Original Article

Risk Factors Associated with Outcomes of Continuous Ambulatory Peritoneal Dialysis Survival: A Single-Center Study in A General Hospital

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Abstract

Introduction: Continuous ambulatory peritoneal dialysis (CAPD) has improved survival for renal replacement therapy in patients with end-stage renal disease (ESRD) in Thai patients. The benefit of CAPD in ESRD patients has been demonstrated in medical and quality of life. Nevertheless, the data of risk factors associated with CAPD mortality is dismal. Thus, this study aims to identify the factors associated with mortality of ESRD patients treated by CAPD modality.

Methods: A retrospective cohort study enrolled ESRD patients who had received CAPD in a general hospital in Nakhon Nayok, Thailand. Medical records including clinical characteristics, laboratory, and mortality outcomes were reviewed and analyzed, respectively. A Cox proportional hazard regression method was performed to evaluate the risk factors associated with mortality outcomes. Overall survival (OS) was calculated using the Kaplan-Meier method.

Results: Two hundred and twenty-eight ESRD patients receiving CAPD between 2012 and 2019 were enrolled in the study. The median OS was 2.5 years (95%CI: 1.8 - 3.5). Multivariate analysis showed patients with older age ($\geq$ 65 years), diabetes mellitus, and low serum albumin (< 2.5 g/dL) associated with mortality outcomes.

Conclusions: Elderly patients, diabetes mellitus, and low serum albumin have been risked factors for overall mortality in CAPD patients.

Keywords: Continuous ambulatory peritoneal dialysis, Survival, Mortality, Diabetic mellitus, Elderly

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Introduction

End-stage renal disease (ESRD) is a worldwide problem, the incidence of the disease is increasing.[1] Hemodialysis (HD) and peritoneal dialysis (PD) are appropriated for renal replacement therapy (RRT). The previous study has been shown no different outcomes between both PD and HD.[2] Continuous ambulatory peritoneal dialysis (CAPD) has become the first option and improved survival for renal replacement therapy before kidney transplantation in ESRD patients under the universal health coverage (UHC) scheme in Thailand. The benefit of PD on the overall survival rate in ESRD under the UHC were 79, 66, and 57% at 1, 2, and 3 years, respectively.[3] Several previous studies also demonstrated the substantial factors associated with overall mortality were older age at the start of PD,[4-6] female,[4] a history of diabetes mellitus (DM),[4, 5, 7, 8] low educational levels,[4] and high body mass index (BMI).[9] Moreover, clinical factors also associated with overall mortality included low level of serum albumin,[5, 6] low diastolic blood pressure, high systolic blood pressure, high hemoglobin,[6] reserve renal function,[5] and urine volume.[6] There are several reasons to explain how residual function can predict mortality. First, patients with reserve renal function can maintain euvolemia leading to reduce volume overload on the heart system.[5] Second, the peritoneal dialysate is lower osmotic solutions in patients with higher urine output than patients with lower urine output.[5] The use of hyperosmotic solution resulted in the damage of peritoneal mesothelium and peritoneal macrophage.[10] Third, the peritoneum is injured from the production of advanced glycosylation end-products.[5] Forth, peritoneal clearance of large molecular weight is lower than renal clearance,[11] the inadequate of large uremic molecules clearance lead to serious medical complication such as pericarditis, and peripheral neuropathy.[5]

However, CAPD may benefit these patients in terms of both medical and quality of life, but there are some limitations of evidence to demonstrate the risk factors associated with mortality outcomes in ESRD patients in the general hospital. Thus, this study aimed to identify the factors related to mortality outcomes of ESRD patients treated by CAPD modality in a general hospital in Nakhon Nayok, Thailand.

Methods

Study population

The study population consisted of ESRD patients who had firstly initiated CAPD in the general hospital, Nakhon Nayok, belonging to the Ministry of Public Health, Thailand. This study was performed between January 2012 to December 2019. Patients over 100 years of age, survived less than 1 month after initiating CAPD, and those with incomplete and invalid data were excluded from this study. Furthermore, patients showing the presence of acute renal failure, serum albumin as < 0.3 or > 6 g/dL, and hemoglobin as < 3 or > 20 g/dL were also excluded from the study.

Clinical endpoint

Overall survival rates were calculated from the first initiation of Tenchkoff insertion to the date of the patient's death. The survival data comprised overall mortality with all causes. Patients were censored who were lost to follow-up or survived at the end of the study (December 2019).

Data collection

The original values of clinical and biochemical data were reviewed and analyzed as a retrospective study. Patient characteristics included age at the start of CAPD, gender, marital status, religion, smoking, body mass index, and coexisting medical conditions. Clinical characteristics data using standardized data extraction form were gathered and evaluated. Laboratory data including complete blood count, albumin, BUN, Creatinine, and GFR were collected on the first day of Tenchkoff insertion.

Statistical methods

Statistical analyses were performed using Stata MP14. Overall survival (OS) was calculated from the date of the initial Tenchkoff insertion using the Kaplan-Meier method. A multiple Cox proportional hazard regression method was performed to evaluate the risk factors associated with mortality. A P-value less than 5% was considered statistically significant.

Results

A total of 239 patients who performing CAPD between 2012 and 2019 were identified in our study. Eleven-one patients were excluded due to invalid end dates, survived less than 1 month after initiating CAPD, and discontinuing CAPD.

Therefore, 228 patients were included for the final analysis (Figure 1). The mean age of participants was 56.59 ± 13.62 years. Table 1 showed baseline characteristics and results of laboratory examina- tion of CAPD patients Infected peritonitis was the most common complication of CAPD insertion (Figure 2).
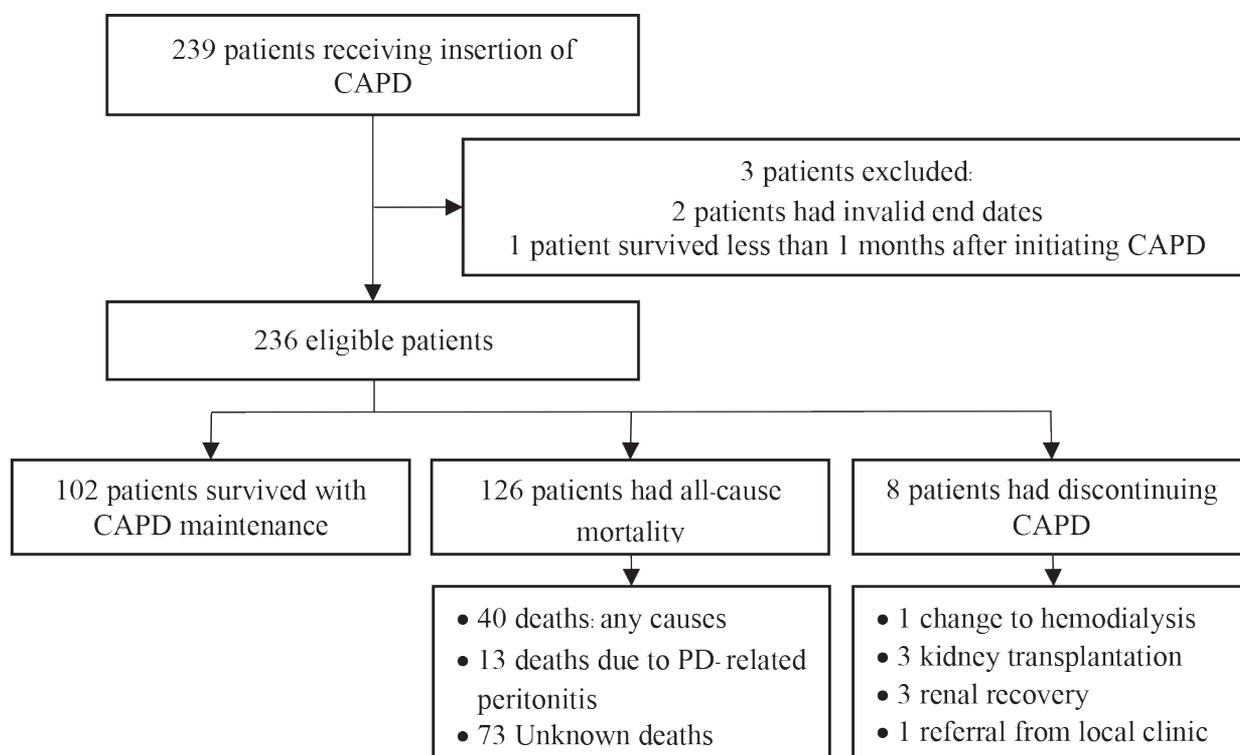

Figure 1 Flowchart of patients with continuous ambulatory peritoneal dialysis (CAPD) (n = 239).
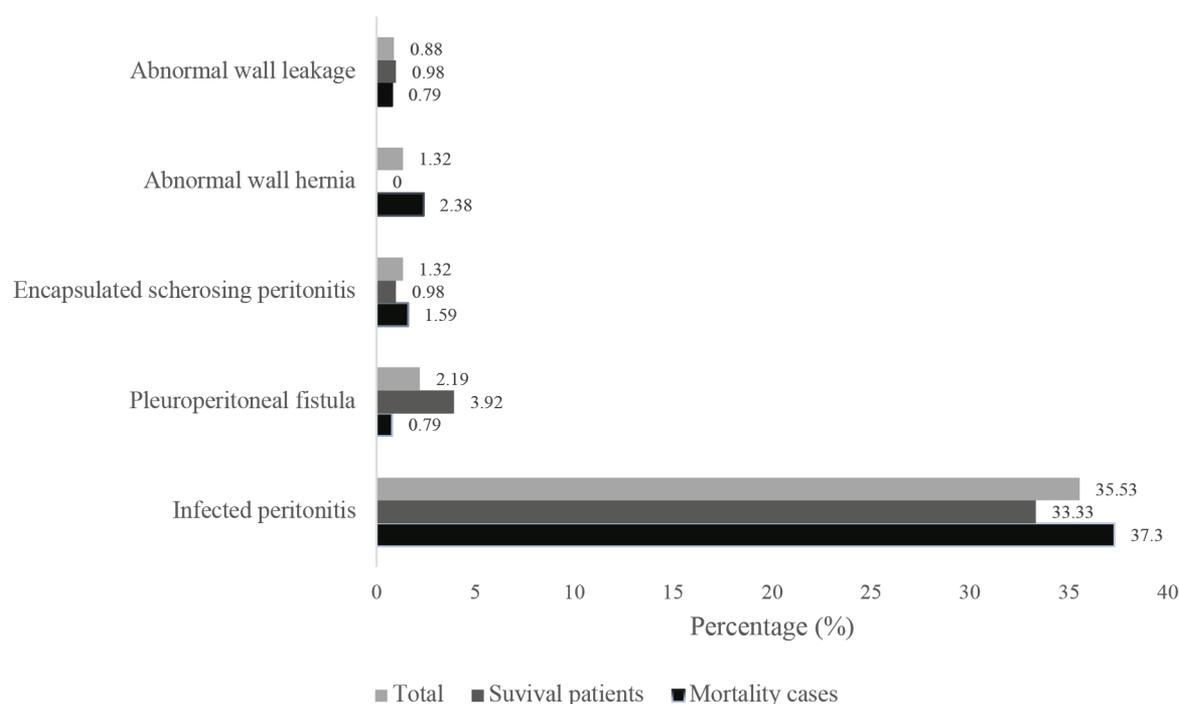

Figure 2 Continuous ambulatory peritoneal dialysis-related complications (n = 228).

Table 1 Baseline characteristics of CAPD patients between mortality and survival patients

Characteristics	Total (n = 239)	Mortality (n = 128)	Survival (n = 111)
Age, mean ± SD, years	56.59 ± 13.62	53.67 ± 13.56	59.12 ± 13.22
Gender, n (%)			
Male	115 (48.12)	60 (46.88)	55 (49.55)
Female	124 (51.88)	68 (53.13)	56 (50.45)
Marital status, n (%)			
Married	158 (66.11)	93 (72.66)	65 (58.56)
Single	55 (23.01)	24 (18.75)	31 (27.93)
Widowed	22 (9.21)	8 (6.25)	14 (12.61)
Divorced	4 (1.67)	3 (2.34)	1 (0.90)
Religion, n (%)			
Buddhism	238 (99.58)	127 (99.22)	111 (100.00)
Islam	1 (0.42)	1 (0.78)	0
Smoking, n (%)			
No smoking	208 (87.03)	112 (87.50)	96 (86.49)
Ex-smoking	30 (12.55)	16 (12.50)	14 (12.61)
Current smoking	1 (0.42)	0	1 (0.90)
Coexisting condition, n (%)			
Hypertension	225 (94.14)	123 (96.09)	102 (91.89)
Diabetes mellitus	149 (62.34)	94 (73.44)	55 (49.55)
Dyslipidemia	117 (48.95)	59 (46.09)	58 (52.25)
Gouty arthritis	56 (23.43)	28 (21.23)	28 (25.23)
Heart disease	55 (23.01)	20 (15.63)	35 (31.53)
BMI (kg/m²), mean ± SD	23.58 ± 4.77	23.26 ± 4.24	23.95 ± 5.32
Baseline lab data, mean ± SD			
Hemoglobin (g/dL)	8.34 ± 1.56	8.45 ± 1.59	8.22 ± 1.52
Hematocrit (%)	25.54 ± 4.60	25.78 ± 4.82	25.26 ± 4.34
MCV (fL)	82.62 ± 7.38	82.41 ± 6.85	82.86 ± 7.97
WBC (×109/L)	8124.90 ± 3296.32	8491.02 ± 3775.85	7702.70 ± 2591.01
Neutrophil (%)	72.31 ± 11.86	72.29 ± 11.88	72.34 ± 11.90
Lymphocyte (%)	18.15 ± 9.45	18.20 ± 10.02	18.09 ± 8.81
Basophil (%)	2.01 ± 3.88	2.70 ± 4.76	1.22 ± 2.29
Eosinophil (%)	5.70 ± 4.44	6.16 ± 4.53	5.16 ± 4.29
Platelet counts (×10⁹/L)	245364.00 ± 91878.19	252867.20 ± 101564.10	236711.70 ± 78829.32
BUN (mg/dL)	82.75 ± 39.13	92.59 ± 41.17	71.40 ± 33.36
Creatinine (mg/dL)	10.90 ± 6.73	11.06 ± 5.57	10.72 ± 7.88
GFR (mL/min), n = 235	5.47 ± 2.85	5.40 ± 2.95	5.54 ± 2.75
Albumin (g/dL), n = 237	3.30 ± 0.62	3.22 ± 0.63	3.40 ± 0.60

BMI: Body mass index; MCV: Mean corpuscular volume; WBC: White blood cell; GFR: Glomerular filtration rate; BUN: Blood urea nitrogen; Heart disease was diagnosed by a physician and recorded in medical records

One hundred and twenty-six patients had mortality after analyzing all causes. The person-time at risk was 475.60 patient-years with a median overall survival of 2.5 years (95%CI: 1.8 - 3.5). The factors associated with overall mortality after univariate analysis were age equal or over 65 years, and DM as shown in Table 2. Multivariate analysis also showed age equal to or over 65 years, DM, and serum albumin less than 2.5 g/dL associated with mortality outcomes after adjusted with sex, Hb level, albumin level, and dyslipidemia (Table 2). Kaplan-Meier curves showed overall survival in Figure 3A. Figure 3B - 3C showed overall survival by factors such as age, DM, and albumin.

Table 2 Factors associated with overall mortality in patients with CAPD (n = 228)

Parameters	Univariate Analysis			Multivariate Analysis		
	HR	95%CI	*P*-value	HR	95%CI	*P*-value
Age ≥ 65 years	1.84	1.28 - 2.66	.001	1.89	1.31 - 2.74	.001
Male	0.83	0.59 - 1.18	.312	-	-	-
Hypertension	1.28	0.52 - 3.13	.595	-	-	-
Diabetes mellitus	1.99	1.34 - 2.94	.001	1.95	1.31 - 2.88	.001
Gout	0.90	0.60 - 1.37	.640	-	-	-
Dyslipidemia	0.78	0.55 - 1.12	.181	-	-	-
BMI < 18.5 kg/m^2	1.01	0.60 - 1.77	.962	-	-	-
BMI ≥ 25 kg/m^2	0.86	0.58 - 1.28	.459	-	-	-
Hemoglobin ≤ 6 g/dL	0.65	0.29 - 1.47	.301	-	-	-
Hemoglobin ≤ 7 g/dL	1.11	0.70 - 1.76	.658	-	-	-
Hemoglobin ≤ 8 g/dL	1.02	0.71 - 1.45	.932	-	-	-
Hemoglobin ≤ 9 g/dL	0.73	0.51 - 1.05	.092	-	-	-
Hemoglobin ≤ 10 g/dL	0.63	0.40 - 1.00	.052	-	-	-
Albumin < 2 g/dL	1.69	0.42 - 6.88	.462	-	-	-
Albumin ≤ 2.5 g/dL	1.85	0.99 - 3.45	.054	2.07	1.10 - 3.89	.024
Albumin ≤ 3.0 g/dL	1.45	1.00 - 2.10	.049	-	-	-

BMI: Body mass index; HR: Hazard ratio; adj HR: Adjusted hazard ratio; CI: Confidence interval
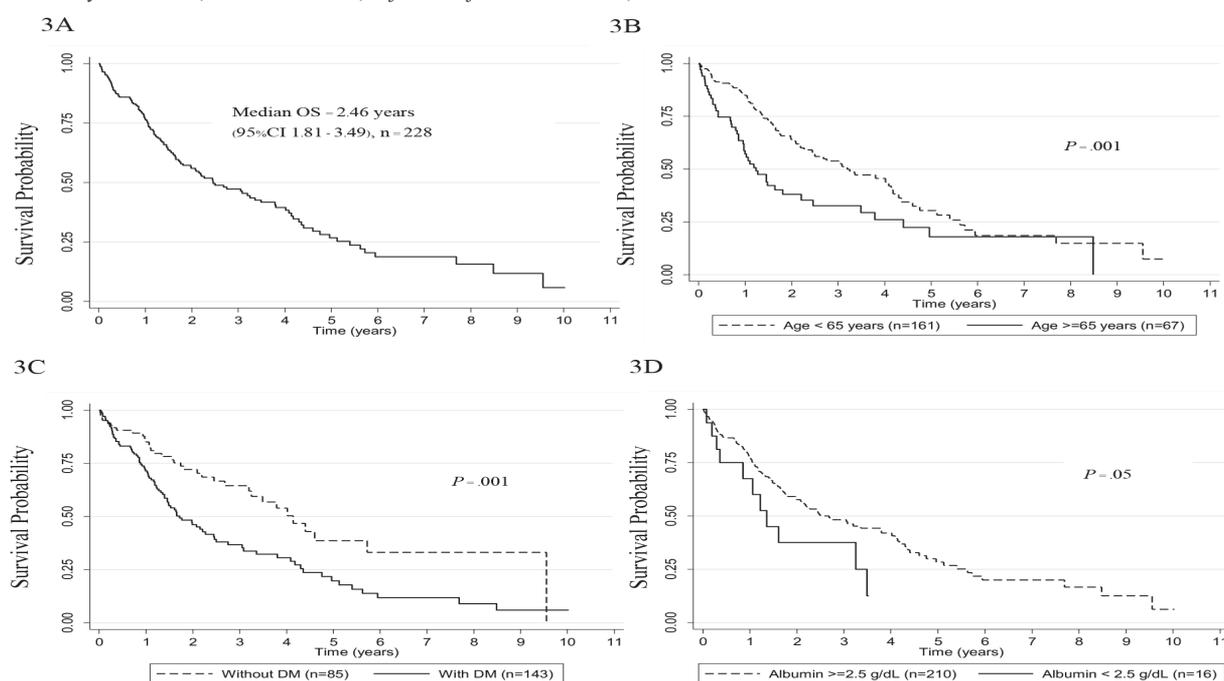

Figure 3 Graphs were performed by Kaplan-Meier Method A) Overall survival in patients with continuous ambulatory peritoneal dialysis; B) Overall survival of age ≥ 65 and < 65 years; C) Overall survival with or without diabetes mellitus (DM); D) Overall survival in patients with albumin ≤ 2.5 and > 2.5 g/dL.

Discussion

The retrospective cohort study of first initiated CAPD in Nakhon Nayok general hospital, Thailand was evaluated. The median overall survival of patients was 2.5 years. The survival rate of CAPD patients who coexist with DM in our study was lower when compared with those from previous reports.[4, 12] Several previous studies have also described the critical risk factors associated with the overall mortality in CAPD patients.[4, 8] Our study also confirmed the factors associated with the overall mortality were older age, DM, and the low level of serum albumin.

In our study showed patients with old ages had less overall survival during the first 5 years. Our results were consistent with previous studies suggesting which older age at the start of PD[4-6] and had a history of DM[4, 7, 8] were associated with mortality in CAPD patients. Although some previous studies[13-15] showed the elderly PD patients had a higher mortality rate than that of elderly hemodialysis patients, the survival of elderly PD patients was still inferior to the younger PD patients.[16] Several reports also showed a higher risk of mortality and morbidity from infection.[17-19] CAPD-related infections were consistently increased in the elderly.[20] Death due to infection may be more increased in the elderly, who have especially low immune systems. In addition, the larger in coexisting medical conditions such as diabetes mellitus or the use of high-glucose dialysate may have an additional effect on the high mortality rate.[21, 22]

DM was an independent risk factor for overall survival in our study which is similar to the previous study.[4, 7, 8] Many complications of DM such as cardiovascular, cerebrovascular, and peripheral arterial disease lead to mortality.

Several studies showed lower serum albumin levels associated with mortality.[5, 6] Although, a low level of albumin was not significant associated with survival on univariate analysis. But patients with serum albumin levels less than 2.5 g/dL were related to poor survival after multivariate analysis. Thus the level of albumin was not an independent risk factor. Hypoalbuminemia can present in poor nutritional status which occurs in elderly and DM patients. Moreover, heavy loss of serum albumin on the urinary system results in hypoalbuminemia in DM patients.

Yen-Hung Lin, et al. demonstrated that PD patients with ESRD had impaired cardiac complexity.[23] These could cause a loss of complexity in heart rate dynamics. Some studies also reported that PD is a risk factor for all-cause mortality,[24] which is inconsistent with the findings of Wang, et al.[25] However, due to incomplete data of heart disease such as types, duration, echocardiogram. So we excluded this factor from the analysis.

A previous study reported the low educational levels[4] related to mortality. Nevertheless, this factor was not collected in our study. Low education level may be involved process of CAPD care, hygiene, and nutritional status.

Particularly, the results were inconsistent between our study and other studies in terms of the association between females,[4] high BMI,[9, 26] and high hemoglobin level[6] in mortality risk. Limitation of small populations between BMI groups. Most of the patients had hemoglobin levels less than 12 g/dL so we cannot identify the elevated hemoglobin level associated with mortality.

This study constructed only the CAPD patients from a single institute, which limits the generalizing to other PD modalities. Some variables were missing. Hence, further studies with more complete data collection, additional multicenter studies might reveal more accurate risk factors for overall mortality.

In conclusion, elderly patients, diabetes mellitus, and low serum albumin are risk factors for overall mortality in CAPD patients. 3-year OS rates were determined accounting for prognostic factors. These may be used to facilitate future trial design and stratification in ESRD.

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