

# Chronic peritoneal dialysis in children with chronic kidney disease: An experience from a North Indian teaching institute

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## ABSTRACT

**Introduction:** Chronic peritoneal dialysis (CPD) is an important modality of renal replacement therapy (RRT) in children of all ages with end-stage renal disease (ESRD). We retrospectively assessed the clinical profile of children with chronic kidney disease (CKD) initiated on CPD at a tertiary care centre in Northern India. **Materials and Methods:** Retrospective data of 13 children with CKD and initiated on CPD between 2016 and 2019 were retrieved and analysed. The demographic and clinical profile, aetiology of CKD, method of catheter insertion, mode of dialysis, complications, and catheter survival rate were analysed. **Results:** The median age at the onset of the symptoms was 81 months interquartile range (IQR 11–90) and the median age at the diagnosis was 81 months (IQR 36–103). The median age at the initiation of CPD was 92.97 months (IQR 74.43–108.79). The median serum creatinine at the initiation of CPD was 6.3 mg/dL (IQR 4.25–8.4). During a total study period of 84 CPD months, we observed 16 catheter-related complications and a complication rate of 1 per 5.25 CPD months. The overall peritonitis rate was 1 episode per 13.66 patient-months (0.87 episodes per patient-year). The catheter displacement/migration was seen in 23% of the cases. The median duration of follow-up was 175 days (IQR 85–249) with the longest follow-up duration of 502 days. **Conclusion:** CPD is the modality of choice for smaller children with ESRD as venous access is difficult to achieve in smaller children. Complications especially related to infections are a major concern in addition to poor growth associated with ESRD.

**Keywords:** Children, chronic kidney disease, chronic peritoneal dialysis, peritonitis

## Introduction

Chronic peritoneal dialysis (CPD) is an important modality of renal replacement therapy (RRT) in children of all ages with end-stage renal disease (ESRD).<sup>[1]</sup> The exact burden of chronic kidney disease (CKD) and the need of RRT in children is unknown owing to the non-homogeneity of various registries across the

globe [Table 1]. Worldwide, in children aged less than 20 years, the median incidence of RRT is ~9 per million age-related population, whereas the prevalence is reported as ~65 per million age-related population.<sup>[1,2]</sup> Majority of RRT (80%) in children is performed in developed countries like North America, Europe and Japan where affordability is not an issue.<sup>[1]</sup> In developing countries, due to financial constraints or unavailability of RRT facility, the real impact of CKD in children is not exactly known.<sup>[3-5]</sup>

For children with ESRD, renal transplant ensures better growth and quality of life, however, the percentage of renal transplants

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Received: 03-02-2021

Revised: 01-07-2021

Accepted: 05-07-2021

Published: 05-11-2021

### Access this article online

#### Quick Response Code:



Website:  
www.jfmpc.com

DOI:  
10.4103/jfmpc.jfmpc\_250\_21

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**How to cite this article:** Tiewsoh K, Soni A, Dawman L, Peters NJ, Malik MA. Chronic peritoneal dialysis in children with chronic kidney disease: An experience from a North Indian teaching institute. J Family Med Prim Care 2021;10:3682-7.

**Table 1: Chronic kidney disease prevalence data from registries across the globe**

	NAPRTCS	ANZDATA	ESPN/ERA-EDTA	CKDRI
Country	North America	Australia + New Zealand	Europe	India
Year of beginning	1987-Transplants only 1992-RRT + Transplants	1991	2006-RRT	2006
Age range	≤20	≤17	≤14	≤18
Scope	≥ Stage 3	ESRD	ESRD	≥ Stage 3
Number of cases	7039 (1992-2010) 11,186 (1992-2011)	323 (2011-2016)	531 (2015)	948 (2006-2009)

\*NAPRTCS: North American Paediatric Renal Trials and Collaborative Studies, ANZDATA: Australia and New Zealand Dialysis and Transplant Registry, ESPN/ERA-EDTA: European Registry for Children on Renal Replacement Therapy, CKDRI: Chronic kidney disease registry of India

**Table 2: Demographic, clinical and laboratory profiles of children with chronic kidney disease**

Variables	Values
Age at onset of symptoms (months)	
Mean (SD)	60.61 (44.4)
Median (IQR)	81 (11-90)
Age at diagnosis (months)	
Mean (SD)	67.07 (43.14)
Median (IQR)	81 (36-103)
Serum creatinine at initiation of PD (mg/dL)	
Mean (SD)	6.97 (3.22)
Median (IQR)	6.3 (4.25-8.4)
eGFR at initiation of PD (mL/1.73 m <sup>2</sup> )	
Mean (SD)	7.18 (2.84)
Median (IQR)	6.45 (5.59-8.6)
Age at catheter insertion (months)	
Mean (SD)	82.38 (38.39)
Median (IQR)	92.22 (74.27-107.80)
Age at initiation (months)	
Mean (SD)	82.94 (38.52)
Median (IQR)	92.97 (74.43-108.79)
Weight at initiation (kgs)	
Mean (SD)	16 (5.75)
Median (IQR)	16.2 (15-18.9)
Height at initiation (cm)	
Mean (SD)	104.2 (18.82)
Median (IQR)	110 (95.6-114.3)
Body Mass Index at initiation	
Mean (SD)	14.79 (1.88)
Median (IQR)	14.32 (13.15-16.42)
Gap between insertion of catheter and initiation of dialysis (days)	
Mean (SD)	17.08 (10.96)
Median (IQR)	15 (12-23)
Follow-up duration (days)	
Mean (SD)	191.77 (139.77)
Median (IQR)	175 (85-249)
Time to onset of peritonitis (days)	
Mean (SD)	96.5 (128.39)
Median (IQR)	52 (11-137.5)

\*SD: Standard deviation, IQR: Interquartile range, PD: Peritoneal dialysis

in the paediatric age group in India is very small in number.<sup>[6,7]</sup> Hence, they are exposed to chronic dialysis in the form of peritoneal dialysis or hemodialysis (PD or HD), while awaiting renal transplant. Most of the paediatric renal transplants are from live related donors, as the cadaveric transplant programme or transplant registry is absent in India. The paediatric renal transplant experience from India depicts that the graft survival

ranges from 73 to 88% at 1 year and 71 to 86% at 3 years.<sup>[8-11]</sup> Haemodialysis and PD remain the bridge to renal transplant and the wait is often unending for want of financial support.

There are very few centres offering dedicated paediatric HD which is technically more challenging and requires close monitoring and skilled nursing support. Haemodialysis performed twice or thrice weekly with each session lasting for 3–4 h can contribute to considerable interruption of a child and family's normal life.<sup>[12]</sup> Home nocturnal HD is now emerging as a feasible option in developed countries. However, HD is far from being the modality of choice for RRT because of subnormal growth, delayed sexual maturation, poor quality of life and high cost.<sup>[11]</sup> Vascular access is a major technical problem faced by paediatric HD units. The complications related to dialysis are the main cause of mortality in developing countries and a majority opt out due to financial constraints.<sup>[13]</sup> More dedicated paediatrics HD units with trained personnel are the need of the hour for children with ESRD.

Unlike HD, CPD offers a near steady-state biochemical control with no significant risk of disequilibrium syndrome and freedom from repeated visits to the hospital and venous punctures. With very meticulous attention towards the aseptic technique, PD fluid exchanges are carried out 4–5 times a day. As an increasing number of children with CKD undergo RRT, adequate training of the primary care physicians and healthcare workers at the community level are important to improve their knowledge and skills as well as awareness of the associated complications, which will help in providing continued care of children on CPD, especially in low-income countries.<sup>[4]</sup> In addition, the training of caregivers is an important component of chronic PD to prevent the complications of peritonitis, exit site and tunnel infection.<sup>[14]</sup> The procedure and troubleshooting-related training, as well as the maintenance of asepsis, also need to be emphasised and it requires the involvement of a dialysis nurse and regular follow-up to check for compliance.<sup>[15]</sup> The availability of paediatric dialysate bags is also an issue, resulting in wastage and increased financial burden. In the developing world, PD acts as a successful bridge for children with ESRD awaiting renal transplantation.<sup>[16]</sup> Due to the lack of dedicated paediatric HD facilities in the rural sector, PD is the only option for people in remote areas, however, the recurring costs too are deterrents for the continuation of CPD.<sup>[13]</sup> Despite all these hurdles, the utilisation of PD is increasing in India.<sup>[16-19]</sup>

The commonly used techniques for PD catheter insertion are percutaneous, open surgical, and laparoscopic methods. The ideal method of PD catheter insertion is still debatable. The clinical outcome and the success rate of catheter survival depend on the catheter placement techniques. It has been seen that laparoscopic placement of PD catheter lowers the rate of peritonitis and the need for catheter revision was reduced in children who underwent omentectomy at the time of PD catheter insertion.<sup>[20-22]</sup> The commonly used technique for CPD is the open surgical method which is usually combined with omentectomy. The laparoscopic insertion is the only method that allows for direct visualisation of the intraperitoneal structures and its use is rapidly expanding.<sup>[23]</sup> We retrospectively assessed the clinical profile of children with CKD initiated on CPD at a tertiary care centre in Northern India.

## Materials and Methods

Retrospective data of 13 children with CKD attending the Paediatric Nephrology services at our institute and initiated on CPD between 2016 and 2019 were retrieved and analysed. The demographic and clinical profiles, aetiology of CKD, method of catheter insertion, mode of dialysis, complications, and catheter survival rate were analysed. Patients were labelled to have ESRD when their renal dysfunction had progressed to a point at which the homeostasis and survival could no longer be sustained by medical management alone and required initiation of dialysis. Peritonitis was diagnosed when at least two of the following were present: (i) clinical features consistent with peritonitis, i.e. abdominal pain and/or cloudy dialysis effluent, (ii) dialysis effluent white cell count above 100/ $\mu\text{L}$  or with over 50% of polymorphonuclear leukocyte in the differential count, and (iii) identification of infective organisms by dialysis-effluent Gram stain or culture. The peritonitis rate was reported as the number of episodes per patient-year.<sup>[24]</sup> The study protocol was approved by the Institutional Ethics Committee (IRB approval number: DRB-185-20). Data were entered in the Microsoft spreadsheet (MS Office, Microsoft Corp., Seattle, WA, USA) and appropriate statistical tests were performed.

## Results

### Baseline characteristics

Thirteen children (11 males) were initiated on chronic PD between 2016 and 2019. A majority of the children had congenital anomalies of the kidney and urinary tract (CAKUT) (84.6%), with posterior urethral valve (PUV) and hypoplastic/dysplastic kidneys being the most common subtype (38% each). Glomerulonephritis was seen in 15.38% of the cases. The median age at onset of the symptoms was 81 months (IQR 11 – 90) and the median age at diagnosis was 81 months (IQR 36–103) [Table 2]. The median age at the initiation of chronic PD was 92.97 months (IQR 74.43–108.79). The median serum creatinine at the initiation of chronic ambulatory peritoneal dialysis (CAPD) was 6.3 mg/dL (IQR 4.25–8.4). The median estimated glomerular filtration rate (eGFR) was 6.45 mL/min/1.73 m<sup>2</sup> (5.59–8.6). Most of our patients had anaemia, metabolic acidosis, hypocalcaemia,

hyperphosphatemia, hypovitaminosis D and hyperparathyroidism at presentation [Table 3]. A majority (61.54%) of the patients had received some form of RRT prior to being initiated on CAPD, with a major proportion of these patients (87.5%) having received HD prior to chronic PD initiation.

### Chronic peritoneal dialysis

Tenckhoff catheter insertion was done at a median age of 92.21 months (IQR 74.27–107.80) and dialysis was initiated after a median duration of 15 days. The youngest child was 8 months and 18 days old at the time of catheter insertion. Open surgical approach with omentectomy was used for surgically-placed catheters (8 out of 13) while the rest of the catheters (5 out of 13) were inserted percutaneously by the nephrologists. Only 2 out of 13 patients opted for automated peritoneal dialysis (APD) and the remaining patients were on CAPD. At least two caregivers were trained by the doctors and dialysis instructors prior to discharge. They were also taught to screen for turbid effluent and exit site erythema/or discharge. Hand hygiene practices were reinforced.

### Complications

During a total study period of 84 CPD months, we observed a total of 16 catheter-related complications and a complication rate of 1 per 5.25 CPD months.

**Infectious complications:** Peritonitis was seen in 30.7% of the patients (2 out of 5 in those with percutaneous-placed catheters and 2 out of 8 in those with surgically placed catheters;  $P = 0.325$ ). Overall, the peritonitis rate was 1 episode per 13.66 patient-months (0.87 episodes per patient-year). None of the patients on automated PD developed infection-related complications. The exit site infection was seen in 30.7% of the cases.

**Noninfectious complications:** Catheter displacement/migration (confirmed on abdominal roentgenogram/ultrasonography) was seen in 23% of the cases and required manipulation, either external or surgical. The catheter had to be reinserted in one case. Catheter malfunction was also found in 23% of the cases. Occlusion of PD catheter was seen in 7.6% of the cases.

### Follow-up

The median duration of follow-up was 175 days (IQR 85–249) with the longest follow-up duration of 502 days. One catheter had to be removed because of refractory peritonitis and the child was shifted to haemodialysis. Two children subsequently underwent a successful renal transplant. Two children died due to infection-related complications.

## Discussion

In this study, 13 children with ESRD were initiated on CPD and we observed a total of 16 catheter-related complications and a complication rate of 1 per 5.25 CPD months. Overall, the peritonitis rate was 1 episode per 13.66 patient-months.

**Table 3: Comparison of biochemical parameters at presentation and at onset of PD**

	At presentation	At PD initiation
Serum creatinine (mg/dL)		
Mean (SD)	3.12 (0.61)	3.09 (0.62)
Median (IQR)	2.8 (2.7-3.4)	3 (2.8-3.4)
Blood urea (mg/dL)		
Mean (SD)	221.3333 (118.2634)	146.3077 (72.42627)
Median (IQR)	171 (136-307.5)	127 (101-206)
pH		
Mean (SD)		7.3328 (0.106427)
Median (IQR)		7.369 (7.3-7.39)
Hb (gm/dL)		
Mean (SD)	6.651667 (2.018018)	7.030769 (1.234494)
Median (IQR)	6.5 (6.025-7.44)	6.7 (6.3-7.3)
Bicarbonate (mmol/L)		
Mean (SD)	10.38 (5.733516)	18.57273 (5.432327)
Median (IQR)	7.14 (7.07-12.07)	19.7 (15.5-23.1)
Serum potassium (mmol/L)		
Mean (SD)	5.02 (0.84)	4.78 (0.65)
Median (IQR)	4.75 (4.6-5.3)	4.79 (4.3-5.1)
Serum calcium (mg/dL)		
Mean (SD)	7.16 (1.69)	6.27 (1.35)
Median (IQR)	7.6 (5.85-8.1)	7.9 (7.3-8.1)
Serum phosphate (mg/dL)		
Mean (SD)	7.02 (6.3)	5.15 (2.01)
Median (IQR)	6.3 (5.6-7.55)	5 (4.1-5.6)
Serum ALP (U/L)		
Mean (SD)	329.46 (340.93)	242.62 (158.36)
Median (IQR)	222 (121-295.5)	190 (129-284)
S. 25 OH Vit D levels (ng/mL)		
Mean (SD)	18.01 (17.15)	38.55 (29.07)
Median (IQR)	10.01 (7.19-20.92)	26.75 (16.5-58.56)
S. PTH (pg/mL)		
Mean (SD)	608.03 (461.03)	554.84 (312.87)
Median (IQR)	550.85 (277.68-793.45)	546.7 (322.6-842.25)
S. albumin (g/dL)		
Mean (SD)	3.12 (0.61)	3.09 (0.62)
Median (IQR)	2.8 (2.7-3.4)	3 (2.8-3.4)

CAKUT was the most common underlying aetiology for CKD (84.6%) with PUV and hypoplastic/dysplastic kidneys being the most common subtype (38% each) followed by glomerulonephritis (15.38%). In our series of cases, two of the children had undergone surgical management for PUV in early infancy itself, yet they progressed to ESRD over the course of time.

The etiological distribution is similar to most other studies across the world.<sup>[21,23]</sup> In a study from India by Kamath *et al.*,<sup>[3]</sup> CAKUT was the most common aetiology of CKD. However, in a study by Prasad *et al.*,<sup>[16]</sup> chronic interstitial nephritis was the most common cause of ESRD. In a notable exception, data from the US showed that the leading causes of ESRD in children were primary glomerular disease (25.3%) which was almost equal to CAKUT (24.1%), cystic/hereditary/congenital disorders (14.3%), and secondary glomerular disease (12.4%). Among the younger children, CAKUT and congenital/hereditary/cystic disorders were the common cause of ESRD and in the older children, primary and secondary glomerulonephritis and other aetiologies were more common.<sup>[25]</sup>

The most common modality of chronic dialysis in children is peritoneal dialysis, especially in younger children where HD is not feasible.<sup>[26]</sup> Peritoneal dialysis was opted as a choice of RRT in majority when the option was provided to the family, as patients coming from remote areas did not have easy access to HD facility, and moreover, dedicated paediatric HD centres are scarce in our country. While PD is especially beneficial for patients coming from remote areas, round the clock availability of electricity, steady supply of peritoneal dialysis fluid bags and the availability of a separate room for peritoneal dialysis are major challenges. In our centre, only two of our patients could opt for APD.

The treatment success and sustainability of PD is usually affected by its related complications, both infectious as well as noninfectious complications which may lead to the discontinuation of the therapy.<sup>[27]</sup> Therefore, close monitoring of children on CPD for early identification and treatment of complications are necessary to maintain the proper functioning of the PD catheter.<sup>[28]</sup>

**Table 4: Comparison of CAPD cohorts**

	<b>Our study</b>	<b>Prasad <i>et al.</i><sup>[16]</sup></b>	<b>Sinha <i>et al.</i><sup>[19]</sup></b>	<b>Aksu <i>et al.</i><sup>[21]</sup></b>
Study period	2016-2019	1994-2004	2011-2014	1995-2005
<i>n</i>	13	30	23	93
Age (months)				
Median (IQR)	92.97 (74.43-108.79)	156 (96)	110.4 (36-198)	109 (51.6)
Mean (SD)	82.94 (38.52)			
Male: Female	5.5:1	1.5:1	2.85:1	1.06:1
Aetiology	PUV (38.46%) Hypoplastic/dysplastic (38.46%) PUV+Dysplastic kidney (7.69%) GN (15.38%)	Chronic interstitial nephritis (30%)	CAKUT (26.09%)	Urological diseases (49.6%) {VUR (22.6%)} Primary GN (25.9%)
Follow-up (CPD months)	82	438	-	2670
Peritonitis rate (episodes per patient-year)	0.87	0.58	0.85	0.66
Transplant	15.38%	23.3%	35%	34.4%
Mortality	15.38%	26.6%	17%	-

Given the conditions, the infection remains a major concern which causes significant morbidity and a need for frequent hospitalisation. The most serious complication of CPD is peritonitis, which increases the morbidity as well as mortality of children on CPD.<sup>[20]</sup> In our cohort, peritonitis was the most common presentation. The median time to the onset of peritonitis was 52 days after PD catheter insertion. During a total of 82 CPD months, 4 patients presented with peritonitis with 2 patients having peritonitis twice. The peritonitis rate of 1 per 13.66 patient-months (0.87 episodes per patient-year) was comparable to that found in a similar cohort in East India (0.85 episodes/year) and greater than that found in a study cohort from Lucknow, India (0.58 episodes per patient-year) [Table 4].<sup>[13,16,19]</sup> Globally, peritonitis is more frequently seen in children when compared to adults. The recent annual report of the North American Paediatric Renal Transplant Cooperative Study (NAPRTCS), which included data collected through January 2007, there were 3,892 episodes of peritonitis in 5,764 years of follow-up for an annualised rate of 0.68 (one episode every 17.8 months).<sup>[30]</sup> Data from a 25-year follow-up study from South Korea showed 0.43 episodes per patient-year of treatment while a 10-year follow-up study from Turkey showed 0.66 episodes per patient-year.<sup>[21,31]</sup> Peritonitis was seen in 30.7% of the patients. It was not seen in any of the children on APD which could imply poor hand hygiene among the caretakers as an etiological factor in peritonitis. This was also seen in the NAPRTCS annual data report, where the patients who received APD had a lesser frequency of peritonitis compared to those on CAPD.<sup>[30]</sup> Peritonitis rates were higher in percutaneously placed catheters (2 out of 5) as compared to surgically placed catheters (2 out of 8); however, it was not statistically significant ( $P = 0.325$ ).

The incidence of noninfectious complications such as mechanical and catheter-related complications are also encountered commonly which can lead to discontinuation of treatment. Hence, it requires close attention for a proper continuation of therapy.<sup>[27]</sup> Noninfectious complications such as catheter displacement/migration were encountered in 23% of the study population and required catheter repositioning. One catheter had to be reinserted.

The lack of dedicated paediatric HD centres in our country is similar to the rest of the developing world. Hence, the dialysis treatment of choice is CPD in children with ESRD and is considered a bridge to renal transplantation.<sup>[32]</sup>

In conclusion, CPD is the modality of choice for smaller children with ESRD as venous access is difficult to achieve in smaller children. It is also useful when access to a dedicated paediatric HD centre is not available. It is a home-based therapy for children undergoing RRT and acts as a bridge for renal transplants. Complications especially related to infections are a major concern in addition to poor growth associated with ESRD. By enhancing the knowledge and skills of caregivers and healthcare professionals by regular training, catheter-related complications can be minimised.

### Informed consent

Informed consent was obtained from all individual participants included in the study.

### Acknowledgements

None

### Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee at which the studies were conducted (IRB approval number: DRB-185-20) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

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