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Original Article

Factors affecting patient survival and technical survival in patients undergoing peritoneal dialysis

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Abstract: Background: This study was aretrospective investigation aimed at determining the factors affecting the termination of peritoneal dialysis (PD) in patients with end stage renal failure (ESRF). Methods: Patients monitored in our PD Unit between 2000 and 2012 were included in the study. Demographic, clinical, and laboratory data were recorded for each patient. Treatment outcomes (technical survival and patient survival) were obtained for the patients who dropped out of the PD treatment. These patients were separated into sub-groups according to ESRF etiologies, sociodemographic characteristics, working conditions, and properties related to PD. The survival data were analyzed by the Kaplan-Meierand Cox regression methods. Results: Of the 322 patients treated by PD, 249 dropped out of PD for reasons including exitus, peritonitis, renal transplantation, own request, dialysis, and ultrafiltration (UF) failure. Technical survival was significantly higher in patients who underwent PD under their own initiative, in patients with glomerulonephritis, and in patients whose first renal replacement treatment (RRT) was PD ($P < 0.05$). The key factor for technical survival was the albuminlevel at the end visit ($P = 0.040$). Low albumin levels at the last visit ($P = 0.001$, HR = 1.695) and patient age of 65 or over ($P = 0.01$, HR = 5.555) negatively affected patient survival, whereas active employment had a positive effect ($P = 0.01$, HR = 0.272). Conclusion: Technical survival and patient survival were affected by end visit albumin levels. Patient survival was also affected by patient age and employment status.

Keywords: Peritoneal dialysis, dropout, patient survival, technical survival

Introduction

Peritoneal dialysis (PD) is a treatment that should be preferred over hemodialysis (HD), considering its advantages in terms of good protection of remaining kidney function and superior patient survival time compared to HD in the early stages [1]. However, the number of patients undergoing PD treatment has decreased in recent years [2].

The use of PD as a treatment could be increased by providing sufficient dialysis durations and ultrafiltration targets, encouraging patients to undergo the treatment, and minimizing some of the technical problems. Examination of patients who have undergone PD treatment initially and then HD treatment for any reason can be beneficial in determining the reasons for dropping out of PD treatment. In addition, determination of other reasons for termination of PD and evaluation of the maintenance time of peritoneal dialysis (PD technique or patient survival) may provide additional reasons.

Many factors could play a role in the declining use of PD, including the growth of large-scale organizations for dialysis, recurrent peritonitis, the HD transition of increasing numbers of patients who have undergone transplantation, PD catheter-related technical problems and the patient's social and economic status [3]. The aim of the present study was to examine the factors that affect patient's survival and technical survival and the reasons for termination of PD in patients undergoing PD treatment.

Methods

Subjects

This study was conducted between 2000 and 2012 at the Nephrology Clinic of Ataturk Uni-

versity Faculty of Medicine to investigate patients with chronic renal disease whose PD treatment was terminated for any reason. Patients who were still receiving treatment were also included. Patients who had initiated PD while under the age of 18, who had transferred to other centers, or whose treatment was less than 3 months in duration were excluded from the study. Patient data were retrospectively obtained from registered follow-up files.

Data collection

The ageat initiation/termination of treatment, gender, marital status, occupation, educational status, and place of residence were determined for each patient from the records. The date of termination of treatment for each patient was used to determine monthly PD administration. The causes of end-stage renal failure in patients, concomitant conditions (including comorbid conditions), history of abdominal surgery, and lifestyle habits (such as smoking) were also determined.

Early and late complications related to PD catheters (leaks, camphor emergence, omental wrapping, and adhesions) and any infections (catheter exit site infections, peritonitis) or mechanical complications were scanned from the files. The reasons for termination of PD were then identified and recorded. For this purpose, the reasons for discontinuance of PD were identified (death, transition to hemodialysis, transplantation, etc.). The causes of death were also identified when possible.

Patients were divided into three groups: patients who were still undergoing PD treatment, patients who had been lost to PD treatment, and patients who had transferred to hemodialysis. At the first visit and the end visit, several parameters, such as weight, height, body mass index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), complete blood count, biochemical parameters, and parathyroid hormone and ferritin levels, were measured and recorded for each patient.

The initial method of renal replacement therapy and the reasons for choosing peritoneal dialysis were recorded for each group. Residual renal function (creatinine clearance) was assessed by collecting 24-hour urine after initiation of PD treatment, one month later, and at the time of termination of PD (three months before the date of drop-out). Peritoneal clearance was calculated and determined on a weekly basis. Data from peritoneal equalization tests (PETs), Kt/V_{urea}, weekly creatinine clearance (CrCl), and nPNA tests were obtained from the record so fall patients at the initiation and termination of treatment [4-6].

The PD treatment etiology of the patients was used to plot survival curves by the Kaplan-Meier method and significant differences were determined by the log rank statistical method.

Patients were further divided into subgroups based on gender (male or female), marital status (married or single, including widowed), educational level (primary six and over), obesity (body mass index (BMI) $\geq$ 30 kg/m^2) and non-obese (BMI < 30 kg/m^2), age $\geq$ 65 years and age < 65 years, PD catheter insertion with percutaneous and surgical techniques, abdominal surgery, presence or absence of comorbid diseases or conditions (diabetes, cardiovascular disease, cerebrovascular disease, peripheral arterial disease, cancer, congestive heart failure, chronic obstructive pulmonary disease, cirrhosis, systemic collagen vascular disease, hands or feet, disability state), the initial renal replacement therapy (RRT) type (hemodialysis (HD) or PD), previous history of HD, treatment preference (mandatory or self-chosen), the person implementing dialysis (i.e., the patients themselves or another), place of residence (rural or city), professional groups, and physical activity (active or inactive) and PD treatment survival analysis. Factors affecting both patient survival and PD treatment survival were also investigated. The equilibration of the effects was provided by using Cox regression analysis lamination techniques when necessary for pairwise comparisons that were significant for the effect of age and gender. The PD technique survival was defined as the time to transitioning to HD, while PD treatment survival was defined as the time to death and the time to transitioning to HD.

Statistical analysis

Statistical analysis was performed using SPSS version 18.0 and descriptive, frequency analysis, independent sample T test, chi-square test, life tables, and Kaplan-Meier survey analysis.

Table 1. PD patients characteristic features

	PD Drop-out Patients	PD continued patients	P
N	249	73	
Age (year)	48.6 ± 17.5	47.0 ± 16.7	0.761
Gender (M/F)	125/124	31/42	0.287
Weight	61.9 ± 14.4	60.6 ± 13.9	0.501
BMI	23.7 ± 5.0	23.4 ± 4.9	0.589
BSA	1.66 ± 0.22	1.64 ± 0.21	0.411
Fallowing time	34.9 ± 26.1	42.7 ± 29	0.012

BMI: Body mass index, BSA: Body surface area.

Table 2. PD drop-out causes of patients undergoing PD treatment

Cause	n	%
Death	135	54.2
Peritonitis	42	16.9
Transplantation	28	11.2
Own request	15	6.0
Inadequate dialysis	11	4.4
Ultrafiltration failure	5	2.0
Catheter related other problems*	4	1.6
Others**	9	3.6

*Drainage problems = 2, catheter malfunction = 1, leakage = 1; **abdominal surgery = 1, renal function improved = 2, omental wrapping = 1, peritoneal adhesion = 2, sepsis = 1, incompliance of treatment = 1, umbilical hernia = 1.

Patient survival and technical survival indicators were determined with the Cox regression proportional hazards method. It was compared by logrank tests to determine differences between the survival curves. A *P* value of < 0.05 was considered to be statistically significant.

Results

By the end of 2012, 355 patients received PD in our center. Patients who were under the age of 18 (n = 5), or had undergone PD treatment for less than 3 months (n = 8), or who had been transferred to another center (n = 20) were excluded from the study. The PD treatment of 249 in the remaining 322 patients (77.3%) was terminated during follow-up (**Table 1**).

The reasons for discontinuance of PD treatment are shown in **Table 2**. The most important reasons for this discontinuance were death (54.2%), peritonitis (16.9%); transplantation (11.2%), the patient's own request (6%), dialysis failure (4.4%), and ultrafiltration failure (2.0%). Rare causes were as follows, in order of frequency: improvement of renal function, peritoneal adhesions, drainage problems, leaks, catheter malfunction, abdominal surgery, omental wrapping, sepsis, noncompliance with the treatment, and umbilical hernia.

The 5-year patient survival was 62% and the 1-, 3-, and 5-year technical survival rates were 91%, 67%, and 57%, respectively. These data did not include patients who underwent transplantation. Exclusion of deceased patients revealed the main reasons for transition to HD as peritonitis (48.8%), dialysis UF insufficiency (18.6%), and own request of the patient (17.4%). Increased duration of PD also changed the distribution of dropout reasons.

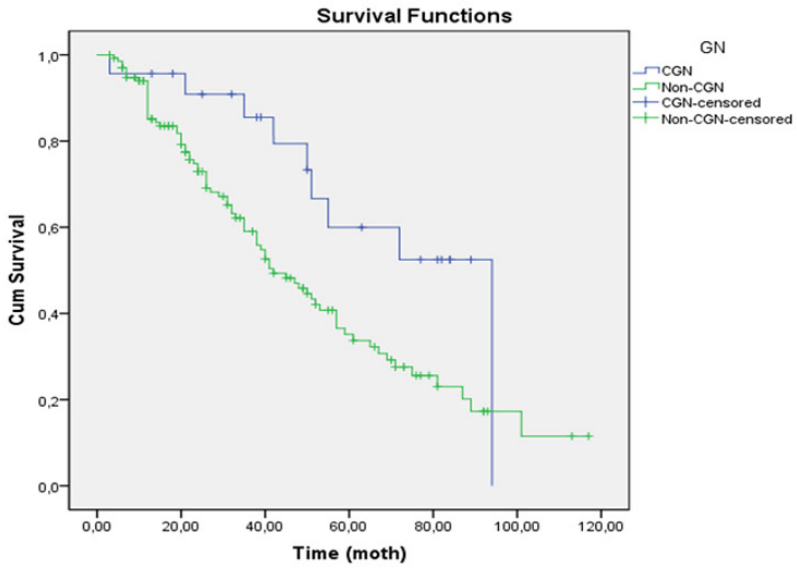
Determinants of technical survival

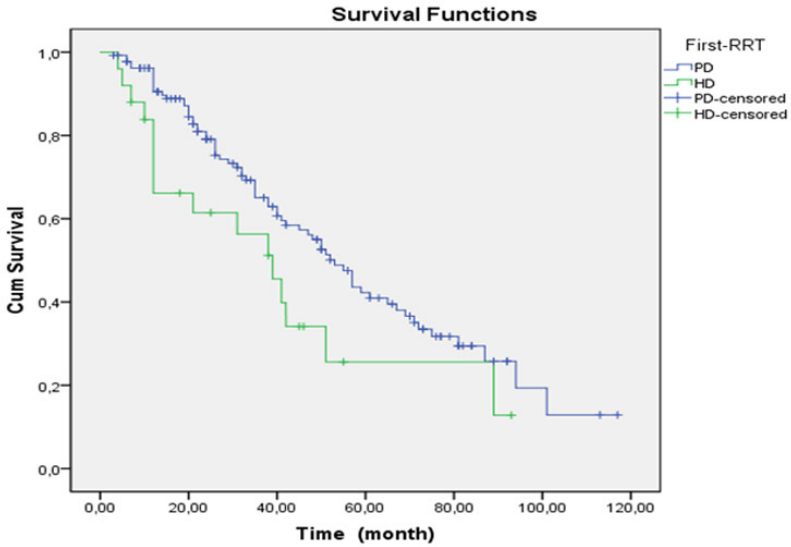
Patients with chronic glomerulonephritis (CGN) had a better survival (CGN 94 months, non-CGN 42 months; P = 0.020). The survival of patients who received PD as the initial RRT was better (PD 53 months, HD 39 months; P = 0.040). Survival was also better in patients who chose PD under their own initiative (own choice 51 months, mandatory 12 months; P = 0.015, **Figure 1**).

The results of baseline clinical and laboratory findings and residual renal function and peritoneal characteristics (taken in the first 1-3 months) prior to the end of the PD treatment (in the last 3 months) are shown in **Table 3**. Significant differences, indicated in red font in the Table, were found between patients with respect to age, albumin at the last visit, hemoglobin, and ALP levels (P < 0.05). Cox regression analysis indicated that only the albumin level at the end visit had a significant effect on technical survival (**Table 4**).

Determinants of mortality

No significant effect of gender on patient survival was determined (men 30 months, women 49 months; P = 0.147). Although not statistically significant, married patients had better survival compared to single patients (married 41 months, single 33 months; P = 0.498). Patients with high school and higher education level had better survival, although it was not statistically significant (primary education 36





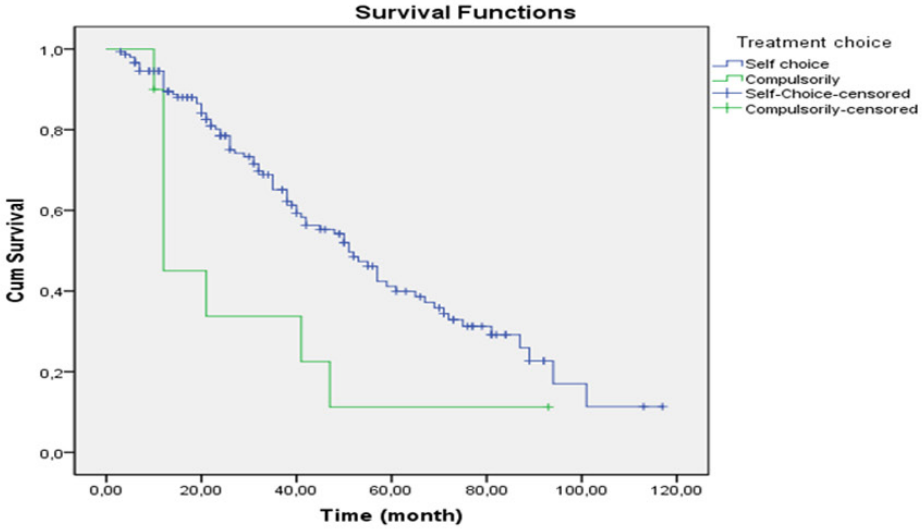


Figure 1. Determinations of technical survival.

Table 3. Clinical, laboratory and peritoneal dialysis and adequacy measures and residual renal function indicators PD dropout (death or transfer of hemodialysis) and PD continued patients

	PD continued	Death	P	PD continued	Transfer to HD	P
Gender (M/F)	31/42	71/64	0.147	31/42	40/46	0.363
Age	48 ± 16	56 ± 15	0.001	48 ± 16	41 ± 16	0.013
BMI	23 ± 5	25 ± 5	0.018	23 ± 5	22 ± 4	0.162
Alb-first visit	3.1 ± 0.7	3.2 ± 0.6	0.665	3.1 ± 0.7	3.2 ± 0.7	0.406
Alb-last visit	3.5 ± 0.5	2.8 ± 0.6	0.0001	3.5 ± 0.5	3.0 ± 0.6	0.006
Hb-first visit	8.4 ± 2.0	9.7 ± 1.9	0.01	8.4 ± 2.0	9.1 ± 2.2	0.244
Hb-last visit	10.9 ± 1.5	10.7 ± 2.3	0.700	10.9 ± 1.5	9.6 ± 2.0	0.016
PTH-first visit	455 ± 175	360 ± 346	0.255	455 ± 175	430 ± 435	0.807
Pth-last visit	366 ± 246	262 ± 337	0.213	366 ± 246	391 ± 417	0.806
Ferri-first visit	404 ± 311	444 ± 458	0.711	404 ± 311	520 ± 459	0.311
Ferri-last visit	365 ± 270	480 ± 417	0.259	365 ± 270	616 ± 594	0.083
ALP-first visit	188 ± 83	169 ± 124	0.623	188 ± 83	184 ± 119	0.918
ALP-last visit	243 ± 179	159 ± 104	0.017	243 ± 179	147 ± 118	0.019
Ca-first visit	7.7 ± 1.0	8.0 ± 1.0	0.288	7.7 ± 1.0	8.1 ± 1.0	0.226
Ca-last visit	8.6 ± 0.9	8.4 ± 1.0	0.614	8.6 ± 0.9	8.7 ± 0.8	0.504
P-first visit	5.2 ± 2.0	5.4 ± 1.9	0.748	5.2 ± 2.0	5.2 ± 1.4	0.996
P-last visit	4.7 ± 1.0	4.3 ± 1.6	0.371	4.7 ± 1.0	4.6 ± 1.5	0.849
nPNA-first visit	1.7 ± 1.1	0.9 ± 0.3	0.0001	1.7 ± 1.1	1.3 ± 1.0	0.329
nPNA-last visit	1.2 ± 0.5	0.7 ± 0.3	0.002	1.2 ± 0.5	1.0 ± 0.5	0.394
GFR-first visit	5.7 ± 4.3	4.6 ± 5.7	0.626	5.7 ± 4.3	4.0 ± 4.8	0.369
GFR-last visit	5.1 ± 5.4	1.8 ± 5.3	0.045	5.1 ± 5.4	3.8 ± 10.1	0.657
KT/V-first visit	2.3 ± 0.7	2.3 ± 1.0	0.883	2.3 ± 0.7	2.4 ± 0.7	0.801
KT/V-last visit	2.2 ± 0.6	2.0 ± 0.6	0.253	2.2 ± 0.6	2.1 ± 0.5	0.446

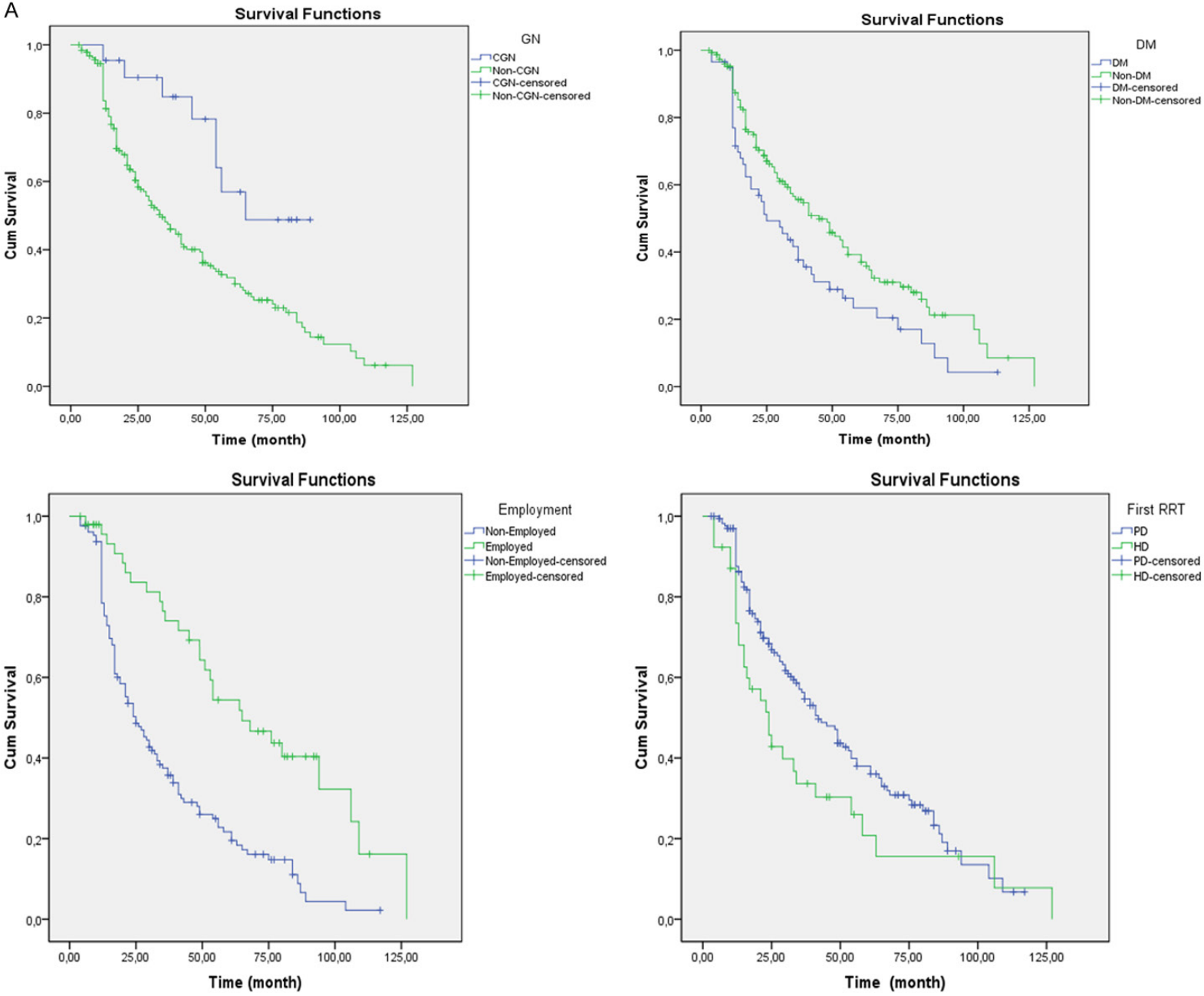
Abbreviations: PTH: Parathyroid hormone, UF: ultrafiltration, RRF: residual renal function, rGFH: residual glomerular filtration rate, CrCl: creatinine clearance, nPNA: normalized protein equivalent, D/P creatinine: dialysate/plasma creatinine ratio.

Table 4. Factors, affecting technical survival according to Cox regression analysis

	P	HR	95% CI
Age	0.662	1.003	0.988-1.018
Treatment Choice	0.074	1.549	0.916-6.609
Albumin (last visit)	0.040	1.693	0.525-5.763

months, high school and over 58 months; P = 0.220). Employed patients had a significantly better survival than unemployed patients (employed 65 months, unemployed 25 months; P = 0.0001). Although not significant, the survival of patients living closer to the dialysis center was better (urban areas 39 months, rural areas 37 months; P = 0.529). Patient survival was worse in diabetes (DM) patients (DM 25 months, non-DM 45 months; P = 0.016). Patients with CGN had a better survival compared to patients without CGN (CGN 65 months, non-CGN 34 months; P = 0.004). Survival for patients with amyloidosis was worse, although not statistically significant (amyloidosis 24 months, non-amyloidosis 41 months, P = 0.083). Survival was better for patients who initiated their RRT with PD (PD42 months, HD 24 months; P = 0.036). The survival was worse for patients who were mandatorily assigned PD (own choice 41 months, mandatory 16 months; P = 0.001). Patient survival was worse in patients with 3 or more comorbid conditions (≥ 2 conditions, 41 months, ≥ 3 conditions, 30 months; P = 0.022). Patient survival was better in patients who could conduct dialysis themselves (self 35 months, assisted 21 months; P = 0.007). Patients aged 65 years and over had a poorer survival compared to younger patients (elderly 26 months, young 49 months; P = 0.0001, **Figure 2A** and **2B**). Cox regression analysis revealed that age, employment, and albumin levels at the final visit were important determinants of patient survival (**Table 5**).

A


Survival Functions
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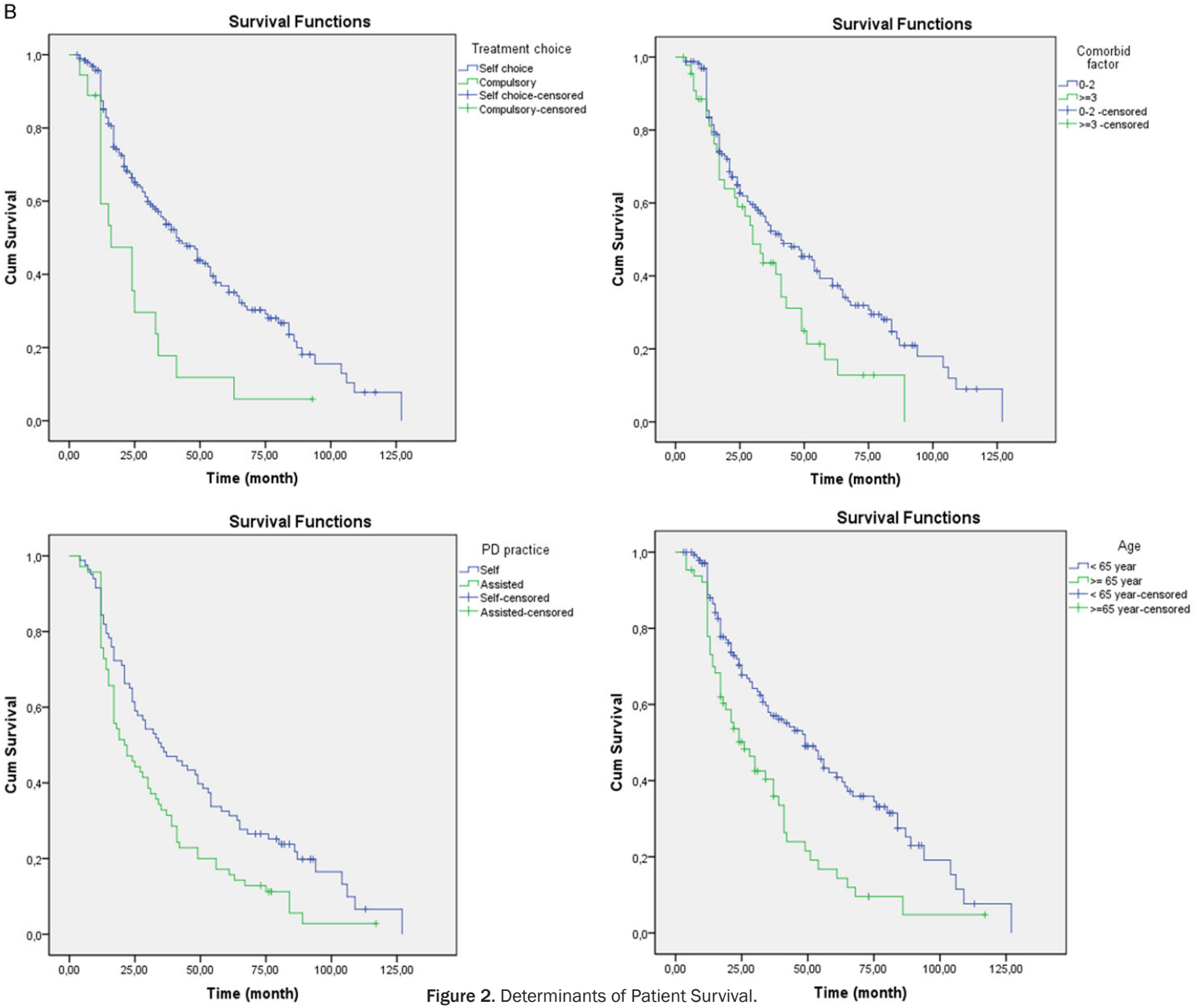

Figure 2. Determinants of Patient Survival.

Table 5. Factors affecting patient survival according to Cox regression analysis

	P	HR	95% CI
> 65 year	0.01	5.555	1.507-20.473
Employed	0.01	0.292	0.115-0.742
Albumin (last visit)	0.001	1.695	0.370-7.763

Discussion

According to our findings, the most important reasons for termination of PD were death, peritonitis, and transplantation. These reasons were followed by transition to HD at the patient's own request, insufficiency of dialysis, and insufficiency of ultrafiltration. The factors affecting the duration of the PD treatment term were primarily ESRF (DM, CHN, and amyloidosis), the activity level of the patient, whether the patient had been mandatorily assigned the treatment, the presence of HD history, the ability of the patient to conduct self-treatment, and patient age. The ESRF etiologies significantly affected PD treatment durations. The lowest median PD treatment term was observed in patients with DM and amyloidosis, while the longest was observed in patients with CGN. Patient survival and technical survival rates were very good during the first year of PD treatment. At year 5, the decrease was somewhat greater than that reported at other centers. Sociodemographic characteristics, such as gender, marital status, education level, and proximity to the dialysis center, did not have statistically significant effects on the term of administration of PD. In physically active patients, the term of treatment was statistically significantly longer when compared to inactive patients. In patients who had received HD as the initial RRT, the PD term was shorter; it was longer in patients whose initial RRT was PD. The duration was shortened in cases where the patient was mandatorily assigned PD. The PD survival decreased with an increase in comorbid conditions. PD survival was shorter in patients aged 65 years and over. Low albumin levels at the last visit negatively affected patient survival.

PD is an inexpensive ESRF treatment that provides patients with the ability to move freely. It has no differences in terms of survival when compared with HD and has similar end points [7, 8]. Consequently, the reduction in PD patients in recent yearsis noteworthy [9].

The 5-year technical survival rate varies between countries. This rate has been reported as 83% in Japan, [10], 72% in Italy [11], 61% in Canada [12], and 55.7% in China [13]. In Turkey, Sipahioğlu *et al*. have reported a 5-year survival rate of 66.7% [14]. In our study, the 5-year technical survival rate was 57%. This relatively lower result may be due to regional differences (poor hygiene, low educational level, and low socioeconomic level).

In Japan, the primary cause of technical failure was reported as a loss of UF [10, 15, 16]. Nakamoto *et al*., in a study conducted in Japan on 139 PD patients, reported that three primary reasons for transition to HD were UF insufficiency or non-compliance with salt-water restriction (34.1%), peritonitis (30.1%), and choice of physician or family (6.5%) [16]. Ke *et al*. conducted an observational study in China on 130 PD patients and reported the most important reasons for technical insufficiency were dialysis insufficiency (28.5%) and peritonitis (21.4%) [17]. A multi-center study conducted in Italy found the most frequent causes of technical insufficiency were peritonitis (36.7%) and insufficient dialysis (16.7%) [18]. The results of our study are similar to the study in Italy. The high rates of peritonitis in our country, compared to Japan and China, may be related to poor sanitation and failure to provide adequate training.

Hypoalbuminemia has previously been reported to have a negative effect on technical survival [19]. A similar finding was observed in the present study, where low albumin level, particularly at the last visit, negatively affected the technical survival. A lower technical survival has also been reported for diabetic patients [20]. In our study, technical insufficiency was more prevalent in patients with diabetes mellitus.

Several studies have reported that technical survival was affected by treatment preference. Koç *et al*. demonstrated that patients who were mandatorily assigned PD treatment, rather than choosing it on their own initiative, had poorer PD treatment survival. This poorer survival in these patients could be due to comorbid conditions [21]. In the patients who had previously received HD treatment, most of the transitions (70%) could be due to vascular problems and this could adversely affect patient and technical survival [14]. If the choice of

treatment is a person's own decision, then the compliance with the treatment may increase [22]. In our study, mandatory assignment of PD treatment had a negative effect on technical survival. Therefore, mandatory assignment of PD can be said to accompany bad endpoints.

The various studies report differences in death as the most important reason for drop-out of PD. Kawaguchi *et al*. examined 282 patients who had discontinued peritoneal dialysis and reported a mortality rate of 32.3% [23]. In other studies, the mortality rates have been reported as 27.4% [24], 39.7% [25], and 40.3% [26]. Sanchez *et al.* reported a mortality rate of 57% in patients whose PD treatment was terminated and who were treated with CAPD [27]. In our patient group, death was the most important reason for PD treatment termination and approximately half the patients discontinued treatment for this reason. These results were similar to recent studies. Comparison of our findings to the first study gave a mortality rate half of that reported, while comparison to the second study gave a higher rate. The reason for these discrepancies can be geographic, sociocultural, and genetic factors of the patients, as well as an impact of the treatment center.

Many studies have reported hypoalbuminemia as one of the important determinants of patient survival, in particular in CKD patients [28-31]. In our study, similar to previous studies, low albumin level had a negative effect on patient survival. Studies have also reported that the survival was dramatically decreased in patients over 65 years of age [32, 33]. Our study showed similar results, as Cox regression analysis indicated that the most important factor negatively affecting patient survival was the increase in age.

In our study, the PD patients who were actively working (physically) had a significantly higher patient survival rate when compared to the inactive (non-employed) patients. A previous study reported that PD patients who decreased their physical activity were more likely to experience depression and insomnia [34]. Our results can be explained by taking this earlier study into account: our patients who were inactive, older, or bedridden may have had a tendency toward depression and chronic fatigue syndrome. Consideration of age status in our study indicated that the average age of inactive patients was statistically higher when compared to the active patients. The PD technical survival difference was thought to be related to this. However, even after accounting for patient age, physical activity was found to have a significant effect on survival. According to these results, physical activity (employment) status has a protective effect on PD technical survival.

Consequently, the reasons for termination of PD were death, peritonitis, and transplantation. Peritonitis was the most important reason for leaving PD, although this may change since the rate of transplantation is increasing. The albumin levels affected both technical and patient survival, while the treatment choice had a near-significant effect on technical survival. Advnced age negatively affected patient survival, whereas the employment status of patients positively and significantly affected their survival.

Disclosure of conflict of interest

None.

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