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The impact of type of assistance on characteristics of peritonitis in elderly peritoneal dialysis patients

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Abstract
Background The elderly patients are the fastest-growing end-stage renal disease (ESRD) population in Taiwan. Assisted peritoneal dialysis (PD) has been employed to overcome the barriers to PD. The aim of this retrospective, single-center study was to describe the status of assisted PD and the impact of type of assistance on peritonitis in elderly patients in Taiwan.
Methods One hundred and two patients initiated PD at the age of 65 or older between 2000 and 2008; 79 episodes of peritonitis occurred during the follow-ups. The patients and episodes of peritonitis were divided into three groups based on the type of assistance: (1) self-care: patients performing dialysis independently, (2) family: patients whose dialysis was performed by family, (3) caregiver: patients whose dialysis was performed by a private caregiver. Patient characteristics and incidence, etiology and outcomes of peritonitis were compared.
Results There were 26 (25.5%), 44 (43.1%), and 32 (31.4%) patients in the self-care, family, and caregiver groups, respectively. The overall peritonitis rate was 1/33 patient-months. Patients in the caregiver group were older and had more comorbidities than the self-care group. They had a trend of higher overall peritonitis rate (1/24 patient-months, $P = 0.077$) and fungal peritonitis rate ($P = 0.060$) compared to the self-care and family groups, but this was statistically non-significant.
Conclusions Three-fourths of elderly PD patients in the present study required assistance from family members or private caregivers. Caregiver-assisted patients were significantly older and had more comorbidities. Also, a non-significant trend of higher peritonitis incidence was observed in these patients.

Keywords Assisted peritoneal dialysis · Caregivers · Elderly patients · Peritoneal dialysis · Peritonitis

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Introduction

The elderly population is the fastest-growing age-group of end-stage renal disease (ESRD) in developed countries [1, 2]. A similar trend is observed in Taiwan with patients at 65 years of age or older, accounting for nearly one half of the incident dialysis population in recent years [3]. For elderly patients, home-based peritoneal dialysis (PD) therapy offers particular advantages, including cardiovascular stability, no vascular access, independence from hospital, and better preservation of residual renal function [2, 4]. The North Thames Dialysis Study (NTDS), a 12-month prospective cohort study conducted in the

United Kingdom, showed similar clinical outcomes and quality of life in elderly PD and hemodialysis (HD) patients [5]. Nonetheless, elderly patients are treated with PD at a lower rate than younger patients, since greater disease burdens, functional decline, and psychosocial problems are common obstacles to self-care PD [1, 6]. Assisted PD has been developed in a number of countries to overcome the barriers and to increase the availability of PD for elderly patients. The risk of peritonitis in elderly assisted PD patients has been a particular concern. Previous studies have shown similar risks of peritonitis in elderly and younger patients [7–11]. Besides, elderly patients treated with assisted PD had comparable peritonitis rates to self-care patients [8, 9, 12].

Home-care assistance for PD can be provided by family members, home-care nurses, or visiting health care professionals [1]. The prevalence and type of assistance for PD vary from country to country. A previous study in our PD unit showed that 73.6% of elderly patients required assistance [10]. The type of PD assistance in Taiwan has not been addressed previously. Home care has been the mainstay of elder care in Taiwan. Families are allowed to employ migrant caregivers if there is a sick or elderly individual requiring 24-hour care and if no domestic caregiver is available. An increasing number of migrant caregivers have been employed in health care services, most commonly from Vietnam, Indonesia, and the Philippines. Family members and migrant workers were the principal caregivers for 53.61 and 14.27% of disabled elders, respectively [13]. Family members as well as migrant caregivers play an important role in assisting home-based PD in dependent elderly patients in Taiwan. Caregiver-assisted PD poses a challenge to PD programs, and it is not known whether the incidence and characteristics of PD-related peritonitis are affected. This retrospective study was carried out to describe the status of assisted PD and the impact of the type of assistance on peritonitis rate in elderly patients from a single PD center in Taiwan.

Methods

Patients

Six hundred and ninety-four patients entered the PD program in our medical center in Taiwan between January 2000 and December 2008, and 141 patients (20.3%) who initiated PD at 65 years of age or older were defined as the elderly population. Elderly patients initiating PD with continuous follow-up in this hospital were enrolled in the study. Patients were excluded if they had expired or had been transferred to other modalities of renal replacement therapy within 90 days from PD start. The eligible patients were followed until permanent withdrawal from PD, death, or study end (September 2009).

A qualified PD nurse was assigned to each patient at the start of PD. The patients and their family and/or caregiver undertook standardized PD training courses and simulated PD procedure. They were required to pass the posttraining test before starting to perform PD at home or in the hospital. After discharge, the patients were monitored in our PD clinics on a monthly basis. Routine reevaluations of PD-related knowledge and techniques were performed one month after discharge from the hospital, one year after the initiation of PD, and whenever an episode of peritonitis occurred.

The eligible patients were divided into three groups based on the type of PD assistance: (1) self-care group: patients who performed the dialysis procedure independently, (2) family group: patients whose dialysis procedure was performed by a family member, (3) caregiver group: patients whose dialysis procedure was performed by a private caregiver. The latter two groups were collectively termed as the "assisted PD group". Patient demographics and clinical data were compared among the three groups.

Data collection

Patient characteristics including age, gender, cause of ESRD and comorbid conditions at the initiation of PD were retrieved. The modified ESRD comorbidity index and the Charlson comorbidity index were used to assess comorbid disease in this cohort of elderly ESRD patients [14, 15]. Clinical data including the modality of PD [continuous ambulatory peritoneal dialysis (CAPD) or automated peritoneal dialysis (APD)], the status of PD assistance, and duration of follow-up were recorded.

Peritonitis was diagnosed according to the ISPD guideline when the patient exhibited at least two of the following three criteria: (1) abdominal pain or cloudy peritoneal effluent, (2) peritoneal effluent with a white blood cell count more than 100/mm^3 and the

percentage of neutrophil more than 50%, (3) positive peritoneal effluent culture [16]. All episodes of peritonitis in the eligible patients were reviewed. In order to evaluate the impact of the type of assisted PD on peritonitis, those episodes that occurred within 30 days from peritoneal catheter placement or other abdominal surgery were excluded. Relapsing peritonitis, defined as an episode that occured within 4 weeks of completion of therapy of a prior episode with the same organism or one sterile episode, was not counted as a distinct episode [16]. The etiology of each episode was recorded, as well as outcomes such as relapse, Tenckhoff catheter removal, technique failure, and peritonitis-related death. Technique failure was defined as permanent transfer to HD. Peritonitis-related death was defined as death due to sepsis, death occurring with a positive effluent culture, death within 14 days after onset of peritonitis, or death occurring during hospitalization for any patient admitted with peritonitis [17].

Statistical analysis

Statistical analysis was performed using SPSS software, version 16.0 (SPSS Inc, Chicago, IL, USA). Continuous variables were expressed as means and standard deviations (SD), and categorical variables were expressed as frequencies and percentages, unless otherwise specified. Patient demographics, clinical data, characteristics of peritonitis, and probability of a 12-month peritonitis-free period were compared among the three patient groups using chi-square test, Fisher's exact test, or one-way ANOVA test, as appropriate. The peritonitis rate was expressed as the interval between episodes of peritonitis (one episode per '*n*' patient-months). To compare the peritonitis rates, the occurrence of peritonitis was assumed to distribute as binomial distribution with treatment duration. *P* was tested, and 95% confidence interval was calculated. *P* values < 0.05 were considered statistically significant. *P* values were corrected by the Bonferroni method to allow for multiple comparisons.

Results

Patient demographics and clinical data

A total of 102 incident patients met the eligibility criteria. Their mean age at the start of PD was 73.0 ± 6.4 years (range 65–100 years), and 15 patients (14.7%) were 80 years of age or older. There were 50 men (mean age 72.5 ± 6.5 years-old) and 52 women (73.4 ± 6.4 years-old). The most common cause of ESRD was diabetes mellitus (40.2%). The median follow-up duration was 616 days (range 93–2676 days).

The type of assistance for PD in elderly patients was distributed as follows: 26 patients in the self-care group (25.5%), 44 patients in the family group (43.1%), and 32 patients in the caregiver group (31.4%). Self-care patients were significantly younger (68.5 ± 3.6 years) than patients in the family group (73.5 ± 7.1 years) and caregiver group (75.9 ± 5.3 years) ($P < 0.001$). There were more male patients in the self-care group (20/26, 76.9%) ($P = 0.002$). Patients in the caregiver group had more severe comorbid conditions, represented by a higher modified ESRD comorbidity index (mean = 2.38 ± 2.14, median = 2), than those in the self-care (mean = 1.15 ± 1.76, median = 0) and family groups (mean = 1.55 ± 1.45, median = 1) ($P = 0.027$). The result was similar when the Charlson comorbidity index was used ($P = 0.006$). We observed no significant difference regarding the cause of ESRD or the prevalence of diabetes mellitus among the three groups. Patients in the family group had the highest rate of APD utilization (15/44, 30.4%), but the difference was not statistically significant ($P = 0.101$). Comparisons of baseline demographics and clinical data of three groups of elderly PD patients are presented in Table 1.

Incidence of peritonitis

From January 2000 to September 2009, 79 episodes of peritonitis occurred in 48 patients. Overall, the peritonitis rate was one episode per 33 patient-months, and the probability of a 12-month peritonitis-free period was 72.5%. The peritonitis rate in the self-care, family, and caregiver groups was one episode per 39, 37, and 24 patient-months, respectively. Patients in the caregiver group had a higher peritonitis rate, and the difference from those of the self-care and family groups was not significant ($P = 0.077$). There was no significant difference regarding the probability of a 12-month peritonitis-free period ($P = 0.267$), as well. Eleven episodes (13.9%) of peritonitis occurred during hospitalization for other causes than peritonitis, implying nosocomial infection. The incidence of

Table 1 Baseline demographics and clinical data of elderly incident peritoneal dialysis patients

	Total	Self-care	Family	Caregiver	*P*
Number of patients	102	26 (25.5%)	44 (43.1%)	32 (31.4%)	
Age at PD start (years)†	73.0 ± 6.4	68.5 ± 3.6	73.5 ± 7.1	75.9 ± 5.3	<0.001
Male gender†	50 (49.0%)	20 (76.9%)	20 (44.4%)	10 (32.3%)	0.002
Cause of renal failure					0.235
Diabetes mellitus	41 (40.2%)	6 (23.1%)	21 (47.7%)	14 (43.8%)	0.094
Hypertension	12 (11.8%)	2 (7.7%)	8 (18.2%)	2 (6.2%)	
Chronic glomerulonephritis	31 (30.4%)	11 (42.3%)	8 (18.2%)	12 (37.5%)	
Gouty nephropathy	5 (4.9%)	2 (7.7%)	3 (6.8%)	0	
Polycystic kidney disease	2 (2.0%)	1 (3.8%)	0	1 (3.1%)	
Tubulointerstitial nephritis	1 (1.0%)	1 (3.8%)	0	0	
Obstructive uropathy	2 (2.0%)	0	1 (2.3%)	1 (3.1%)	
Unknown	8 (7.8%)	3 (11.8%)	3 (6.5%)	2 (6.2%)	
Charlson comorbidity index (median and range)*	4 (2–10)	2 (2–7)	4 (2–6)	5 (2–10)	0.006
Modified ESRD comorbidity index (median and range)*	1 (0–7)	0 (0–7)	1 (0–6)	2 (0–7)	0.027
Follow-up duration (days) (median and range)†	616 (93–2676)	1025 (157–2588)	568 (109–2676)	539 (93–1832)	0.001
Automated PD	26 (25.5%)	7 (26.9%)	15 (34.1%)	4 (12.5%)	0.101

† $P < 0.05$, caregiver and family versus self-care group

* $P < 0.05$, caregiver versus self-care group

nosocomial peritonitis was higher in the caregiver group (6/29, 20.7%), but the difference was not statistically significant ($P = 0.384$).

Etiology of peritonitis

Eighteen episodes (22.8%) were culture-negative, and 11 episodes (13.9%) grew more than one organism. Gram-positive and Gram-negative infections accounted for 31 (39.2%) and 17 (21.5%) episodes of peritonitis, respectively. The caregiver group had a significantly lower rate of culture-negative peritonitis [1/29, 3.4% ($P = 0.007$)]. Otherwise, the rate of peritonitis caused by Gram-positive organisms, Gram-negative organisms, or specific bacteria was not significantly different between the groups.

A total of 10 episodes of fungal peritonitis (12.7%) occurred in 10 individuals. The majority of fungal peritonitis was caused by *Candida* species, including *Candida albicans* (30%), *Candida parapsilosis* (30%), *Candida tropicalis* (20%), and *Candida glabrata* (10%). *Trichosporon* was responsible for one episode (10%). A higher frequency of fungal peritonitis in the caregiver group (7/29, 24.1%) than the self-care (2/25, 8.0%) and family groups (1/25, 4.0%) was observed, and the difference was of borderline statistical significance ($P = 0.060$). The frequency and causative microorganisms of peritonitis as well as comparisons between the three groups are shown in Table 2.

Clinical outcomes of peritonitis

Overall, the rate of relapsing peritonitis was 7.6%, and the rate of catheter removal was 20.3%. The caregiver group had a higher rate of catheter removal (10/29, 34.5%) than the family group (2/25, 8.0%) (overall $P = 0.044$; $P = 0.020$ in post hoc comparisons). Technique failure complicated 22.8% of the episodes. Peritonitis-related death occurred in 10.1% of all episodes, and the mortality rate was not significantly different between the three groups ($P = 0.713$). Clinical outcomes following peritonitis and comparisons of groups are shown in Table 3.

Different causative microorganisms of peritonitis were associated with diverse outcomes. Among culture-negative peritonitis, none of the patients experienced catheter removal, technique failure, or

Table 2 Frequency and characteristics of peritonitis in elderly peritoneal dialysis patients

	Total	Self-care	Family	Caregiver	*P*
Episode of peritonitis	79	25 (31.6%)	25 (31.6%)	29 (36.7%)	
Automated PD	18 (22.8%)	6 (24.0%)	9 (36.0%)	3 (10.3%)	0.080
Nosocomial peritonitis	11 (13.9%)	2 (8.0%)	3 (12.0%)	6 (20.7%)	0.384
Peritonitis rate (one episode per '*n*' patient-months) (95% confidence interval)	1/33 (1/27–1/43)	1/39 (1/28–1/64)	1/37 (1/27–1/59)	1/24 (1/17–1/38)	0.077
Probability of a 12-month peritonitis-free period	72.5%	80.8%	75.0%	62.5%	0.267
Microbiology					
Number of growth (*n*)*					0.050
$n = 0$	18 (22.8%)	9 (36.0%)	8 (32.0%)	1 (3.4%)	
$n = 1$	50 (63.3%)	11 (44.0%)	15 (60.0%)	24 (82.8%)	
$n \geqq 2$	11 (13.9%)	5 (20.0%)	2 (8.0%)	4 (13.8%)	
Causative microorganisms*					0.032
Culture-negative[¶]	18 (22.8%)	9 (36.0%)	8 (32.0%)	1 (3.4%)	0.007
Gram-positive	31 (39.2%)	9 (36.0%)	9 (36.0%)	13 (44.8%)	0.741
CNS	11 (13.9%)	4 (16.0%)	5 (20.0%)	2 (6.9%)	0.358
Staphylococcus aureus	10 (12.7%)	2 (8.0%)	2 (8.0%)	6 (20.7%)	0.263
Gram-negative	17 (21.5%)	3 (12.0%)	6 (24.0%)	8 (27.6%)	0.356
E. coli	7 (8.9%)	3 (12.0%)	3 (12.0%)	1 (3.4%)	0.436
Pseudomonas aeruginosa	3 (3.8%)	0	2 (8.0%)	1 (3.4%)	0.332
Fungus	10 (12.7%)	2 (8.0%)	1 (4.0%)	7 (24.1%)	0.060
Other (mixed or anaerobes)	3 (3.8%)	2 (8.0%)	1 (4.0%)	0	

CNS coagulase-negative staphylococci

* $P < 0.05$, caregiver versus self-care group

[¶] $P < 0.05$, caregiver versus self-care and family groups

Table 3 Clinical outcomes following peritonitis in elderly peritoneal dialysis patients

	Total	Self-care	Family	Caregiver	*P*
Episode of peritonitis	79	25 (31.6%)	25 (31.6%)	29 (36.7%)	
Relapse	6 (7.6%)	3 (12.0%)	3 (12.0%)	0	0.152
Catheter removal[§]	16 (20.3%)	4 (16.0%)	2 (8.0%)	10 (34.5%)	0.044
Technique failure	18 (22.8%)	4 (16.0%)	4 (16.0%)	10 (34.5%)	0.168
Peritonitis-related death	8 (10.1%)	2 (8.0%)	2 (8.0%)	4 (13.8%)	0.713

[§] $P < 0.05$, caregiver versus family group ($P = 0.020$ in post hoc comparisons)

mortality. On the other hand, all the ten episodes of fungal peritonitis were treated with immediate catheter removal according to the ISPD recommendations, and the mortality rate of fungal peritonitis was 40%.

Discussion

Taiwan reported the highest rates of incidence and prevalence ESRD in the world in 2007. Patients aged 65 or above accounted for 52.5% of incident and 40.8% of prevalent dialysis population. The rate of utilization of PD in the elderly ESRD population rose from 3.1% in 2001 to 4.0% in 2007 as the overall rate grew from 6.5% to 8.5% in Taiwan [18, 19]. Elderly individuals were still less likely to start on PD than their younger counterparts despite potential benefits of PD for both active and frail elders. The number of barriers to PD increases with age and in part contributes to the under-utilization of PD in the

elderly population [2, 6]. Consequently, assisted PD has been advocated and funded in a number of countries [20, 21].

In the present study, the majority of elderly patients (74.5%) required assistance for PD. The home-care assistance was provided by a family member (43.1%) or a private caregiver (31.4%). All of the private caregivers in this cohort were migrant workers from neighboring Southeast Asian countries, indicating the importance of migrant caregivers in the elderly assisted PD in Taiwan. Patients in the caregiver group were older and had more severe comorbid diseases than the self-care and family groups. Verger et al. reported a similar association in the analysis of the French Language Peritoneal Dialysis Registry (RDPLF). They observed that patients with older age and with more comorbidities had lower degrees of autonomy and were more commonly assisted by a private nurse than by a family member [22]. With the expansion of elderly PD population in Taiwan, migrant caregivers will continue to play an important role in assisted PD, especially for more dependent elderly patients.

Previous studies showed that elderly assisted and self-care PD patients had similar peritonitis risks, and results in both CAPD and APD patients have been reported. Szeto et al. reviewed 1,065 episodes of peritonitis in 832 patients from 1997 to 2007. The incidence and etiology spectrum of peritonitis were similar in elderly and younger PD patients, and in elderly self-care and assisted patients as well [9]. Kadambi et al. studied a cohort of 493 PD patients with a high percentage (>90%) of APD utilization. The elderly patients had similar overall and Gram-positive peritonitis rates compared to younger ones, but a higher rate of Gram-negative peritonitis [11]. In France, the elderly population accounts for a high percentage of PD patients, and assistance is frequently needed and most commonly provided by a private nurse [22]. Verger et al. reviewed 1,624 new APD patients in RDPLF to study the association of type of home-care assistance with peritonitis rate. Family-assisted patients had a higher probability of a 2-year peritonitis-free period than nurse-assisted patients. When visits by nurses from the training center were provided, the probability of being peritonitis-free in nurse-assisted patients improved. The degree of personal involvement in the care of a single patient and the availability of retraining were presumed to account for the difference between family and private nurses [23]. In the present study, patients in the caregiver group showed a trend of higher overall peritonitis rate. The rates of peritonitis due to Gram-positive organisms, coagulase-negative staphylococcus, and *Staphylococcus aureus* were not different among the three groups of patients. There was no significant difference in the rate of Gram-negative peritonitis, as well.

A high incidence (12.7%) of fungal peritonitis was observed in this study, especially in the caregiver group (24.1%), compared to 3–6% reported in the literature. Recent bacterial peritonitis and prolonged use of antibiotics have been regarded as major risk factors for fungal peritonitis [24, 25]. Age was not found as a risk factor [26]. Troidle et al. studied 19 episodes of nosocomial peritonitis with a high incidence of candidal peritonitis (21%). They reported that increased age and prolonged hospitalization were risk factors for nosocomial peritonitis, and causative microorganisms were different from those in community-acquired infections [27]. In our cohort, six patients acquired fungal peritonitis during hospitalization, and six patients had prior bacterial peritonitis. Only one patient had neither risk factor for fungal peritonitis. Higher prevalence of comorbid conditions among patients in the caregiver group may predispose them to protracted hospital courses and frequent exposure to antibiotics. These frail patients may therefore have an increased risk of fungal peritonitis, followed by a higher overall peritonitis rate. The process of care regarding prescription of antibiotics and course of hospitalization should be reviewed in these patients. Moreover, fungal prophylaxis during antibiotics therapy has to be considered in view of the high rate of fungal peritonitis in this population [16]. Reducing the overall bacterial peritonitis rate may also facilitate the decrease in the absolute incidence of fungal peritonitis [25]. Our PD programs should continue to provide comprehensive training for patients, family members, and caregivers of diverse origins in order to lower the overall peritonitis rate.

Szeto et al. reported a higher mortality rate of peritonitis in elderly PD patients and a higher risk of relapse in elderly assisted PD patients [9]. In our study, there was no difference regarding the rate of relapse among the groups, but patients in the caregiver group had a higher risk of catheter removal.

The difference may be attributed to more episodes of fungal peritonitis in the caregiver group, since all of the patients underwent prompt catheter removal after being diagnosed with fungal peritonitis.

The retrospective and single-center nature is the major limitation of the present study. Small patient numbers in each group may limit the power of statistical analysis. Further larger-scale studies are necessary to reveal the risk factors and effect of interventions for peritonitis in elderly assisted PD patients. The association of type of assistance with patient survival and technique survival will be an important issue in future investigations.

Conclusion

Assisted PD has been employed for the growing elderly ESRD population in Taiwan. Three-fourths of elderly PD patients required assistance by family members or private caregivers in the present study. Patients in the caregiver group were significantly older and had more comorbidities. Both self-care and assisted elderly patients had reasonable peritonitis rates meeting ISPD guideline targets. A non-significant trend towards higher overall peritonitis and fungal peritonitis rates was observed in the caregiver group.

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