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Components of peritonitis preventive self-care education programs associated with self-care knowledge and behavior among patients undergoing peritoneal dialysis in Japan: a cross-sectional study

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Abstract

Background Preventing peritoneal dialysis (PD)-associated peritonitis remains a major concern in continuing safe treatment and improving patient quality of life. This study aimed to determine the self-care education and quality care initiatives performed for patients undergoing PD and explored their association with patient self-care knowledge and behavior regarding peritonitis prevention.

Methods A nationwide cross-sectional survey was conducted with PD patients and their nurses in Japanese hospitals as respondents. Nurses provided the regular practice of self-care education and quality care initiatives for PD patients within the hospital while patients answered questions on their self-care knowledge and behaviors. Multivariate logistic regression analyses were performed to explore the factors of patients' self-care knowledge and behaviors.

Results We analyzed data on 170 patients (mean age: 65.1 years old) matched with those of 58 nurses from 58 hospitals. Although most educational contents were taught, teaching methods varied; evaluating patients' learning levels and re-educating during follow-up periods were less frequently performed. As for quality care initiatives, 60% of hospital nurses monitored peritonitis rates, 33% shared peritonitis-associated information with relevant departments, and 47% had performed home visits before PD patients' discharge in the past. The factors of patients' self-care knowledge include nurses' re-educating during follow-ups (odds ratio (OR) = 1.11, 95% confidence interval (CI) = 1.01–1.22, p = 0.025), sharing information with relevant departments (OR = 1.66, 95% CI = 1.01–2.74, p = 0.047), and patients' younger age (OR = 0.98, 95% CI = 0.96–1.00, p = 0.019). Hospitals performing home visits and patients' perceived social support were associated with both self-care knowledge (OR = 1.16, 95% CI = 1.01–1.34, p = 0.038 and OR = 1.33, 95% CI = 1.10–1.61, p = 0.003, respectively) and behavior (OR = 1.29, 95% CI = 1.02–1.64, p = 0.031 and OR = 1.61, 95% CI = 1.14–2.28, p = 0.007, respectively).

Conclusions Re-education during follow-up visits, sharing information, and home visits before discharge may benefit patients in promoting peritonitis preventive self-care.

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Keywords Patient education, Quality care initiatives, PD-related peritonitis, Patient knowledge, Self-care behavior

Background

Peritonitis is one of the major complications of patients undergoing peritoneal dialysis (PD) [1]. According to a previous study on Japanese PD patients, almost half of the patients withdrew from PD within three years after initiation, primarily due to PD-associated peritonitis (PD peritonitis) [2]. Since peritonitis episodes increase the risk of various complications, including PD discontinuation and mortality [3], preventing peritonitis early on is critical for continuing safe and long-lasting PD therapy, allowing for increased patient quality of life. Previous studies reported various determinants of the occurrence of peritonitis, including patient characteristics such as advancing age, lower education level, and social support; a larger treatment center size, which is commonly measured using the number of PD patients, has also been reported as a significant factor [4-7]. In addition to these factors, inadequate self-care increases the risk of PD peritonitis. Poor patient self-care, exhibited by not wearing masks or non-compliance with procedures, was associated with a higher risk of peritonitis [8, 9]. Since PD is a home medical treatment performed mainly by patients or their caregivers, patients and caregivers are expected to acquire adequate skills and knowledge and perform self-care properly to prevent peritonitis [10]. Thus, optimal self-care education programs to support PD patients' self-care are essential.

Self-care education is usually provided to improve the self-care ability of patients and their families; in clinical settings, patients receive self-care education when initiating PD. The International Society of Peritoneal Dialysis (ISPD) has stated that the goals of patient self-care education are to educate patients or caregivers in safely performing PD procedures; recognizing contamination and taking appropriate action; detecting, reporting, and managing potential dialysis complications; and understanding when and how to communicate with health care professionals [11]. Studies indicate the importance of practical education, including training for more than 15 h, training before or ten days after the operation, and re-education after PD initiation [7, 12]. Based on existing literature, we could assume that appropriate teaching methods, such as evaluating patients' learning levels during the initiation period and providing re-education during the follow-up visits, would increase patients' understanding and performance in self-care, leading to a decreased risk of peritonitis. However, most studies on the associations between self-care education and self-care knowledge or behavior have been conducted at a single treatment center with limited generalizability. The specific contents and teaching methods of self-care education regarding peritonitis have not been measured comprehensively. The actual status of educational content and methods provided in Japanese hospitals, along with their effect on patients' self-care, remain unclear.

Various quality care initiatives are performed in clinical settings to improve the care quality and empower patients in conducting self-care. For example, monitoring peritonitis rates and interprofessional collaboration in PD care are recommended as continuous quality improvement approaches in ISPD guidelines to decrease peritonitis rates [1]. Home visit programs were likewise reported to lower the risk of peritonitis [13]. Although such quality care initiatives may improve PD patients' self-care and prevent peritonitis, the association between these quality care initiatives and patients' self-care has not been thoroughly examined, and the evidence for optimal care is limited. Furthermore, the frequency of these quality care initiatives performed in Japanese institutions has not been investigated.

Thus, in this study, we aimed to (1) describe the patient self-care education and institutional quality care initiatives provided to patients undergoing PD in Japan and (2) determine their association with PD patients' self-care. We especially focused on self-care knowledge and behavior regarding peritonitis prevention.

Methods

Study design and data collection

We conducted a national survey of nurses and patients in Japanese medical institutions providing PD therapy from September to December 2019. All medical institutions which claimed the additional payment associated with PD therapy in the Japanese medical payment system [14] (n=712) in July 2019 were invited to this study. We extracted these eligible institutions from the medical institution lists provided on the websites of each Regional Bureau of Health and Welfare in Japan [15-22]. We mailed explanation documents to hospitals' nursing directors and asked permission to conduct surveys in their hospitals. Upon agreement, we mailed questionnaires and asked them to distribute these to the nursing manager of the department where the nurses see PD patients for their regular follow-up visits; these mainly were dialysis or kidney centers or outpatient departments. The nursing manager selected one participant nurse most skilled in PD care and distributed the survey documents to the

person. Subsequently, the nurse selected five patients who had initiated PD most recently. After answering their own questionnaires, the nurse filled out the patients' information on the patient questionnaires, including diagnosis and history of peritonitis, and distributed the form to each patient. Both the nurses and patients returned their questionnaires individually by mail; the data provided by both subjects were matched using the identification number written on the questionnaires.

Study participants

One nurse and up to five patients undergoing any type of PD from each hospital participated in this study. The inclusion criteria for nurses were: (1) working at a department where nurses see PD patients during their regular follow-up visits, and (2) having the most years of experience or whom the nursing manager thinks is the most skilled in PD care in the department. The inclusion criteria for patients were: (1) over 20 years of age, (2) undergoing PD therapy at the time, (3) initiated PD at the surveyed hospital, (4) receiving PD therapy education at the surveyed hospital, and (5) capable of giving consent to participate in the study and answer the questionnaire. The exclusion criteria for patients were those not participating in self-care for PD procedures.

Measures

We collected data on self-care knowledge and behavior regarding peritonitis from PD patients, while the data on self-care education programs were collected from the nurses. We developed the question items (Additional file 1: Table S1) with reference to the guidelines and some previous studies and revised them by consulting with a nephrologist, two expert nurses, and one researcher in the field of PD care. We also conducted a preliminary survey that included two PD patients and five clinical nurses to confirm face validity.

Patient questionnaire for self-care knowledge and behavior regarding peritonitis

In this study, we specifically focused on the self-care knowledge and behaviors essential in preventing and detecting PD peritonitis and developed items with reference to ISPD guidelines and previous studies. [1, 8, 11, 23–25] To ascertain patients' knowledge regarding peritonitis, the questionnaire included nine true or false statements such as, "It is possible to develop peritonitis if contamination occurred during the bag exchange. (risk of contamination)." The patient could answer "true," "false," or "not sure." The answers to all questions were captured as either correct (=1) or wrong/not sure (=0). After collecting the data, we divided the knowledge items into two

types based on the accuracy rate; the item group with high accuracy rates (50% or more participants answered correctly) was named "*basic knowledge*," and the item group with low accuracy rates (<50% of participants answered correctly) was named "*advanced knowledge*."

For self-care behavior, the questionnaire asked, "How often have you performed the following in the past seven days?" and provided seven items; for example, "I assessed the effluent for any infectious symptoms after dialysis (assessed effluent)." The answers were rated on a 5-point Likert scale from 1 (never performed) to 5 (performed every time).

Nurse questionnaire for self-care education and quality care initiatives

We developed the items for self-care education for patients initiating PD with reference to ISPD guidelines and previous studies [1, 11, 23, 24, 26] and asked nurses for the educational contents and teaching methods performed regularly within the hospital. Eleven items measured the educational contents for PD patientsfor example, "the necessity of effluent assessment" and "hand hygiene." The teaching methods consisted of 1) providing information through written materials, 2) providing information through verbal explanation, 3) objective evaluation of patients' learning level during the PD initiation period using tests or checklists (evaluation of learning level), and 4) re-education during the follow-up period (re-education at the follow-up). In a multiple-choice question, we asked the nurses how each educational content is taught (teaching method) to patients initiating PD. Each teaching method's total number of contents was used as an ordinal scale score.

To identify the quality care initiatives for patients undergoing PD, we asked nurses about some institutional initiatives; for example, "whether any nurse is monitoring peritonitis rate," "sharing peritonitis-related information with relevant departments," and "performing home visits before PD patients' discharge." For home visits, nurses indicated the frequency on a 5-point Likert scale from 1 (never performed) to 5 (performed every time), while other items were used as dichotomous variables (Yes/No).

Patient and hospital characteristics

We collected data on the patients' age, sex, educational level, working status, PD initiation date, and perceived social support. Perceived social support was measured using seven items from the Japanese version of the Social Support Scale (short form) [27]. Higher scores indicate a stronger perception of receiving support from family, friends, and significant others. Hospital characteristics



Fig. 1 Flow chart of study participants

included the number of PD patients and the number of physicians, nurses, and other health professionals engaged in PD therapy.

Analysis

We used the data of patients who initiated PD at the surveyed hospital within the last three years. First, we conducted the descriptive analysis to determine the practice of self-care education programs performed at the hospitals and patients' self-care knowledge and behavior. Second, we conducted bivariate ordinal logistic regression analyses (for the score of basic knowledge and advanced knowledge as dependent variables) and binary logistic regression analysis (for favorable and unfavorable selfcare behavior groups as a dependent variable) to examine associations between the components of hospitals' selfcare education programs, patients' characteristics, and patients' self-care knowledge/behavior. The total score of the self-care behaviors was divided as dichotomous variables by median because of the skewed distribution. Finally, we conducted the multivariate ordinal and binary logistic regression to examine the association between components of hospitals' self-care education programs, hospitals and patients' characteristics, and patients' self-care knowledge/behavior. Patients' age, education level, working status, perceived social support, and hospitals' PD patient number were entered into the model as control variables. All analyses were conducted using IBM SPSS Statistics

Premium GradPack ver. 26.0 for Mac OS, and *p*-values < 0.05 were considered statistically significant.

Ethical considerations

In the written document enclosed with each questionnaire, we explained the purpose and method of the study, the voluntary nature of participation, the right to refuse participation, and the anonymity of responses. To confirm consent, we input a checkbox on the questionnaire, and if participants agreed to participate, they checked the box and returned the completed questionnaire directly to the researcher via mail. This study was approved by the Research Ethics Committee of the Graduate School of Medicine, University of Tokyo (No. 2019081NI).

Results

Hospital or participant characteristics and the distribution of outcomes

Of the 712 eligible hospitals, 93 hospitals accepted both nurse and patient surveys (acceptance rate = 13.6%). We received 75 responses from the nurses (response rate = 80.6%) and 280 responses from the patients. Patients with more than 36 months of PD duration, those who initiated PD at another hospital, and those who answered less than 50% of items were excluded from this analysis. Consequently, we analyzed 170 patient data matched with 58 nurse data (Fig. 1). The

Table 1 Patient and hospital characteristics and quality care initiatives

	Mean ± SD	[Range]
	n (%)	
Patient characteristics (n = 170)		
Age	65.1±11.3	[32–88]
Gender (male)	111 (68.1)	
Living arrangement (living with others)	144 (84.7)	
Education level		
Elementary school or junior high school	27 (17.0)	
High school	75 (47.2)	
Vocational school or junior college	24 (15.1)	
University or higher	31 (19.5)	
Working status (currently working)	65 (38.2)	
Criteria for ADL for a person with dementia (independent)	165 (98.2)	
Primary disease of ESRD		
Diabetic nephropathy	51 (31.1)	
Nephrosclerosis	32 (19.5)	
Chronic glomerulonephritis	30 (18.3)	
Others/unknown	51 (31.1)	
Type of PD		
CAPD	92 (54.4)	
APD and the other method (combination)	77 (45.6)	
PD duration (months)	16.2±9.2	[0-36]
Currently receiving home care service for PD (yes)	29 (17.9)	
Involvement of family during patient education	81 (48.5)	
Peritonitis incidence in the past (yes)	25 (15.6)	
Perceived social support ^a	5.4±1.3	[1.3–7.0]
Hospital characteristics and quality care initiatives ($n = 58$)		
Total number of beds in the hospital		
< 199 beds	14 (24.6)	
200–399 beds	16 (28.1)	
≧400 beds	27 (47.4)	
Number of PD patients	18.3±16.7	[2-80]
Peritonitis rate in the hospital during 2018 (per patient-year)	0.32 ± 0.41	[0-2.0]
Professionals regularly engaged in PD therapy	3.5±1.5	[2-7]
Physicians	58 (100)	
Nurses	58 (100)	
Nutritionists	30 (51.7)	
Pharmacists	22 (37.9)	
Discharge nurses	15 (25.9)	
Social workers	11 (19.0)	
Allocation of nurses with certification related to renal care $(yes)^{b}$	45 (78.9)	
Monitoring peritonitis rate (at least once a year)	34 (59.6)	
Sharing peritonitis-related information with relevant departments	19 (33.3)	
Standard protocol for peritonitis treatment	56 (96.6)	
Home visit by a nurse before discharge		
Every time	14 (24.1)	
Most of the time	3 (5.2)	
Some time	3(5.2)	
Rarely	7 (12.1)	
Never	31 (53.4)	
Introduced home care for the PD patient in the past	51 (87.9)	

Table 1 (continued)

Missing data were excluded from the analysis

ADL the ability of daily living, APD automated peritoneal dialysis, CAPD continuous ambulatory peritoneal dialysis, ESRD end-stage renal disease, PD peritoneal dialysis, SD standard deviation

^a Mean score of Japanese versions of the Social Support Scale (short version). Higher scores indicate higher perceived social support

^b Any certificates possessed by nurses in the surveyed department

Table 2 Patient knowledge of peritonitis (n = 156)

	Mean±SD <i>n</i> (%)	[Range]
Basic knowledge		
Risk of contamination	155 (99.4)	
Necessity of catheter exchange	150 (96.2)	
ESI as a cause of peritonitis	141 (90.4)	
Bringing cloudy effluent to the hospital	126 (80.8)	
Cloudy effluent as a symptom of peritonitis	124 (79.5)	
Contacting a HCP	118 (75.6)	
Total scores of basic knowledge ^a	5.22 ± 1.04	[1-6]
Advanced knowledge		
Constipation as a risk factor of PD complica- tion	63 (40.4)	
Peritonitis as a risk factor of PD technique failure	58 (37.2)	
Peritonitis without abdominal pain	38 (24.4)	
Total scores of advanced knowledge ^b	1.02 ± 0.94	[0-3]

participants and hospital characteristics are shown in Table 1. The mean number \pm standard deviation (SD) of PD patients in a hospital was 18.3 ± 16.7 (ranging from 2 to 80 patients). The mean age of patients was 65.1 ± 11.3 , 68.1% were male, and 38.2% were currently working.

For the patients' knowledge regarding peritonitis, we identified six items as *basic knowledge* (correct answer rate: 75.6–99.4%) and three items as *advanced knowledge* (correct answer rate: 24.4–40.4%) (Table 2).

For the patients' self-care behavior, the median of the total self-care behavior score was 32 (interquartile range from 28 to 34) (no table). 10.7–27.5% of the patients answered "never" or "rarely" for three items (performed hand hygiene, checked dialysate bag leakage, and assessed the tunnel condition). In contrast, almost all patients performed self-care behavior "most of the time" or "every time" for the remaining items (Table 3).

Missing data were excluded from the analysis

ESI exit site infection, *HCP* health care professional, *PD* peritoneal dialysis, *SD* standard deviation

 $^{\rm a}$ Number of correct answers for items with \geq 50% accuracy rate

^b Number of correct answers for items with < 50% accuracy rate

Table 3 Patient self-care behavior in preventing or detecting peritonitis (n = 160)

	Never performed	Rarely performed	Sometime	Mostly performed	Performed
			performed		every time
	n (%)	n (%)	n (%)	n (%)	n (%)
Assessed effluent after dialysis	0 (0)	0 (0)	1 (0.6)	16 (10.0)	143 (89.4)
Performed PD in a clean environment	0 (0)	0 (0)	7 (4.4)	44 (27.5)	109 (68.1)
Performed ES care	0 (0)	6 (3.8)	8 (5.0)	50 (31.3)	96 (60.0)
Assessed ES infectious symptoms	1 (0.6)	2 (1.3)	7 (4.4)	32 (20.0)	118 (73.8)
Performed hand hygiene	2 (1.3)	15 (9.4)	15 (9.4)	48 (30.0)	80 (50.0)
Checked dialysate bag leakage	3 (1.9)	21 (13.1)	3 (1.9)	36 (22.5)	97 (60.6)
Assessed the tunnel condition	5 (3.1)	39 (24.4)	18 (11.3)	45 (28.1)	53 (33.1)

For each item, the patients indicated the frequency of performance in the past seven days

ES exit site, PD peritoneal dialysis

	Not provided	Written materials	Verbal explanation	Evaluation of learning level ^a	Re-education at the follow-up	
	n (%)	n (%)	n (%)	n (%)	%	
ES assessment	0 (0)	54 (93.1)	50 (86.2)	38 (65.5)	49 (84.5)	
Effluent assessment	0 (0)	55 (94.8)	50 (86.2)	37 (63.8)	47 (81.0)	
Normal/abnormal effluent	0 (0)	55 (94.8)	49 (84.5)	34 (58.6)	45 (77.6)	
Hand hygiene	0 (0)	55 (94.8)	48 (82.8)	39 (67.2)	44 (75.9)	
Tunnel site assessment	0 (0)	52 (89.7)	47 (81.0)	33 (56.9)	43 (74.1)	
Clean environment	0 (0)	54 (93.1)	47 (81.0)	38 (65.5)	40 (69.0)	
Appropriate action for peritonitis	0 (0)	47 (81.0)	52 (89.7)	23 (39.7)	40 (69.0)	
The necessity of catheter exchange	1 (1.7)	45 (77.6)	51 (87.9)	19 (32.8)	39 (67.2)	
Risk of peritonitis	1 (1.7)	48 (82.8)	48 (82.8)	19 (32.8)	39 (67.2)	
Appropriate actions for dialysate bag leakage	0 (0)	48 (82.8)	48 (82.8)	27 (46.6)	34 (58.6)	
Constipation as a risk factor for PD complications	15 (25.9)	23 (39.7)	35 (60.3)	10 (17.2)	21 (36.2)	

Table 4 Characteristics of educational content and methods in hospitals

^a Evaluation of learning level: assessing the patient's achievement of knowledge or skills by using objective tools such as a checklist or test

ES exit site, PD peritoneal dialysis

Self-care education and quality care initiatives for patients undergoing PD (Table 4)

Other than constipation as a risk factor for PD complications, which 25.9% of hospitals did not include in their educational content, the educational content was commonly provided by any of the methods. For the teaching methods, while most hospitals used written materials (77.6–94.8%) and verbal explanations (81.0–89.7.%) for each item of educational content, fewer hospitals evaluated the patients' learning level objectively (32.8–67.2%) or provided re-education at the follow-up period (58.6–84.5%).

As for the quality care initiatives, nurses from 59.6% of hospitals monitored the peritonitis rate, 33.3% shared information related to peritonitis with the relevant departments, and 46.6% had performed home visits before patient discharge at least once. In addition, 87.9% of hospitals had experienced introducing home care nursing for PD patients (Table 1).

Association between hospitals' self-care education program and patients' self-care knowledge and behavior (Table 5)

From the multivariate analyses, the factors associated with patients' higher basic knowledge were hospitals' re-education during the follow-up period (odds ratio (OR)=1.11, 95% confidence interval (CI)=1.01-1.22, p=0.025) and patients' stronger perceived social support (OR=1.33, 95% CI=1.10-1.61, p=0.003). The factors associated with advanced knowledge were hospitals sharing peritonitis-related information with relevant departments (OR=1.66, 95% CI=1.01-2.74, p=0.047), providing home visits before discharge (OR = 1.16, 95%CI = 1.01 - 1.34, p = 0.038), and patients' younger age (OR=0.98, 95% CI=0.96-1.00, p=0.019). The factors positively associated with patients' self-care behavior were hospitals performing home visits before PD patients' discharge (OR=1.29, 95% CI=1.02-1.64, p = 0.031) and patients' stronger perceived social support (OR = 1.61, 95% CI = 1.14 - 2.28, p = 0.007).

Table 5 Multivariate analysis of factors associated with patients' self-care knowledge and behavior

	Basic knowledge ^a (<i>n</i> = 140)			Advanced knowledge ^a (<i>n</i> = 140)					Self-care behavior ^b (<i>n</i> = 143)							
	OR	(95% CI)		(95% CI)		p	OR	DR (95% CI)			p	OR	(95% CI)			p
Patient-level characteristics																
Age	1.01	0.98	_	1.03	0.678	0.98	0.96	_	1.00	0.019	1.00	0.96	_	1.03	0.805	
Education level	1.25	0.93	_	1.68	0.136	1.18	0.94	_	1.49	0.150	0.88	0.61	_	1.27	0.493	
Working status (ref. not working)	1.10	0.61	_	1.98	0.758	1.55	0.97	_	2.50	0.069	1.02	0.46	_	2.29	0.953	
Social support	1.33	1.10	_	1.61	0.003	1.17	0.97	_	1.41	0.104	1.61	1.14	-	2.28	0.007	
Hospital-level characteristics and components of sel	f-care e	educati	ion p	rogram	IS											
Number of PD patients	1.00	0.98	_	1.01	0.813	1.00	0.99	_	1.01	0.711	1.01	0.99	_	1.03	0.587	
Evaluation of patient's learning level	0.97	0.88	_	1.06	0.475	1.01	0.93	_	1.09	0.801	1.00	0.88	_	1.13	0.944	
Re-education during the follow-up period	1.11	1.01	-	1.22	0.025	0.96	0.88	_	1.04	0.286	1.04	0.90	-	1.19	0.605	
Nurse monitoring peritonitis rate	0.80	0.44	_	1.46	0.470	1.54	0.91	_	2.63	0.111	1.21	0.51	_	2.88	0.659	
Sharing information ^c with relevant departments	1.28	0.70	_	2.34	0.431	1.66	1.01	_	2.74	0.047	1.33	0.58	_	3.06	0.496	
Home visit before discharge	1.09	0.92	_	1.30	0.334	1.16	1.01	_	1.34	0.038	1.29	1.02	_	1.64	0.031	
Nagelkerke R ²	0.159)				0.237	,				0.182	2				

Basic knowledge and advanced knowledge were the total number of items answered correctly, used as ordinal scales. The total score of self-care behavior was recoded to dichotomous variables by median (\leq 32 into 0 and > 32 into 1)

95% Cl 95% confidential interval, OR odds ratio, PD peritoneal dialysis

^a Multivariate ordinal logistic regression analysis using the forced entry method

^b Multivariate binary regression analysis using the forced entry method

^c Information related to peritoneal dialysis associated peritonitis

Discussion

This study investigated the patient education and quality care initiatives performed by nurses in Japanese hospitals and explored their association with patients' self-care knowledge and behaviors regarding peritonitis. From the multivariate analysis, hospitals providing re-education at the follow-up, sharing peritonitis-related information with relevant departments, performing home visits before discharge, patients' younger age, and perceived social support were associated with patients' higher selfcare knowledge (either basic or advanced). Further, hospitals performing home visits and patients' perceived social support were also associated with patients' favorable self-care behavior. The strength of this study resides in the separate methods of data collection; that is, reliance on nurses for information on the education and guality care initiatives performed in the hospital and reliance on patients for self-care knowledge and behaviors from multiple medical institutions. These findings should be useful when considering effective self-care education programs to support patients' self-care and prevent PD peritonitis.

The results of the descriptive statistics show that almost all available educational content was provided in most hospitals. This suggests that most educational content regarding the prevention or detection of peritonitis was provided regularly to patients who initiated PD in the hospital. On the other hand, the risk of constipation, a risk factor for peritonitis [1, 28], was not taught in many hospitals. Due to the limited evidence on the influence of constipation on PD patients [29], the risk of constipation may not be as generalized or prioritized as other contents. Valid educational content should be considered to prevent peritonitis in the future.

Regarding teaching methods, most of the content was taught via written documents and oral explanations, while the evaluation of patients' learning levels and reeducation was performed less. Furthermore, providing re-education at the hospital was associated with patients' higher basic knowledge in the multivariate analysis. The ISPD syllabus for patient education recommends evaluating the patient's skill/knowledge paired with re-training after PD initiation [11]. A previous study in Italy demonstrated that almost half of the patients required re-training due to patients' insufficient knowledge or management of PD after initiation [12]. People's memory declines as time passes; however, repetition can reinforce memory retention [30]. The results of this study suggest that patients' knowledge regarding peritonitis declines after PD initiation but can be strengthened through re-education during regular outpatients follow-up visits. However, we could not find a significant association between re-education and patients' self-care behavior. In our study, we did not ask for details about how nurses provided re-education, and the surveyed items may not cover the potential factors affecting self-care behavior. Thus, a further investigation that clarifies the re-education that promotes patients' self-care behavior is needed.

The results also indicate that formal or informal support improves patients' self-care, including knowledge and behavior. Social support is often suggested as a positive factor of self-care for patients with chronic disease [31, 32]. Support from their family, friends, and health care providers may increase patients' motivation and ability to perform PD self-care, thus possibly decreasing the risk of peritonitis. Furthermore, patients from hospitals that provided home visits before discharge had higher advanced knowledge and exhibited more favorable self-care behaviors. The initiation of PD therapy dramatically affects patients' lives and can make them feel nervous or overwhelmed during the transition from the hospital to their homes [33]. In Japan, some hospitals let patients' take an overnight stay at home before being discharged to ensure they understand their PD procedures and how they will integrate into the home environment. In this case, home visits would probably be conducted according to the patient's schedule. Visiting patients' homes would increase opportunities for nurses to assess patients' understanding and how patients would perform PD at their home environment [34], as well as help to alleviate patients' anxiety. Furthermore, conducting home visits facilitates the provision of continuous support after discharge. While we specifically examined the timing of home visits before discharge in our study, it is reasonable to infer that arranging ongoing home support based on patients' needs becomes more feasible following a home visit. This allows healthcare professionals to provide tailored education and support in the patient's own environment, leading to improved self-care acquisition and performance.

On the other hand, the results also showed that more than half of the hospitals had never provided home visits for PD patients before discharge, although the Japanese medical payment system offers financial incentives for home visits before and after patients' discharge. This may be caused by barriers such as insufficient staffing, time consumption against nurses' work overloads, and costs [35]. Strategies to promote cost-effective home visits for PD patients before discharge should be considered in the healthcare system and each healthcare facility.

Furthermore, patients of the hospitals that shared peritonitis-related information with relevant departments as a quality care initiative had higher advanced knowledge. The ISPD recommends a multidisciplinary team approach to improve care quality continuously and reduce peritonitis incidence [1]. A previous study indicated that a multidisciplinary training program significantly lowered the peritonitis risk in the institution [23]. These multidisciplinary teams may vary among hospitals; however, they involve multiple health care professionals and departments. Sharing information about patients' peritonitis episodes with members of the relevant departments (i.e., where they see PD patients, whether either inpatients or outpatients) may enable nurses to review patients' peritonitis episodes and examine any potential issues in their current care practices. By solving these issues, nurses may refine the self-care education program for PD patients, resulting in patients' better understand-

ing of peritonitis. Younger age of the patients was also associated with higher advanced knowledge, which was consistent with the result of previous studies on patients with chronic diseases [36, 37]. Some older PD patients may need more time to understand nurses' explanations and acquire knowledge. Thus, we need to adjust the educational contents and teaching methods to enhance the learning of older PD patients.

This study provides insights into the self-care education methods and quality care initiatives that would promote patient self-care knowledge and behaviors. Repeated education during the patients' regular follow-up visits would strengthen their self-care knowledge. Since the results indicate the importance of inclusive re-education, hospitals can develop a re-education plan, so patients can receive complete and repeated education during the outpatient follow-up visits. Our results also suggest that providing home visits may positively affect both patients' self-care knowledge and behavior. Further studies are required to arrange practical and feasible home visits to support patients initiating PD therapy. Further, creating a connection between inpatients and outpatients in addition to multi-professional corporations, possibly including home visit nurses, can be the first step in delivering quality care for PD patients. Meanwhile, we could not explore the association between pre-dialysis education and patients' self-care in this study. Since, pre-dialysis education is reported to affect patients' choice of renal replacement therapy and risk of peritonitis [38, 39], they may have the potential to strengthen the patients' motivation, readiness, and sequentially self-care. Further investigation is needed to evaluate its effect on self-care.

This study has several limitations. First, selection bias may exist, as it is likely that hospitals and patients who are especially motivated in PD therapy participated in this study. Thus, the results regarding education or initiatives and patients' self-care in this study may paint a more positive picture than the actual circumstances. Second, the educational contents and teaching methods may not reflect each patient's actual education since we asked about the current and standard education of PD provided in the hospital. Third, we acknowledge the limitation regarding the generalizability of our findings to patients with longer durations of PD. By specifically including patients who initiated PD within the past three years, our study may have limited applicability to individuals with more extensive PD experience. Future research should explore the impact of home visits at different timing and among patients with varying durations to provide a more comprehensive understanding of their effectiveness. Lastly, the causal relationship between hospitals' education or quality care initiatives and patient outcomes could not be determined due to the cross-sectional design of this study. Future prospective studies are needed to evaluate the effect of education and quality care initiatives on PD patients.

Conclusions

This study determined the peritonitis preventive selfcare education and quality care initiatives for PD patients in Japanese hospitals and explored their association with patients' self-care knowledge and behavior. Almost all educational content was provided to PD patients as a standard. In contrast, the teaching methods varied among hospitals; the objective evaluation of patients' achievements and re-education were less performed compared to other teaching methods. Re-education at patients' regular follow-up visits and sharing peritonitis-related information with relevant departments were associated with patients' self-care knowledge. Providing home visits before patients' discharge was associated with both patients' self-care knowledge and behavior. The results suggest that these teaching methods and quality care initiatives may enhance patients' adequate self-care in preventing peritonitis. Further prospective studies are needed to evaluate the effect of these teaching methods and initiatives on patients' self-care and peritonitis prevention.

Abbreviations

 PD
 Peritoneal dialysis

 PD peritonitis
 Peritoneal dialysis-associated peritonitis

 ISPD
 The International Society of Peritoneal Dialysis

Supplementary Information

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Additional file 1: Table S1. Items asked in patients' and nurses' questionnaire.

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Author contributions

HK, AI, SA, CF, NS, YH, and NYM contributed to the study design, data collection, analysis, and interpretation of the results. Al and NYM contributed to the supervision or mentorship of the whole study. HK wrote the first draft of the manuscript, AI, CF and NYM participated in revisions, and all authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval for this study was obtained from the Research Ethics Committee of the Graduate School of Medicine, University of Tokyo (No. 2019081NI). Written informed consent was obtained from all subjects before the study.

Consent for publication

Written informed consent was obtained from the patients for their anonymized information to be published in this article.

Competing interests

The authors declare that there is no conflict of interest.

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