Long-Term Outcomes and Survival of Peritoneal Dialysis Beyond 10 Years: A Single-Center Study

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ABSTRACT

Introduction: Long-term peritoneal dialysis (PD) beyond 10 years is uncommon and reflects both advances in dialysis care and the complexity of long-term patient management. The objective of this study is to describe the clinical characteristics, complications, and outcomes of patients undergoing peritoneal dialysis for more than 10 years, and to identify factors associated with long-term technique survival.

Methods: This is a retrospective, descriptive, and analytical study including 12 patients treated with peritoneal dialysis (PD) for more than 10 years between June 2006 and January 2024. Data collected included demographics, comorbidities, dialysis parameters, complications, and outcomes.

Results: The mean age at PD initiation was 45.5 ± 16.5 years. Tubulointerstitial nephropathy was the most common etiology of end-stage kidney disease. The mean duration on PD was 10.4 ± 0.9 years. During follow-up, residual kidney function significantly declined. Seven patients remained on PD at last follow-up. The peritonitis rate was low (0.024 episodes/patient-month), with favorable technique survival and no cases of encapsulating peritoneal sclerosis.

Discussion: PD beyond 10 years is feasible with proper patient selection, education, and follow-up. Preservation of residual kidney function and effective management of complications are key to long-term success, especially in non-transplantable patients.

KEYWORDS

peritoneal dialysis; 10 years; mortality; hemodialysis

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INTRODUCTION

Few patients with kidney failure remain on peritoneal dialysis (PD) for 10 years or more. The clinical outcomes of patients on PD depend on many factors, including age, presence of comorbidities, nutritional status, and the properties of the peritoneal membrane.

Few studies report a peritoneal dialysis survival of more than 10 years. Prolonged survival on PD reflects advances in treatment techniques but also presents significant challenges.

The objective of this study is to describe the demographic and progressive characteristics of patients on PD for more than 10 years.

MATERIAL AND METHODS

STUDY POPULATION AND DESIGN

Our study included 12 patients on peritoneal dialysis (PD) for more than 10 years due to end-stage chronic kidney disease (ESKD) in our PD unit between June 2006 and January 2024.

The patients' age, sex, body mass index (BMI), socioeconomic status, as well as sociodemographic characteristics (such as the presence of a person assisting with PD exchanges), and the indication for PD were examined from their medical records.

The duration of PD, as well as the presence of a history of hemodialysis (HD) or kidney transplantation before starting PD, were recorded.

Comorbidities such as cardiovascular diseases, hypertension, and diabetes were noted.

CLINICAL AND LABORATORY PARAMETERS

Measures of systolic and diastolic blood pressure, daily urine output, average daily ultrafiltration quantities as well as renal kidney function (RKF) for all patients were recorded at the start and during the final consultation. Serum values of urea, creatinine, calcium, phosphate, albumin, intact parathyroid hormone (iPTH), hemoglobin, and ferritin were obtained at the start of treatment and during the last follow-up.

The start of treatment for continuous ambulatory peritoneal dialysis (CAPD) was defined as the time after catheter placement and patient education, when they began using the standard 2 L four times per day CAPD regimen. The start of treatment for automated peritoneal dialysis (APD) was defined as the time when patients began PD with the required exchange volume, approximately 2 to 3 weeks after catheter placement.

We used a standard solution containing: 132 meq/L sodium, 3.5 meq/L calcium, 1.5 meq/L magnesium, 35 meq/L lactate,102 meq/L chloride. Glucose concentrations were adjusted according to the patient's volume status and intra-abdominal pressure (IPP).

Total daily clearance (peritoneal plus residual kidney) of peritoneal urea (Kt/V) and weekly creatinine clearance (WCC) were measured, along with a peritoneal equilibrium test (PET) during PD treatment. Body mass index (BMI) was defined as the body weight divided by the square of the individual's height.

DEFINITIONS OF COMPLICATIONS

Infections were classified as follows:

Exit site infections (defined by drainage, erythema, or pain at the exit site),

Tunnel infections (defined by swelling, pain, or tenderness with or without erythema over the catheter tunnel).

Peritonitis was defined by the presence of cloudy effluent with 100 white blood cells/L, of which 50% were neutrophils according to the ISPD guidelines (1).

Mechanical complications were recorded throughout the duration of peritoneal dialysis and classified according to ISPD guidelines as catheter migration, catheter dysfunction, catheter perforation, and peritoneal leaks. Catheter migration was defined as displacement of the catheter tip from the pelvic cavity, resulting in impaired dialysate inflow or outflow, potentially requiring conservative maneuvers or surgical intervention. Catheter dysfunction was defined as impaired inflow or outflow due to tip malposition, obstruction by fibrin, omentum, blood clots, or kinking, necessitating medical or surgical management such as repositioning, fibrinolytic therapy, or catheter replacement. Peritoneal leaks were defined as the escape of dialysate into subcutaneous tissue, pleura, or other compartments, diagnosed clinically or radiologically, often requiring temporary cessation of PD, reduction of dwell volumes, or catheter management. The relationship between mechanical complications and the duration of PD was also evaluated.

Factors associated with mortality were analyzed for all patients. Patient survival rates were calculated from the start of PD treatment until the end of PD therapy or until the end of follow-up (January 1, 2024).

PATIENT SELECTION AND TRAINING

Before initiating peritoneal dialysis, patient eligibility was carefully evaluated. In addition to the patient's preference, selection criteria included adequate cognitive and functional ability to perform exchanges correctly, absence of major abdominal surgery or hernias, satisfactory home hygiene conditions, and, when necessary, the availability of a caregiver.

All patients and their caregivers participated in a standardized training program conducted by specialized PD nurses. This program lasted an average of 5 to 7 days and combined theoretical and practical sessions on hand hygiene, mask use, exit-site care, preparation of exchange materials, and aseptic exchange techniques. Training was reinforced through visual demonstrations and supervised exchanges until full autonomy was achieved.

Patients were clinically and biologically assessed after 15 days, at one month, and then every three months during routine follow-up visits. Retraining sessions were organized every 6 to 12 months or after any infectious episode to reinforce proper technique. Home visits and periodic audits were also performed to ensure adherence to hygiene and exchange procedures.

Written and visual educational materials were provided in Arabic and French to standardize training and ensure comprehension. These included posters and wall displays within the PD unit, illustrated flyers summarizing key steps of exchange procedures, slide presentations used during training sessions, and therapeutic education courses designed to reinforce adherence and infection prevention practices.

ETHICS STATEMENT

Informed consent has been obtained, that studies have been performed according to the Declaration of Helsinki, and that the procedures have been approved by the local ethics committee.

STATISTICAL ANALYSIS

All quantitative variables were expressed either as mean ± standard deviation or as median with interquartile range, while qualitative variables were expressed as number (percentage). Student's t-tests and ANOVA were performed to determine differences between groups. A binomial test or chi-square test was used for the comparison of qualitative data. A p-value of <0.05 was considered statistically significant. Data management and analysis were performed using Jamovi software version 2.3.21.

Tab. 1 Demographic Characteristics of the Patients.

Patients' Characteristics		Results (n = 12)
Autonomy		10 (83.5%)
Indication for peritoneal dialysis Choice/Vascular access exhaustion		11 (91%) /1 (9%)
Good socio-economic status		9 (75%)
Education level	Higher education High school Primary school Illiterate	9 (75%) 1 (9%) 1 (9%) 1 (9%)
Professional activity	Medical Doctor Engineer Retired Nurse Other	1 (9%) 2 (18%) 3 (27%) 1 (9%) 6 (50%)
Hemodialysis before PD Duration of hemodialysis (months)		3 (27%) 48 [36–60]
Transplantation before DP Duration of transplantation (months)		2 (18%) 72 [60–84]
Initial Nephropathy	Tubulo-interstitial Polycystic Kidney Disease (PKD) Nephrosclerosis (NAS) Indeterminate	4 (33.5%) 1 (9%) 3 (27%) 4 (33.5%)
Transfer to Automated Peritoneal Dialysis (APD) Duration of the initial technique (CAPD or APD) (months)		5 (41.7%) 69 [48–91]
PET	Fast transporter Slow transporter	5 (33.5%) 3 (27%)

RESULTS

DEMOGRAPHIC AND CLINICAL CHARACTERISTICS

Since the establishment of our peritoneal dialysis unit in June 2006 and until January 2024, 235 patients have been recruited. Twelve of these patients, who have remained on peritoneal dialysis (PD) for more than 10 years, were included in the study, representing 5% of the recruited patients.

Among patients who remained on peritoneal dialysis for more than 10 years, the average age at initiation of PD was 45.5 ± 16.5 years, with an age range from 16 to 71 years, 58% were female and 42% were male, yielding a male-to-female ratio of 0.72. The mean body mass index (BMI) was 27.5 ± 4.5 kg/m².

Tubulointerstitial nephropathy was the most common cause of end-stage kidney disease (33.3%), followed by nephrosclerosis (25%).

Two patients had previously received a kidney transplant; one of them lost the graft 7 years after transplantation due to graft sepsis and started peritoneal dialysis 1 year later, while the other had the failed graft left in situ.

Ten patients are hypertensive, one patient is diabetic. Ischemic heart disease was found in two patients, and the median Charlson comorbidity score was 2. None of the patients had a history of hernia.

Only one patient started with automated peritoneal dialysis (APD), while 5 patients out of the 11 initially on continuous ambulatory peritoneal dialysis (CAPD) switched to APD due to loss of ultrafiltration. The demographic data are summarized in Table 1.

CLINICAL AND BIOLOGICAL OUTCOME

After 10 years on PD (T1), no significant changes were found in blood pressure (131/69 mmHg compared to 129/75 mmHg) or BMI (28.5 kg/m² compared to 27.6 kg/m²) ($p > 0.05$). Urine output decreased significantly from 1500 [1000–2000] mL/day to 0 [0–150] mL/day ($p = 0.010$), and residual kidney function declined from 4.6 [1.44–7.7] mL/min to 0 [0–1.14] mL/min ($p = 0.001$). Ultrafiltration increased from 400 [178–600] mL/day to 1000 [900–1500] mL/day ($p < 0.001$). Only one patient was anuric at PD initiation, and residual kidney function became null in 2 patients after 5 years of PD, while two patients still maintained a residual kidney function more than 4 mL/min at 10 years.

Clearance parameters showed a decline, with Kt/V changing from 1.56 ± 0.6 to 1.41 ± 0.48 ($p = 0.800$) and weekly creatinine clearance decreasing from 92.4 ± 43.5 to 49 ± 21 mL/min ($p = 0.010$). Bicarbonate levels dropped significantly from 26.6 ± 2.07 to 17.9 ± 3.7 mmol/L ($p < 0.001$) (Table 2).

Nutritional parameters showed a decrease in normalized protein catabolic rate (nPCR, 0.766 ± 0.21 to 0.615 ± 0.09 g/kg/day, $p = 0.08$), albumin (38.2 ± 6.08 to 37.1 ± 5.65 g/L, $p = 0.777$), and triglycerides (1.93 ± 1.03 to 1.69 ± 0.85 g/L, $p = 0.633$). Hemoglobin improved from 10.6 ± 2.07 to 11.1 ± 1.65 g/dL ($p = 0.032$) with erythropoietin and iron supplementation.

Calcium levels increased from 79.7 ± 13 to 91 ± 8 mg/L ($p = 0.033$), along with phosphate levels, despite the use of

Tab. 2 Evolutionary Characteristics at the Initiation of PD (T0) and at 10 Years (T1).

	T0	T1	p value
Urine output (mL/day)	1500 [1000–2000]	0 [0–150]	**0.010**
Kt/V (mL/mn)	1.56 +/–0.6	1.41 +/–0.479	0.800
nPCR (g/kg/day)	0.766 +/–0.21	0.615 +/–0.09	0.080
WCC (mL/mn)	92.4 +/–43.5	49 +/–21	**0.010**
RKF (mL/mn)	4.60 [1.44–7.70]	0 [0–1.14]	**0.001**
Albumine (g/l)	38.2 +/–6.08	37.1 +/–5.65	0.777
LDL-Cholesterol (g/L)	1.21 +/–0.410	1.04 +/–0.411	0.501
Triglycerides (g/L)	1.93 +/–1.03	1.69 +/–0.846	0.633
Uric acid (mg/L)	83.5 +/–18.5	63 +/–11.2	**0.018**
Potassium (mmol/L)	4.73 +/–0.66	4.34 +/–0.36	0.112
Calcium (mg/L)	79.7 +/–13	91 +/–8	**0.033**
Bicarbonates (mmol/L)	26.6 +/–2.07	17.9 +/–3.7	**< 0.001**
Hemoglobin (g/dL)	10.6 +/–2.07	11.1 +/- 1.65	**0.0320**
Ultrafiltration (mL/day)	400 [178–600]	1000 [900–1500]	**< 0.001**

hypocalcemic dialysate. These changes likely reflect a combination of treatments tailored to each patient, including oral calcium supplementation, vitamin D analogs, phosphate binders, and, when indicated, an active vitamin D analog (calcitriol/alfacalcidol) or a calcimimetic. Nine patients had hyperparathyroidism; three required parathyroidectomy, while the remaining six were managed conservatively with this individualized regimen to maintain calcium and phosphate within target ranges and minimize the risk of adynamic bone disease.

MECHANICAL AND INFECTIOUS COMPLICATIONS

The median number of exit-site infections is 1 [0–2], while the peritonitis rate is 41 patient-months/peritonitis and 0.024 peritonitis/month-patient, corresponding to 41 patient-months per peritonitis. Five peritonitis episodes were relapse peritonitis, three of which were caused by *coagulase-negative Staphylococcus*, one by *Escherichia coli*, and one by *Streptococcus aureus* in individual patients (Table 3). Only three catheter changes were performed during this period.

Peritonitis episodes were managed according to the ISPD guidelines. Empiric therapy typically included cefazolin or vancomycin combined with ceftazidime ± an aminoglycoside, and treatment was subsequently adapted based on the causative organism and its antibiotic susceptibility. Catheter removal was reserved primarily for refractory peritonitis or cases where medical treatment failed. Although peritoneal permeability was not systematically reassessed after peritonitis, no clinical evidence of ultrafiltration failure or encapsulating peritoneal sclerosis was observed during follow-up.

Mechanical complications included catheter migration, catheter dysfunction, catheter perforation, and peritoneal leak, occurring in 4 (33.5%), 2 (18%), 3 (27%), and 1 (9%) patients, respectively. Some of these complications tended to occur early in the course of peritoneal dialysis, whereas others appeared later. However, no correlation was observed between the occurrence of these mechanical complications or peritonitis and the overall duration of peritoneal dialysis.

Although peritoneal permeability was not systematically reassessed after peritonitis, no clinical evidence of ultrafiltration failure or encapsulating peritoneal sclerosis was observed during follow-up.

EVOLUTION AND MORTALITY

The average survival on peritoneal dialysis (PD) in this cohort was 10.4 ± 0.9 years. Seven patients are still undergoing PD. Three patients were transferred to chronic hemodialysis: one due to a *Candida albicans* peritonitis, and two due to a loss of ultrafiltration and poor dialysis clearance. One patient passed away due to septic shock. Only one patient received a kidney transplant, while three patients are on the national kidney transplant waiting list from a

Tab. 3 Complications related to PD occurring in patients.

Complications		Patients (n = 12)
Mechanical	Catheter migration Catheter dysfunction Catheter perforation Peritoneal leak	4 (33.5%) 2 (18.0%) 3 (27.0%) 1 (9.0%)
Infectious	Exit site infection Tunnel infection Peritonitis Repeat peritonitis *Staphylocoque coagulase négative* *Escherichia coli* *Staphylocoque aureus* Relapse peritonitis	1 [0–2] 0 4 [2–4.25] 5 3 1 1 0

brain-dead donor. One patient refused the kidney transplant, and six patients are deemed non-transplantable due to specific comorbidities. No parameter was found to be associated with the survival of the technique beyond 10 years or with mortality.

DISCUSSION

The survival of the peritoneal dialysis technique or the patient on PD reported in studies is often underestimated, since the final event for technique survival is the permanent transfer to hemodialysis, and the final event for patient survival is death. The recovery of kidney function and transfer to another center are censored events. For these reasons, the percentage of patients remaining on treatment is much lower than what is calculated based on current survival data of patients or the technique.

The survival rates on PD reported by different countries are highly variable and mainly depend on the incidence of kidney transplantation in each country. At the end of the 20th century and the beginning of the 21st century, the survival rate on PD for more than 8 years was 33% in Italy (2). Similarly, data from Australia and the United Kingdom show that only 0.4% and 1.4% of patients, respectively, remain on PD after eight years (3). In North America, the percentage of patients on PD for more than ten years ranges from 0.8% to 7.3% (4). Recently, a survival rate of 19.6% at 10 years was reported in Spain in 2013 (5), while Japanese data from 2018 reported a 15% survival rate of PD patients after eight years (6). It is important to note that Japan has a low transplantation rate (7). In the United States, the 10-year survival rate is 11%. Cardiovascular diseases remain the leading cause of death (8). Similarly, the long duration of peritoneal dialysis in our cohort can be explained by limited access to kidney transplantation and the presence of non-transplantable patients, as detailed in the results section. In our setting, the scarcity of available organs and medical contraindications to transplantation contribute to maintaining patients on long-term PD. Moreover, the good tolerance of PD, the low peritonitis rate, and adequate technique survival further supported the continuation of PD over many years.

Additionally, in 1996, De Vecchi et al. reported a prevalence of 7.8% of patients on continuous ambulatory peritoneal dialysis for more than 10 years, with a mean age of 50.8 years (9). In a second study, Abdel-Rahman et al. in 1997 reported that 7 patients with type 1 diabetes were among those who survived more than 100 months, with a mean age of 41.6 years. They represented 12% of the survivors and 16% of all type 1 diabetic patients, whereas none of the 24 type 2 diabetic patients survived more than 100 months (10). In 2024, Erol Demir et al. found a survival rate of 64.6% at 10 years and 41.1% at 15 years, with a mean age of 53 years. Diabetic nephropathy represented 6.4% of the causes of end-stage kidney disease (ESKD), and the factors associated with mortality were advanced age, male gender, and vascular access as the indication for PD (11).

In our study, tubulointerstitial nephropathy was the most common cause, and only one patient had diabetes. Our study showed that the 10-year survival rate was 5%. PD discontinuation in our study was mainly related to a loss of ultrafiltration due to peritoneal aging, and only one patient presented with *Candida peritonitis*, making the peritoneum unsuitable for exchanges.

Importantly, achieving long-term preservation of the peritoneal membrane depends on multiple strategies. In general, the literature recommends the use of biocompatible dialysis solutions, careful fluid management, strict prevention and prompt treatment of peritonitis, periodic assessment of peritoneal membrane function, and maintaining residual kidney function (12, 13). In our cohort, we observed that patient education, individualized dialysis prescriptions, early intervention for complications, and switching from CAPD to APD when indicated contributed significantly to long-term peritoneal membrane preservation. These measures likely played a key role in maintaining the technique beyond 10 years despite the advanced age of some patients and the natural decline in residual kidney function.

Finally, Xi Xia et al. (2020) demonstrated that long-term PD can be successfully performed, depending on the management of cardiovascular diseases and diabetes, as well as the preservation of peritoneal function. The 10-year survival rate in their study was 36%. In our study, the young age of our population (45.5 ± 16.5 years), low Charlson comorbidity index, and high educational level of patients contributed to the survival of the technique beyond 10 years (14).

Furthermore, complications related to prolonged use of PD, such as encapsulating peritoneal sclerosis (EPS), remain a major concern. EPS is rare but serious, reported in about 0.7% to 3.3% of long-term PD patients. None of our patients developed EPS (11).

Moreover, the preservation of residual kidney function plays a crucial role in the survival of the technique beyond 10 years. As shown in the study by Li et al. (2017), patients who maintain significant urine output after several years show much better clinical outcomes (15). However, in our study, the loss of residual kidney function in three patients was not a factor for PD discontinuation. In our patients, the decline in residual kidney function happened gradually, but it was most noticeable during the first 5 years of PD. After that, it slowed down and became more stable. At 10 years, only two patients still had a residual kidney function above 4 mL/min. This pattern is similar to what has been reported in previous reports, where the fastest drop in kidney function happens in the early years of PD, followed by a plateau.

Overall, maintaining technique survival is closely related to the prevention of peritoneal infection episodes, which remain a frequent cause of technique failure. A study by Mehrotra et al. (2016) showed that technique survival after 10 years strongly depends on reducing infectious episodes. The low peritonitis rate found in our study is associated with better survival on PD. The therapeutic education program, as well as retraining patients and staff, are important factors for improving survival (16).

Lastly, the small and highly selected group of patients who remained on PD beyond 10 years in our cohort illustrates the feasibility of long-term peritoneal dialysis even in challenging settings. Despite limited human resources,

with 1 to 2 dedicated PD nurses managing approximately 50 active patients per year, these patients successfully maintained the technique. All were well-educated and demonstrated excellent compliance, supported by a strong medical staff-patient relationship, which played a crucial role in achieving favorable outcomes. This insight highlights that with structured care, individualized management, and close monitoring, long-term PD can be safely and effectively sustained, providing valuable guidance for dialysis programs in similar resource-limited contexts.

CONCLUSION

Although prolonged peritoneal dialysis beyond 10 years is uncommon, our experience shows that it is feasible with a combination of patient education, individualized care, and careful monitoring. Success depends on multiple factors: effective management of infectious complications, preservation of residual kidney function, use of biocompatible solutions, careful fluid management, optimized dwell times through CAPD to APD switching, and prompt treatment of peritonitis. Together, these strategies not only improve patient outcomes but also help preserve long-term peritoneal membrane function. Further research is needed to refine these approaches, extend peritoneal membrane health, and prevent complications such as encapsulating peritoneal sclerosis, particularly in patients who are not candidates for kidney transplantation.

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