conclusion

Peritoneal dialysis is a desirable method for dialysis in infants, which is technically easy and can be continuously administered to infants admitted to the NICUs. However, more extensive and multicenter studies are needed to obtain more accurate results. On the other hand, further studies are recommended to make a comparison between peritoneal dialysis and hemodialysis in neonates.

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## Conflicts of interest

None declared.

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