

# Analysis of outcome and factors correlated with maintenance peritoneal dialysis

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## Abstract

**Objectives:** This study aimed to analyze the outcome and factors correlated with maintenance peritoneal dialysis (PD) to provide guidance for improving prognosis, and prolonging the catheterization and survival times of patients on PD with end-stage renal disease.

**Methods:** Clinical data of patients at The Third Xiangya Hospital of Central South University were retrospectively analyzed. We compared the survival and technique survival rates of patients, and analyzed relevant factors.

**Results:** A total of 510 cases of PD were included. Two hundred thirty-nine patients continued to receive PD treatment, 73 received kidney transplants, 72 transferred to hemodialysis, and 126 died. The main reasons of death were cardiovascular (27.00%) and cerebrovascular diseases (23.80%). The main reasons of transfer to HD were peritonitis and inadequate dialysis. The survival rates at 1, 2, 3, 5, and 7 years were 95.75%, 90.34%, 82.35%, 66.21%, and 54.32%, respectively. The technique survival rates at 1, 2, 3, 5, and 7 years were 93.22%, 86.76%, 77.91%, 63.16%, and 47.67%, respectively. Female sex and older age were protective factors that affected patients' withdrawal from PD and survival time.

**Conclusions:** Death is the primary reason for withdrawal from PD. Female sex and older age affect patients' withdrawal from PD and survival.

## Keywords

End-stage renal disease, peritoneal dialysis, outcome, risk factor, older age, survival, hemodialysis

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## Introduction

End-stage renal disease (ESRD) is the end stage of chronic kidney disease (CKD) caused by various renal diseases. The number of patients with ESRD is significantly increasing in developed and developing countries.<sup>1</sup> By 2030, the projected number of people receiving renal replacement therapy (RRT) will reach 5.439 million. Approximately 2284 to 7083 million people will die prematurely because they do not have access to treatment, especially in low-income and middle-income countries in Asia, Africa, Latin America, and the Caribbean.<sup>2</sup> Currently, hemodialysis (HD) and peritoneal dialysis (PD) are the most conventional RRTs for ESRD. PD has become a common therapy because of its flexibility of home treatment, increased freedom, less hemodynamic instability issues, residual renal function preservation, lower hospitalization and intervention rates, and a higher quality of life compared with HD.<sup>3-6</sup> Despite numerous technical advances in PD therapy, rates of withdrawal from PD range from 19.80% to 54.80% depending on different populations and the study period.<sup>7,8</sup>

A recent trial by Cooper et al. showed that compared with “late” or deferred dialysis, the prognosis of patients with PD did not improve survival or quality of life, or reduce the hospitalization rate.<sup>9</sup> Furthermore, a national registry study reported an increase in the risk of death from patients on dialysis compared with the general population.<sup>10</sup> Peritonitis is an important factor for withdrawal from PD therapy in Japan.<sup>11</sup> A national renal registry study showed that increasing age, female sex, and prior cerebrovascular disease were associated with withdrawal from dialysis.<sup>12</sup> However, there have been few reports about the causes of withdrawal from PD in China. Several studies have investigated risk factors associated with withdrawal from PD that include older

people, hernia formation during PD therapy, and patients transferring from HD to PD.<sup>13-15</sup> Furthermore, the overall follow-up time was relatively short. Therefore, we conducted a retrospective study, which mainly focused on the long-term follow-up of Chinese patients, to identify the risk factors for withdrawal from treatment in patients on PD.

## Patients and Methods

### Patients

A total of 1260 patients underwent catheterization in the center for PD of the Third Xiangya Hospital of Central South University from 2002 to the end of 2016. The study protocol was approved by the Ethics Committee of Central South University Xiangya Third Hospital (No: 2018-S372). All patients provided written informed consent.

The inclusion criteria were as follows: (1)  $\geq 18$  years old; (2) continuous ambulatory peritoneal dialysis treatment for not less than 3 months; (3) patients had a clear time of catheter implantation and withdrawal; and (4) patients visited the hospital for reexamination at least every 6 months. The exclusion criteria were as follows: (1) lack of basic information; (2) acute renal failure or drug poisoning; (3) malignant tumor; (4) patients with severe underlying organ diseases, such as the heart and brain; (5) transfer to other centers; (6) patients did not adhere to the scheduled follow-up; and (7) loss to follow-up.

### Study protocol

Basic clinical information of the patients on PD at the beginning of dialysis was collected, such as the patient’s name, sex, age of opening the tube, primary disease, complications, the date of catheterization, the condition and reason for the outcome, the date

of withdrawal, the age of PD, and the occurrence of peritonitis.

Cardiovascular disease was defined as having a history of ischemic heart disease, angina attack, myocardial infarction, cerebral infarction or cerebral hemorrhage, coronary artery bypass/stenting, and transient ischemic attacks. The patient's survival rate was defined as the start of PD treatment to death or to the end of the study (December 31, 2017). Death was recorded as an end-point event for the patient's survival and was independent of the type of treatment that the patient received at the time. Except for death, any termination of peritoneal treatment (including a kidney transplant and PD transferred to HD) was used as censored data. The technical survival rate was defined as from the beginning of PD therapy to the failure of PD or to the end of the study (December 31, 2017). The retention and persistence of PD treatment as an end-point event was independent of whether the patient was alive at the time. The age of opening the tube was defined as the age at the time of catheterization. Insufficiency of dialysis was defined as failure to achieve an effect of dialysis.

### Statistical analysis

Statistical analyses were conducted using SPSS, version 22.0 (IBM Corp., Armonk, NY, USA). Results are described as number and percentage for categorical data, and mean and standard deviation (SD) for approximately normally distributed continuous variables. The Student's *t*-test was used to compare measurement data, while the  $\chi^2$  test was used to compare different rates. Kaplan–Meier analysis was used to calculate survival rates. Multivariate Cox regression analysis was used to analyze the risk factors of patients' survival time, technique survival time, and withdrawal of PD. A *P* value <0.05 was considered statistically significant.

## Results

### Patients' characteristics

A total of 510 patients on PD (308 [60.40%] men, 202 [39.60%] women) were included in this study. The mean age of the patients was  $48.35 \pm 13.92$  years and the majority of patients were aged <65 years. The primary disease was mainly chronic glomerulonephritis, followed by hypertensive nephropathy and diabetic nephropathy. Peritonitis occurred in 166 (32.50%) patients (Table 1).

### Patients' outcomes

To the end of the study, 239 (46.90%) patients continued to receive PD treatment, 73 (14.30%) received a kidney transplant, 72 (14.10%) were transferred to HD, and 126 (24.70%) died. Death and transfer to HD were the primary reasons for withdrawal from PD therapy. A total of 271 (53.10%) patients withdrew from PD. Of

**Table 1.** Basic characteristics of the patients.

Index	Values
Sex	
Male	308 (60.40)
Female	202 (39.60)
Age (years)	
<65	442 (86.70)
≥65	68 (13.30)
Primary disease	
Chronic glomerulonephritis	321 (62.90)
Diabetic nephropathy	50 (9.80)
Hypertensive nephropathy	67 (13.10)
Polycystic renal	13 (2.50)
Obstructive nephropathy	21 (4.10)
Lupus nephritis	3 (0.60)
Gouty nephropathy	5 (1.00)
Anaphylactic purpura nephritis	3 (0.60)
Others	27 (5.30)
Peritonitis	
No	344 (67.50)
Yes	166 (32.50)

Values are number (%).

**Table 2.** Outcomes of all patients.

Outcome	Cases (n)	%
Transferred to HD	72	14.10
Peritonitis	50	69.40
Inadequate dialysis	11	15.20
Peritoneal rupture	4	5.50
Dialysis failure	2	3.00
Others	5	6.90
Death	126	24.70
Cardiovascular disease	34	27.00
Cerebrovascular disease	30	23.80
Dialysis failure	13	10.30
Alimentary tract hemorrhage	8	6.30
Infection	6	4.80
Multiple organ failure	5	4.00
Others	30	23.80
Peritoneal dialysis	239	46.90
Kidney transplant	73	14.30

HD: hemodialysis.

the patients who transferred to HD, the most common reason was for peritonitis, followed by inadequate dialysis, peritoneal rupture, and dialysis failure. The reasons of death were cardiovascular disease, cerebrovascular disease, dialysis failure, alimentary tract hemorrhage, infection, multiple organ failure, and others (Table 2).

### *Multivariate Cox proportional hazards model for patients' survival and technique survival*

The survival rates at 1, 2, 3, 5, and 7 years were 95.75%, 90.34%, 82.35%, 66.21%, and 54.32%, respectively. Multivariate Cox regression analysis showed that older age ( $P < 0.001$ ) and diabetic nephropathy ( $P = 0.05$ ) were risk factors for the survival of patients (Table 3).

The technique survival rates at 1, 2, 3, 5, and 7 years were 93.22%, 86.76%, 77.91%, 63.16%, 47.67%, respectively. Multivariate Cox regression analysis showed that female sex was a protective factor for the technique survival time ( $P = 0.02$ ). The risk of

**Table 3.** Multivariate Cox regression analysis of survival time in patients on PD.

Factors	P	HR	95% CI	
			Lower limit	Upper limit
Sex				
Male		1.00		
Female	0.18	0.77	0.53	1.13
Age (years)				
$\leq 39$		1.00		
40–64	0.04	1.92	1.04	3.56
$\geq 65$	$< 0.001$	4.01	2.04	7.87
Peritonitis rate	0.11	0.85	0.70	1.04
Primary disease				
Others		1.00		
Glomerulonephritis	0.70	1.12	0.63	2.01
Diabetic nephropathy	0.05	1.90	1.01	3.56
Hypertensive nephropathy	0.32	1.41	0.72	2.75

PD: peritoneal dialysis; HR: hazard ratio; CI: confidence interval.

technical failure of PD in women was lower than that in men (Table 4).

### *Multivariate Cox proportional hazards model for withdrawal from PD*

Female sex was a protective factor that affected withdrawal of PD ( $P = 0.02$ ). Multivariate Cox regression analysis showed that older age was a risk factor of patients withdrawing from PD (Table 5).

## **Discussion**

In this study, we retrospectively collected the clinical data of 510 cases of PD in a single center in China. We analyzed the general condition of the patients, the reasons for withdrawal from PD therapy, and the risk factors for survival of patients, to provide guidance for improving prognosis and prolonging the catheterization time and survival time of patients on PD with ESRD.

**Table 4.** Multivariate Cox regression analysis of technique survival time in patients on PD.

Factors	P	HR	95% CI	
			Lower limit	Upper limit
<b>Sex</b>				
Male		1.00		
Female	0.02	0.57	0.35	0.93
<b>Age (years)</b>				
≤39		1.00		
40–64	0.68	0.89	0.51	1.55
≥65	0.47	1.40	0.56	3.51
Peritonitis rate	0.08	1.18	0.98	1.43
<b>Primary disease</b>				
Others		1.00		
Glomerulonephritis	0.79	1.10	0.56	2.15
Diabetic nephropathy	0.41	0.63	0.21	1.88
Hypertensive nephropathy	0.52	1.39	0.52	3.76

PD: peritoneal dialysis; HR: hazard ratio; CI: confidence interval.

In this study, chronic glomerulonephritis was the primary disease of the 510 cases of PD, which is consistent with other studies.<sup>16,17</sup> We found that, in the present study, 271 (53.10%) patients withdrew from PD. Furthermore, death was the main reason for patients' withdrawal from PD (24.70%), with most mortalities resulting from cardiovascular and cerebrovascular diseases. Luo et al. also reported that death was the main reason of early withdrawal from PD therapy.<sup>15</sup> In many previous studies, the most common cause of death was cardiovascular disease.<sup>18–20</sup> However, other studies have shown that infection, rather than cardiovascular disease, is the main cause of death in patients of PD.<sup>21–23</sup> A reason for the difference between studies may be the duration of PD because a long time of PD therapy is more likely to cause infections. However, Japan's national survey showed that the main reason for withdrawal from PD treatment was transfer to HD.<sup>24</sup> In this study,

**Table 5.** Multivariate Cox regression analysis of factors that affected withdrawal of PD.

Factors	P	HR	95% CI	
			Lower limit	Upper limit
<b>Sex</b>				
Male		1.00		
Female	0.02	0.70	0.52	0.93
<b>Age (years)</b>				
≤39		1.00		
40–64	0.31	1.23	0.82	1.84
≥65	0.003	2.02	1.27	3.22
<b>Diabetic nephropathy</b>				
No		1.00		
Yes	0.367	1.10	0.74	1.60
<b>Peritonitis</b>				
No		1.00		
Yes	0.15	1.26	0.92	1.73

PD: peritoneal dialysis; HR: hazard ratio; CI: confidence interval.

transfer to HD was the second leading cause of withdrawal from PD therapy. We also found that peritonitis was the leading reason for transfer to HD. Sakaci et al. also found that the main reason for patients transferring to HD was peritonitis.<sup>25</sup>

In this study, the survival rates at 1, 2, 3, 5, and 7 years were 95.75%, 90.34%, 82.35%, 66.21%, and 54.32%, respectively. Another report showed that the survival rates of patients on PD were 89.0%, 76.0%, and 44.0% at 1, 2, and 5 years, respectively.<sup>26</sup> PD can prolong survival time for patients with ESRD, but the long-term survival rate is still not optimistic. In our study, the technique survival rates at 1, 2, 3, 5, and 7 years were 93.22%, 86.76%, 77.91%, 63.16%, and 47.67%, respectively. These results suggest that PD is a feasible and effective treatment for patients with ESRD, and it can help prolong the survival time of patients with ESRD. Kee et al. found that PD can be considered as a long-term RRT option, especially in non-diabetic, young patients

with ESRD who are not overweight.<sup>21</sup> Rigoni et al. also found that PD may be a viable option for large-scale dialysis treatment in the advanced CKD population.<sup>27</sup> These results were consistent with those of our study.

Multivariate Cox regression analysis was used to analyze the protective and risk factors for survival time, technique survival time, and withdrawal from PD. In the present study, older age and diabetic nephropathy were risk factors that affected survival time. Female sex was a protective factor that affected the technique survival time. A long-term survival study showed that age was a predictor of patients' survival and technique survival.<sup>28</sup> Several studies have shown that older patients on PD have lower survival rates and technique survival rates than do younger patients.<sup>29,30</sup> Previous studies have shown that older age remains an important risk factor for patients withdrawing from PD.<sup>15,31</sup> The cause of this phenomenon may be that older patients tend to have more comorbidities, such as cardiovascular diseases, malnutrition, and hearing and visual impairments,<sup>32</sup> which result in PD failure. In our study, female sex was a protective factor that affected patients' withdrawal from PD. Furthermore, other studies showed that diabetes was a risk factor for patients who withdrew from PD.<sup>33,34</sup> He et al. found that peritoneal infection can increase the catheter removal rate and patients' mortality, which can lead to withdrawal from PD and death of patients.<sup>35</sup> The Canadian Database reported that a higher peritonitis rate was present only among female patients with diabetes for the first time.<sup>36</sup> This may be related to patients' local medical technology level.

Our study has limitations that should be considered in interpreting the results. The sample size of our study group was relatively small, and because it was conducted at a single center, it cannot represent the overall

situation of patients on PD throughout China. Therefore, more large-scale, multi-center joint research needs to be carried out for confirmation of relevant results and conclusions.

## Conclusion

Our findings suggest that chronic glomerulonephritis is the primary disease, and death and transfer to HD are the main reasons for withdrawal from PD therapy. Female sex is a protective factor affecting patients' withdrawal and the PD technique survival time. Older age is a risk factor affecting patients' withdrawal and PD survival time. Diabetic nephropathy is also a risk factor for PD survival time.

## Abbreviations

ESRD, end-stage renal disease; RRT, renal replacement therapy; HD, hemodialysis; PD, peritoneal dialysis; CKD, chronic kidney disease.

## Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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