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*Original Article*

# Clinical features of patients treated by peritoneal dialysis for over a decade

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**Abstract:** Background: Peritoneal dialysis (PD) is well-established as renal replacement therapy in end stage renal disease and has survival rates similar or better than hemodialysis (HD) for the initial years on dialysis therapy. However retention rate is lower due to higher technique failure rates than in HD and few patients stay on PD for more than 10 years ($PD_{>10\ yrs}$). Here we investigated clinical features characterizing $PD_{>10\ yrs}$ patients. Patients and Methods: In a single center study of 450 prevalent PD patients, 35 $PD_{>10\ yrs}$ patients (n=35) were compared with patients (n=415) who had been on PD for shorter periods of time in terms of clinical characteristics. Peritoneal transport, blood pressure, solute clearance, nutrition status, and blood calcium, phosphate and parathyroid hormone levels were measured dialysis start and, in $PD_{>10\ yrs}$ patients, also after 5 and 10 years of PD. Results: The $PD_{>10\ yrs}$ patients differed from the other PD patients in that (1) the proportion of women was higher; (2) body mass index (BMI) was lower; (3) there was no patient with diabetic nephropathy as primary diagnosis; (4) the incidence of peritonitis was lower; (5) glomerular filtration rate was higher; and (6) parathyroid hormone (PTH) levels were lower in those with decade-long PD treatment. In $PD_{>10\ yrs}$ patients, serum albumin was maintained at a high level throughout the 10 year follow up; hemoglobin levels after 5 and 10 years of PD were higher than at the beginning of the treatment; blood calcium and phosphate concentrations were maintained at acceptable levels; while the dialysate/plasma ratio of creatinine, D/*P*-value, increased during the decade-long PD treatment. Conclusions: Patients receiving $PD_{>10\ years}$ had lower incidence of peritonitis, lower BMI, adequate control of blood calcium and phosphate levels and solute clearance, and were more often women than PD patients treated for shorter periods of time.

**Keywords:** End stage renal disease, peritoneal dialysis, long term patient survival, technique failure

## Introduction

Peritoneal dialysis is an important alternative therapy for patients with end-stage renal disease, having the advantages of being a home dialysis treatment and a dialysis modality with less harmful hemodynamic impact than hemodialysis. In recent years, as a consequence of technical innovations and better clinical management, patients have fewer infections and other therapy-related complications, and the survival rate of patients has been improving year by year, especially for the first years after dialysis start. These advances have allowed patients to be maintained on PD for longer periods and the survival rate for patients treated with PD is now equivalent to that with in-center hemodialysis [1]. In parallel, changes in public health care policies have spurred an unprecedented expansion in the use of PD in many parts of the world and the number of patients choosing peritoneal dialysis is increasing rapidly in countries such as China and USA. Nevertheless only a relatively small proportion of patients survive a decade or more on maintenance peritoneal dialysis which makes it important to identify factors associated with long term survival on peritoneal dialysis.

We analyzed clinical data of 450 peritoneal dialysis patients including 35 patients who were treated for more than a decade of maintenance dialysis to identify clinical features that characterize such decade-long survivors.

**Table 1.** Clinical characteristics of peritoneal dialysis (PD) patients who received more than a decade of PD therapy and other PD patients at the beginning of PD therapy

| | More than a decade of PD | Other PD patients | *p*-value |
|---|---|---|---|
| Case | 35 | 415 | |
| Age (year) | 48 ± 11 | 51 ± 15 | 0.091 |
| Sex (male/female) | 7/28 | 212/203 | <0.001 |
| Diabetic nephropathy | 0 | 39/415 | <0.001 |
| Incidence of peritonitis | 182 months/time | 101 months/time | 0.026 |
| PET (D/*P*-value) | 0.56 ± 0.1 | 0.61 ± 0.23 | 0.353 |
| KT/V | 1.92 ± 0.48 | 1.82 ± 0.41 | 0.152 |
| Ccr/week | 62.3 ± 18.4 | 57.2 ± 20.6 | 0.062 |
| Hb (g/l) | 70 ± 31 | 77 ± 18 | 0.167 |
| S-albumin (g/l) | 35.2 ± 5.2 | 34.6 ± 5.3 | 0.346 |
| BMI (KG/$m^2$) | 19.4 ± 6.5 | 22.6 ± 7.1 | 0.022 |
| GFR (ml/min) | 7.3 ± 2.9 | 6.8 ± 3.2 | 0.043 |
| PTH (pg/ml) | 354 ± 238 | 396 ± 357 | 0.028 |
| Calcium (mmol/l) | 2.27 ± 0.3 | 2.07 ± 0.3 | 0.035 |
| $PO_4$ (mmol/l) | 2.14 ± 0.6 | 1.91 ± 0.6 | 0.042 |

Abbreviations: PET, peritoneal equilibration test; D/P, dialysate to plasma concentration ratio of creatinine; Ccr, creatinine clearance; Hb, hemoglobin; BMI, body mass index; GFR, glomerular filtration rate; PTH, blood parathyroid hormone; $PO_4$, blood phosphate

## Patients and methods

In the present study, we included prevalent PD patients without a previous history of dialysis treatment or renal transplantation. 450 peritoneal dialysis patients were divided according to the treatment duration of peritoneal dialysis into two groups, a group of patients treated by peritoneal dialysis for a decade or longer (n=35) and a general group (n=415) treated for shorter periods of time. After successful peritoneal catheter access surgery, patients first received intermittent peritoneal dialysis and then changed to continuous ambulatory peritoneal dialysis (CAPD) using a daily total exchange volumes of 6-10 L. The patients used peritoneal dialysis catheters and lactate-buffered glucose-based dialysis fluids and twin-bag connection system purchased from Baxter Healthcare (Guangzhou, China). All patients underwent routine follow-up with regular appointments at the Renal Division, Hangzhou Hospital of Traditional Chinese Medicine, Hangzhou, Zhejiang province, China. Patient management at follow-up included comprehensive clinical assessment of peritoneal transport, based on peritoneal equilibration test (PET) and determination of dialysate/plasma ratio of creatinine (D/*P*-value), blood pressure, solute clearance, nutrition status, and blood calcium, phosphate and parathyroid hormone levels in accordance with the KDIGO clinical practice guidelines for the management of chronic kidney disease [2] in the dialysis center once every 3 months. We collected and recorded data on clinical treatment at the beginning of peritoneal dialysis, incidence of peritonitis, and all of the clinical information for patients in the extended treatment group in the fifth and tenth years of peritoneal dialysis) for analysis. Our hospital's Medical Sciences Ethics Committe approved the study.

### *Statistical analysis*

SPSS 13.0 (SPSS, Inc., Chicago, IL) software was used for the statistical analysis in this study. Measurement data are presented as mean ± standard deviation (SD). Normally distributed data of two groups were compared using independent samples and paired *t* test. Count data between the groups were compared using the Chi-square test. P<0.05 was considered to be statistically significant.

## Results

Baseline characteristics of the two groups of patients at the beginning of peritoneal dialysis are shown in **Table 1**. Compared to the patients receiving peritoneal dialysis in the general group, patients who received more than a decade of peritoneal dialysis in the extended treatment group had the following characteristics: (1) the proportion of female patients was significantly higher in the extended treatment group as compared to the general group; (2) body mass index (BMI) of the extended treatment group was lower than for the general group; (3) no patients with diabetic nephropathy as primary diagnosis patients were found in the extended treatment group; (4) the incidence of peritonitis in the extended treatment group

**Table 2.** Comparison of clinical data of 35 decade-long PD patients at the beginning, after 5 years, and after 10 years of extended peritoneal dialysis

| | Start of PD | 5 years of PD | 10 years of PD |
|---|---|---|---|
| N | 35 | 35 | 35 |
| Age (year) | 48 ± 11 | 53 ± 11 | 58 ± 11 |
| PET (D/*P*-value) | 0.56 ± 0.1 | 0.62 ± 0.1 | 0.69 ± 0.12※ |
| KT/V | 1.92 ± 0.48 | 2.1 ± 0.3 | 2.12 ± 0.3 |
| Ccr/week | 62.3 ± 18.4 | 51 ± 16 | 53.9 ± 8 |
| Hb (g/l) | 70 ± 31 | 101 ± 19※ | 101 ± 13※ |
| S-albumin (g/l) | 35.2 ± 5.2 | 38.3 ± 2.5 | 37.8 ± 3.6 |
| BMI (kg/m$^2$) | 19.4 ± 6.5 | 20.5 ± 7.6 | 21.2 ± 8.1 |
| GFR (ml/min) | 7.3 ± 2.9 | 0.7 ± 0.8※ | 0.11 ± 0.3※ |
| PTH (pg/ml) | 354 ± 238 | 291 ± 491 | 468 ± 311 |
| Calcium (mmol/l) | 2.27 ± 0.3 | 2.48 ± 0.2 | 2.51 ± 0.3※ |
| $PO_4$ (mmol/l) | 2.14 ± 0.6 | 1.8 ± 0.5 | 1.5 ± 0.5※ |

Abbreviations: PET, peritoneal equilibration test; D/P, dialysate to plasma concentration ratio of creatinine; Ccr, creatinine clearance; Hb, hemoglobin; BMI, body mass index; GFR, glomerular filtration rate; PTH, blood parathyroid hormone; $PO_4$, blood phosphate. ※Compared to the beginning of peritoneal dialysis, $p<0.05$.

was significantly lower than in the general group; (5) the residual kidney function (i.e., glomerular filtration rate, GFR) of the extended treatment group during the initiation of peritoneal dialysis was higher than in the general group; and (6) the parathyroid hormone (PTH) level of the extended treatment group was significantly lower than in the general group.

For patients who received peritoneal dialysis for over 10 years, clinical data at the beginning, after 5 years, and after 10 years of peritoneal dialysis therapy showed the following typical features: Serum albumin was maintained at a high level throughout the 10 year follow up; hemoglobin levels after 5 and 10 years of peritoneal dialysis were higher than at the beginning of the treatment; blood calcium and phosphate concentrations were maintained at acceptable levels; whereas the peritoneal solute transport rate reflecting peritoneal membrane transport characteristics (dialysate/plasma ratio of creatinine, D/*P*-value, at peritoneal equilibration test, PET) gradually increased during the course of the decade-long peritoneal dialysis treatment (**Table 2**).

## Discussion

The incidence of chronic kidney disease (CKD) is increasing across the globe and the prevalence of CKD among the adult population in developed countries is as high as 10.2-13% [3, 4], and in China approximately 10.8% [5]. In parallel the number of patients with end-stage renal disease (ESRD) is increasing, and, in China, the annual growth rate of ESRD patients receiving renal replacement therapy (RRT) is more than 11%. Hemodialysis, peritoneal dialysis, and kidney transplantation are effective means of replacement therapy of ESRD. Compared to hemodialysis, peritoneal dialysis provides better protection of residual renal function and has advantages in form of hemodynamic stability and less impact on cardiovascular system. The operation of peritoneal dialysis devices is simpler and less expensive than hemodialysis; therefore, it has been widely used in clinical practice.

The present study shows that among 450 patients treated by peritoneal dialysis in a single center, 35 patients were treated for more than a decade and several clinical factors were found to be more common among these patients. It is already well established that the long-term survival and quality of life of patients receiving peritoneal dialysis are affected by numerous factors such as age, peritoneal membrane transport function, implantation technique of peritoneal dialysis catheter, nutritional status, anemia, cardiovascular and infectious complications, residual renal function, financial status and psychological factors. In addition, long-term exposure to high glucose peritoneal dialysis fluid induces structural and functional changes in the peritoneal membrane that promote peritoneal fibrosis [6] and contribute to the poor long term survival of peritoneal dialysis patients. However, international and domestic reports show that the 5-year survival of the patients who receive peritoneal dialysis is less than 50% [7] which means that relatively few patients survive 10 years or more on the therapy.

In addition, long term treatment on peritoneal dialysis is compromised by technique failure. Peritoneal dialysis-related peritonitis leads to approximately 15-18% of patients having to remove the peritoneal dialysis catheter [8] making it one of the most common causes of

withdrawal from peritoneal dialysis treatment. In addition to infection, which may result in prompt withdrawal of peritoneal dialysis, peritoneal dialysis-related peritonitis also promotes changes of peritoneal transport function of solutes and fluid, which negatively affects the technique survival and long-term survival of patients [9]. In the present study, the incidence of infections in the patients who received peritoneal dialysis for over a decade was significantly lower than for the other patients while the peritoneal transport function was relatively well protected and maintained.

Diabetic nephropathy is a major cause of ESRD. Many clinical studies show that the survival of patients with diabetic nephropathy undergoing peritoneal dialysis is low [10, 11]. In this study, there were no patients with diabetic nephropathy who received more than 10 years of peritoneal dialysis. Our results are consistent with previous findings [12]. The results of the current study are similar also to results reported in a study from the US by Abdel-Rahman E-M et al [13] who found that no patient with type II diabetes mellitus survived longer than 100 months on CAPD and that long-term survivors were significantly younger, weighed less, had fewer episodes of peritonitis, fewer hospital days, and were prescribed more dialysis per kg body weight, than those who died or switched to HD prior to 100 months. In a study from UK, Ashby et al [14] reported that among 46 patients treated by dialysis for more than 10 years, younger age and non-diabetic renal disease associated with improved survival. While a small proportion of these patients were treated by peritoneal dialysis, 21 patients (46%) had been on peritoneal dialysis at some stage for an average of 5.9 years/patient.

Residual renal function is an important factor affecting the quality of life and survival of patients receiving peritoneal dialysis [15]. The residual renal function of the patients with extended peritoneal dialysis treatment in this study was significantly better than in the patients at the beginning stage of peritoneal dialysis in the general group, results which are consistent with previous report [15]. The impact of BMI on the survival of patients who received peritoneal dialysis varies in different studies [16, 17]. Some studies showed that obese patients who received peritoneal dialysis had poor survival and high mortality compared to non-obese patients [16]. In contrast, Choi et al [18] showed that obesity did not affect the survival of peritoneal dialysis patients. In this study, we showed that patients with a low BMI benefited more from the extended treatment of peritoneal dialysis. Interestingly, female patients accounted for the majority of patients who received the extended treatment of peritoneal dialysis in this study; one may speculate that this may be related to better compliance with health care providers' guidance for peritoneal dialysis in female patients.

Blood calcium and phosphate levels and secondary hyperparathyroidism are closely associated with the quality of life and long-term survival of dialysis patients [19]. High calcium and phosphate levels do not only cause itchy skin, restless legs, and sleep disorders, but also significantly promote cardiovascular complications induced by arterial calcification [20]. In this study, the patients who underwent extended treatment of peritoneal dialysis received strict controls in their blood calcium and phosphorous levels.

This study has limitations that influence the interpretation of the results. This is an observational study which limits any conclusions regarding causality. Secondly, we did not investigate a range of other clinical conditions or underlying factors that conceivably may influence long term patients and technique survival such as cardiovascular disease, inflammation, genetics, and socioeconomic status to name a few. Thirdly, the small size of the patient sample resulted in low statistical power.

## Conclusion

In the present study, the following factors characterized patients who received decade-long peritoneal dialysis treatment: (1) low incidence of peritonitis; (2) low BMI; (3) female gender; (4) absence of diabetes; (5) adequate solute clearance; and, (6) adequate control of circulating calcium and phosphate. While many factors other than the ones investigated in this study are likely to affect the long-term survival of patients who receive peritoneal dialysis, the obtained results confirm that infection control is of utmost importance and that further studies are warranted to better understand why low

BMI and female sex may represent survival factors for long term survival on PD.

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## Disclosure of conflict of interest

Bengt Lindholm is employed by Baxter Healthcare.

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