

## Research Article

# Prevalence of Infection and Non-infection Complications in Continuous Ambulatory Peritoneal Dialysis in Tertiary Children Medical Centre



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**Citation** Tahir A, Aldokhi MH, Moghtaderi M, Bazargani B, Abbasi A, Fahimi D, et al. Prevalence of Infection and Non-infection Complications in Continuous Ambulatory Peritoneal Dialysis (CAPD) Patients. Journal of Pediatric Nephrology. 2024; 12:E44900.

<http://dx.doi.org/10.22037/jpn.v12i1.44900>

### Article info:

Received: 02 Jan 2024  
Accepted: 23 Mar 2024  
Publish: 25 May 2024

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## ABSTRACT

**Background and Aim:** Continuous ambulatory peritoneal dialysis (CAPD) is a conventional treatment for children with end-stage kidney disease. All infectious and non-infectious complications should be detected early and managed because they may cause ultrafiltration, or Sout failure, or catheter failure. This study aims to investigate infectious and non-infectious complications of CAPD, such as mechanical and metabolic issues, at a children's medical center between 2020 and 2022.

**Methods:** A retrospective cross-sectional study was performed on pediatric patients with end-stage renal disease (ESRD) undergoing peritoneal dialysis at Children's Medical Center in 2020-2022. Data were collected from the medical records and files and entered into SPSS software, version 26 for analysis.

**Results:** The study included 30 participants with an average age of  $5.89 \pm 1.2$  years. Two-thirds of the participants were boys. Among the girls, 70% (7 of 10) and 80% of the boys (16 of 20) developed peritonitis. Bacterial infections were mostly observed in girls more than 2 times. Tunnel infections were observed in 10% of patients, three girls and one boy. Exit-site infection occurred in eight boys and one girl. Non-infectious complications, such as seizures, were observed in approximately 40% of patients. An inguinal hernia was observed in all male patients.

**Conclusion:** In our experience, the most common infectious complication observed in CAPD patients was bacterial peritonitis caused predominantly by staphylococcus aureus. Tunnel infection and exit site infection were also common, while the predominant non-infectious complication was hernia.

**Keywords:** Bacterial infection, Continuous ambulatory peritoneal dialysis, Catheter, Children, Complications



## Introduction

**C**hronic peritoneal dialysis (PD) is a highly effective and safe treatment option for children with end-stage renal disease (ESRD), particularly while waiting for a kidney transplant. This method is considered the best approach to manage their condition. Data from the North American Pediatric Renal Trials and Collaborative Studies indicate that a significant majority of infants diagnosed with ESRD (98%) are started on PD rather than hemodialysis, highlighting their preference for pediatric care [1]. However, infants under the age of two are at a significantly increased risk of catheter-related complications compared to older children. Hence, early initiation of peritoneal dialysis in infants is associated with a higher risk of catheter failure; however, the factors affecting catheter survival in this group are not well described. Most studies on risk factors and peritoneal dialysis catheter outcomes in children have either included all children up to 18 years of age or focused on those starting PD for both acute and chronic kidney failure [2]. Complications associated with PD catheters are frequent and more likely to occur when they are used longer. Lower-weight children face a higher risk of leaks; however, smaller initial dialysate volumes can help reduce this risk [3]. However, no significant difference was observed between the groups regarding sex, age at the start of PD, or the overall PD period [4].

Despite these complications, PD is often the preferred dialysis method for children needing renal replacement therapy (RRT) because it allows for a better quality of life, causes less disruption to daily activities, and supports growth. Recently, peritonitis treatment has become very effective. As a result, more focus has shifted towards managing non-infectious complications related to PD, which are now recognized as relatively more significant issues to address in these patients' care. Peritoneal dialysis can be safely performed in pediatric patients without severe complications, and non-infectious issues rarely require catheter removal or a switch to hemodialysis. Additionally, non-infectious dialysate leaks occur in more than 5% of patients but are often clinically insignificant [5]. They can be categorized as early complications occurring within 30 days, often related to the catheter, or late complications arising after 30 days, typically due to mechanical or surgical rupture in the peritoneal membrane. Recommended approaches can help mitigate the complications of peritoneal dialysis [6]. Hernias often develop due to increased intra-abdominal pressure and peritoneal defects caused by catheter placement, affecting up to 25% of patients with CAPD. The most

common sites of these hernias are around the umbilicus, near the catheter, and in the inguinal canal [7].

Encapsulating sclerosing peritonitis (ESP), or sclerosing peritonitis, is an inflammatory condition that results in a thick fibrous membrane on the peritoneum, affecting approximately 1% of patients on CAPD and increasing to nearly 20% after 8 years. Early signs include peritoneal thickening and calcification, with vague symptoms, such as abdominal pain and ultrafiltration failure. Early visceral and parietal involvement detection is crucial to reveal potential bowel complications [5].

## Materials and Methods

This retrospective cross-sectional study included children who underwent CAPD between 2020-2022. All patients underwent a TENCKOFF catheter insertion. All children were treated with dialysis fluid number 1 or 2 and extraneal fluid overnight. The diagnosis of CAPDP follows the 2016 International Society for peritoneal dialysis criteria, requiring two of three specific criteria for confirmation: Symptoms of peritonitis, turbid dialysate, abdominal pain, or fever; a white blood cell count in the peritoneal fluid greater than 100/mL with over 50% neutrophils; and a positive culture of peritoneal dialysis fluid. Peritoneal fluid samples were collected upon patient admission and analyzed in the laboratory for smear and culture, with results adhering to the American National Clinical Laboratory Standards [8, 9].

After obtaining ethical approval, patients' medical files were accessed. Data were collected from the medical records and files. Frequency and percentage were used to report qualitative (categorical) variables and to describe continuous variables, and Mean $\pm$ SD were used. Unrelated sample t-test was used to compare continuous variables in two groups and to evaluate the connection between two categorical variables. The chi-square test was applied, and if needed, Fisher's exact test was used. All statistical analyses were performed using SPSS software, version 26 at the 5% significance level.

## Results

A total of 30 patients with CAPD were admitted to the nephrology department of the [Children's Medical Center Hospital](#). The mean age at diagnosis was 5.89 $\pm$ 1.2 years, and patients who were followed up from the initiation of PD between 2020 and 2022 were included. [Table 1](#) presents the clinical characteristics of the patients. Twenty-three patients (76%) had bacterial peritonitis. Seventeen patients had gram-positive infections and six children

**Table 1.** Initial patient features at onset of CAPD

Features	No. (%) / Mean±SD		
	Patient <5 Years	Patient Above >5 Years	Overall
Age (y)	18	12	5.89±1.2
Sex	Female	2	10(33)
	Male	10	20(66)
Weight (Kg)	11.7	13.1	12.2±3.8
<b>Lab Data</b>			
BUN (mg/dL)	62.3	72.2	68.93±37.6
Creatinine (mg/dL)	4.9	7.1	5.4±2.8
PTH (pg/mL)	339	246	280.53±190
PLT (10 <sup>3</sup> cell/μL)	452	199	217±142
Hb (g/dL)	8.9	11.2	9.13±2.3
Vit D (ng/mL)	39.2	29.2	36.4±17.5
Sodium (mEq/L)	134.8	137.3	135.07±11.1
Potassium (mEq/L)	4.5	5.1	4.97±1.7
Calcium (mg/dL)	8.3	9.6	8.3±1
Phosphorus (mg/dL)	7.3	9.1	7.55±4

Abbreviations: CAPD: Continuous ambulatory peritoneal dialysis; BUN: Blood urea nitrogen; PTH: Parathyroid hormone; PLT: Platelet; Hb: Hemoglobin.

had gram-negative infections (*Pseudomonas*). Ten patients (33%) had fungal peritonitis. All fungal peritonitis occurred following bacterial peritonitis or simultaneously. Eight patients treatment failed, and the catheter was removed or changed. Common electrolyte disorders include hypocalcemia, hyponatremia, hyperkalemia, hypernatremia, and hyperphosphatemia. [Figure 1](#) shows the patients' underlying diseases. The most common underlying disease associated with CAPD was renal dysplasia, accounting for 20% of patients. Neurogenic bladder (14%), autosomal recessive polycystic kidney disease (ARPKD) (14%), and atypical hemolytic uremic syndrome (HUS) (6%) constitute the other common underlying diseases. Some patients had recurrent peritonitis and exit site infections. In 56% of patients, no residual kidney function was observed and in 43%, variable degrees of residual kidney function were observed. Our results identified hypertension and seizures in 50% (n=15) and 40% (n=12) of patients, respectively. Twenty-six patients had a hernia. Hemoperitoneum was present in five patients, pancreatitis in one patient, and hydrothorax in one patient. Many patients have more than one type of infection. One boy had six recurrent episodes of bacterial peritonitis and three episodes of fungal infections. The

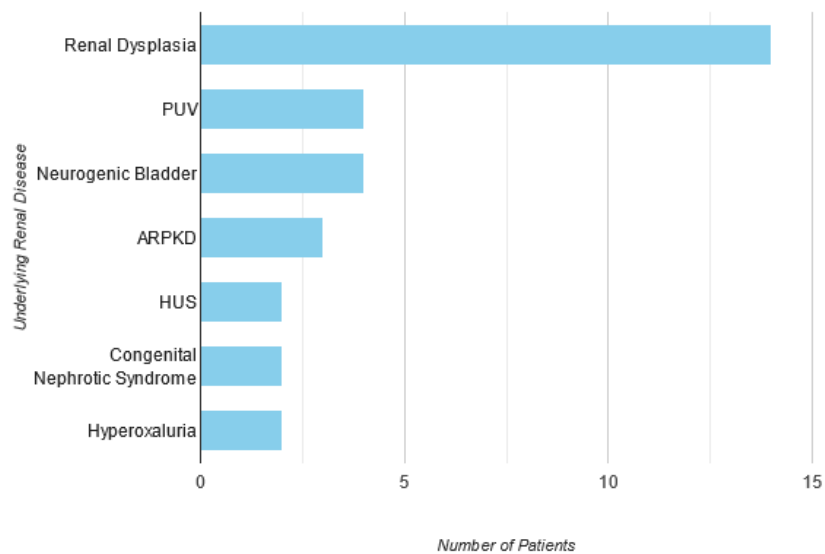
two girls were affected by bacterial peritonitis five times each. Half of the boys were unaffected by fungal infection, and only one boy was affected thrice. Eight boys were affected by exit-site infection only once, one boy was affected twice, one girl was affected by tunnel infection twice, and one was affected only once. Most complications occurred in children aged <5 years. Leakage was observed in three patients after catheter placement, and other leakages occurred at other times ([Table 2](#)).

## Discussion

Peritoneal dialysis (PD) is a favored and convenient treatment option for children with chronic renal failure [10-12]. This cross-sectional study revealed that the most common infectious complication observed in our patients with CAPD was peritonitis, predominantly caused by *Staphylococcus aureus* or *epidermidis*, followed by *Pseudomonas*. Tunnel and exit site infections are also common, while the most common non-infectious complications are hernia and leakage. Our results were similar to those reported by Abir Abdellatif et al. [13].

**Table 2.** The distribution of complications related to continuous ambulatory peritoneal dialysis

Complications	No. (%)			
	Patient <5 Years	Patient >5 Years	Overall	
Hernia	18	8	26(86)	
Peritonitis	17	6	23(76)	
Bacterial infection	Female	6	2	8(34)
	Male	11	4	15(65)
Acidosis	12	6	18(60)	
Exit site infection	12	5	17(56)	
Cardiovascular side effect	3	12	15(50)	
Hypertension	3	12	15(50)	
Death	11	3	14(46)	
Change to hemodialysis	1	12	13(43)	
Residual kidney function	10	3	13(43)	
Seizure	10	2	12(40)	
Transplant of renal	3	8	11(36)	
Fungal infection	Female	2	0	2(6)
	Male	6	2	8(27)
Technical failure	7	2	9(30)	
Tunnel infection	3	6	9(30)	
Catheter leakage	5	2	7(23)	
Alkalosis	1	1	2(6)	

**Figure 1.** Distribution of underlying renal disease in 30 patients

The mean age of patients starting PD was  $9.75\pm 4.67$  years. Among them, 69 experienced infectious complications, including six with hernias, seven with hemoperitoneum, and three with pancreatitis; no cases of hydrothorax were observed [13].

Significant variations are found among continents regarding infecting organisms. Europe shows a higher prevalence of gram-positive peritonitis, while Asia and South America, particularly Argentina, mainly experience gram-negative peritonitis. Factors, such as climate, humidity, the application of mupirocin cream for care at exit sites, and the age demographics of patients may contribute to the regional distinctions observed in culture results [14].

Peritonitis remains the primary cause of procedure breakdown in patients undergoing PD despite a decline in its rate over time in Canada. Recent investigations have shown that peritonitis-related procedure breakdown does not decrease overall [10]. Among our patients, six experienced technique failure and underwent hemodialysis. The mortality rate in our study was 46.6% due to complications and technical failure; 78.5% of the patients were under 5 years of age, and the chief reason for mortality was peritonitis. Research indicates that children who require RRT at a young age exhibit higher mortality rates than older children. Additionally, non-renal comorbidities are significant factors affecting these mortality rates [15].

Peritonitis is the leading cause of catheter revision during the first year of treatment. Additionally, studies have shown that it occurs more often in children aged 0-2 years than in older children and adults [11]. In 2006, Schroff et al. reported that the mortality rate of younger children undergoing dialysis was 10%, which increased to 17% over the entire follow-up period. This indicates that their risk of death was 2.7 times greater than that of older children on dialysis [16]. In our study, all complications were common in children aged <5 years old.

## Conclusion

PD is the preferred method for RRT in children awaiting kidney transplants. Its physiological benefits stem from its greater peritoneal membrane surface area relative to body mass than that of adults. While peritonitis is the primary complication associated with PD, hernias are the most frequent non-infectious issues. In certain centers, many complications can be treated conservatively, helping preserve the peritoneal membrane and avoiding catheter removal or replacement.

## Ethical Considerations

### Compliance with ethical guidelines

This study was approved by the Ethics Committee of **Tehran University of Medical Sciences** (Code: IR.TUMS.CHMC.REC.1402.018).

### Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

### Authors' contributions

All authors contributed equally to the conception and design of the study, data collection and analysis, interception of the results, and manuscript drafting. Each author approved the submission of the final version of the manuscript.

### Conflict of interest

The authors declared no conflict of interest.

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