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**Better Oral Hygiene Habits Are Associated With a Lower Incidence of Peritoneal Dialysis-
Related Peritonitis**

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Abstract:

Some peritoneal dialysis (PD)-related peritonitis cases are thought to be caused by the pathogens in the oral cavity; however, the relationship between peritonitis and oral hygiene habits is unclear. In this study, we retrospectively examined the relationship between oral hygiene habits and peritonitis in patients who agreed to a questionnaire survey. Of the 75 patients, 37 patients developed PD-related peritonitis during the observation period. Peritonitis-free survival was significantly higher in patients who spent more time on oral hygiene daily and in patients who replaced their toothbrush more frequently ($P < 0.05$). According to multivariable analysis, increased daily oral hygiene duration and more frequent toothbrush replacement were associated with a significantly ($P < 0.01$) lower risk for peritonitis (hazard ratio (HR) 0.37 [95% confidence intervals (CI), 0.18–0.77] and HR 0.35 [95% CI, 0.17–0.70], respectively). In conclusion, PD patients with superior oral hygiene habits showed a lower risk for PD-related peritonitis.

Key words: Oral care; Oral hygiene habits; Peritonitis; Peritoneal dialysis.

INTRODUCTION

Peritoneal dialysis (PD)-related peritonitis is a common and serious complication in patients receiving PD. It is also the major cause of discontinuation of PD therapy, reportedly accounting for 17.6–25.3% of such cases in Japan (1–3). Although the three leading causes of peritonitis are touch contamination (23.9%), infection of the intra-abdominal cavity (10.7%), and exit-site tunnel infection (10.1%) according to the Japanese Society for Peritoneal Dialysis data, there are many episodes of peritonitis of unknown origin (38.1%), mainly attributed to culture-negative peritonitis (4). Bacteremia from dental procedures is listed as one of the minor causes of PD-related peritonitis on the International Society of Peritoneal Dialysis (ISPD) position statement (5). Therefore, dental procedures are considered a risk factor for PD-related peritonitis. However, oral *Streptococci* are often cultured from PD effluent in peritonitis, even when peritonitis is not directly related to a dental procedure (6). Although the relationship between PD-related peritonitis and oral disease, such as dental caries and periodontitis or oral hygiene status is theoretically presumed, there is no definite evidence to support this. In this study, as a first step to confirm our hypothesis, we retrospectively examined the relationship between the incidence of PD-related peritonitis and oral hygiene habits.

PATIENTS AND METHODS

Study participants

We performed a single-center, retrospective cohort study. Among patients who received PD therapy from April 2008 to February 2017 at Matsuyama Red Cross Hospital, those who were alive and agreed to the questionnaire survey were enrolled. All questionnaire contents regarding oral hygiene habits (Fig. 1) were cited from the questionnaire used in the Oral Diseases in Hemodialysis (ORAL-D) study (7, 8). Oral hygiene data included questions about visits for dental care, tooth brushing, and dental flossing practices. The questionnaire survey was conducted from January 2017 to June 2017. Questionnaire forms and informed consent forms were mailed to the patients who had already withdrawn and transferred to other hospitals. All patient data, including history of PD-related peritonitis, were collected from our medical charts. The oldest collectable data about PD-related peritonitis was from April 2002 and the most recent data was from June 2017. The study protocol was approved by the local ethics committee of Matsuyama Red Cross Hospital (No. 595) and was registered to the clinical trial registry database (UMIN000030368). This study was performed according to the Ethics of Clinical Research (Declaration of Helsinki). Written informed consent was obtained from each patient.

Outcomes

All episodes of PD-related peritonitis that occurred during the study period were extracted for the analysis. PD-related peritonitis was used as the primary outcome, and oral streptococcal peritonitis was used as the secondary outcome. PD-related peritonitis was diagnosed when at least two of the

following were present: [1] clinical features consistent with peritonitis, i.e. abdominal pain and/or cloudy dialysis effluent; [2] dialysis effluent white cell count $>100/\mu\text{L}$ with $>50\%$ polymorphonuclear cells; and [3] positive dialysis effluent culture (9). In this study, oral *Streptococci* were defined as the causative pathogen when *Streptococcus salivarius* or *Streptococcus mitis* were detected.

Statistical analysis

Normally distributed continuous variables, non-normally distributed continuous variables, and categorical data were described as mean $\pm$ standard deviation, median and interquartile range, and percentage, respectively. Differences between two groups were analyzed by Fisher's exact probability test for categorical variables and t-tests for continuous variables. Cumulative incidence of PD-related peritonitis was analyzed by Kaplan–Meier survival curves across oral hygiene variables. The statistical difference between event rates was examined by log-rank test. Of the five questions, we selected three oral hygiene questions (Q2, Q3, and Q5) that are generally considered to indicate superior oral hygiene habits. To determine the dose-response association between the number of superior oral hygiene habits and the risk of PD-related peritonitis, we semi-quantitatively scored the results of the three questions as follows: [Q2] 'less than once' is 0 point, 'once' is 1 point, 'twice' is 2 points, and 'three times' is 3 points; [Q3] 'less than 1 minute' is 1 point, 'less than 2 minutes' is 2 points, and 'more than 2 minutes' is 3 points; [Q5] 'every 1 month' is 3 points, 'every 3 months' is 2 points, 'every 6 months' is 1 point, and 'less frequently than every six months' is 0 points. Patients who selected 'I

don't remember' were excluded. We calculated the total score of the three questions (9 points for the full score) and classified the patients into two groups: superior oral hygiene group with ≥ 6 points and inferior oral hygiene group with < 6 points. Unadjusted and age-, sex-, and diabetes mellitus (DM)-adjusted hazard ratios (HRs) with 95% confidence intervals (CIs) of each oral hygiene variable for the development of PD-related peritonitis were calculated using a Cox proportional hazards model and Fine-Gray proportional subdistribution hazards model. Patients were censored for death, loss of follow-up, and transfer to hemodialysis and renal transplantation. Because of the large variation in the duration of PD treatment in all enrolled patients (39 months of median duration with an interquartile range of 19–82 months), the maximum observation period of PD-related peritonitis in this study was set to 4 years, considering the general average duration of PD and the mean duration of PD in our patients (52 ± 41 months). All statistical analyses except for Fine-Gray analyses were performed using JMP, version 12.2 (SAS Institute, Tokyo, Japan). Fine-Gray analyses were performed with EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria), and a modified version of R commander designed to add statistical functions frequently used in biostatistics (10). A two-tailed value of $P < 0.05$ was considered significant.

RESULTS

Participant characteristics

Seventy-five patients who received PD therapy from April 2008 to February 2017 at our hospital and agreed to the questionnaire survey were enrolled. Table 1 shows the patients' characteristics at PD initiation. The mean age of the cohort was 59 ± 13 years; 57% of participants were male, and 27% had a history of DM. The mean duration of PD was 52 ± 41 months and the median follow-up period was 39 months with an interquartile range of 19–82 months. As described above, the following analyses were based on a maximum observation period of 4 years.

Microbiology of effluent cultures

Of the 75 patients, 37 patients (49%) developed PD-related peritonitis during the observation period. Among effluent cultures, 20 (32%) episodes were culture-negative, 29 (47%) episodes yielded Gram-positive cultures, 11 (18%) yielded Gram-negative cultures, and 2 (3%) yielded *Candida species*. The rank order of infecting organisms was *Staphylococcus* species (14 episodes, 23%), *Streptococcus* species (11 episodes, 18%) and *Enterobacteriaceae* (6 episodes, 10%). Oral *Streptococci* (9 of 11 episodes; 82%) accounted for the majority of the streptococcal peritonitis cases. There were nine episodes of oral streptococcal peritonitis; five episodes of *Streptococcus salivarius* and four episodes of *Streptococcus mitis*.

Association between PD-related peritonitis and oral hygiene habits

Differences in oral hygiene habits with or without a history of PD-related peritonitis were analyzed by Fisher's exact probability test (data not shown). The number of patients who replaced their toothbrush at least every three months was significantly ($P < 0.05$) higher in the group without a history of PD-related peritonitis. There were no significant differences in the other four oral hygiene variables.

Kaplan–Meier curves for overall peritonitis-free survival are shown in Fig. 2. Peritonitis-free survival in the group with oral hygiene exceeding two minutes daily was significantly ($P < 0.05$) higher than the group with oral hygiene under two minutes daily. Peritonitis-free survival in the group that replaced their toothbrush at least every three months was also significantly ($P < 0.01$) higher than the group that changed their toothbrush less frequently. Unadjusted and age-, sex-, and DM-adjusted HRs of each oral hygiene variable for the development of PD-related peritonitis are shown in Table 2.

Similar to the results of overall peritonitis-free survival in Kaplan-Meier analysis, Cox proportional hazards risk analysis showed that spending at least two minutes on oral hygiene daily and changing toothbrushes at least every three months were associated with a significantly ($P < 0.05$) lower risk of PD-related peritonitis in both univariable analysis (HRs 0.42 [95% CI, 0.20–0.85] and 0.34 [95% CI, 0.17–0.67], respectively) and multivariable analysis (HRs 0.37 [95% CI, 0.18–0.77] and 0.35 [95% CI, 0.17–0.70], respectively). Patients who performed oral hygiene at least twice a day had a marginally significantly ($P = 0.10$) lower risk of PD-related peritonitis than those who did not (HR 0.56 [95% CI, 0.28–1.12]). Conversely, there were no significant differences in the risk of PD-related peritonitis between patients with or without the use of dental floss (HR 0.65 [95% CI, 0.24–1.50], $P = 0.33$) or

between patients who last attended the dentist within one year or more than one year ago (HR 1.22 [95% CI, 0.61–2.45], $P = 0.58$). Consistent results were obtained even in the analysis using a Fine-Gray proportional hazards model (data not shown).

Association between oral streptococcal PD-related peritonitis and oral hygiene habits

Oral streptococcal peritonitis-free survival was analyzed by Kaplan–Meier survival curves across oral hygiene variables. Although there were no significant differences in peritonitis-free survival between any oral hygiene variables, there was a marginally significantly ($P = 0.05$) lower risk of oral streptococcal peritonitis among patients who replaced their toothbrush at least every three months.

Association between PD-related peritonitis and particularly relevant oral hygiene habits

There were 68 PD patients who answered to all of three oral hygiene questions (Q2, Q3, and Q5). The mean total score of the three questions was 5.8 ± 1.6 points. We classified 68 PD patients into two groups: 43 patients belonged to superior oral hygiene group with ≥ 6 points and 25 patients belonged to inferior oral hygiene group with < 6 points. The baseline data of the PD patients stratified by oral hygiene habit and the detailed data of PD-related peritonitis are shown in Table 3. The proportion of female was significantly ($P < 0.05$) higher and the frequency of overall PD-related peritonitis was significantly ($P < 0.05$) lower in superior oral hygiene group than those in the inferior hygiene group. There were no significant differences in the proportion of cultured microorganisms between two

groups. The details about the association between oral streptococcal PD-related peritonitis and oral hygiene habits are also shown in Table 4. The mean total score of the three questions was 5.1 ± 1.8 points. Kaplan-Meier curves for overall peritonitis-free survival and oral streptococcal peritonitis-free survival are shown in Fig. 3. Both overall PD-related peritonitis-free survival and oral streptococcal peritonitis-free survival were significantly higher in the group with ≥ 6 points than in the group with < 6 points ($P < 0.001$ and $P < 0.05$, respectively). Furthermore, Cox proportional hazards risk analysis showed that the group with ≥ 6 points was more strongly associated with a lower risk of overall PD-related peritonitis for each single question category (Q2, Q3, or Q5) in univariable (HR 0.25 [95% CI, 0.12–0.53], $P < 0.001$) and multivariable analyses (HR 0.23 [95% CI, 0.10–0.52], $P < 0.001$).

DISCUSSION

In this study, we retrospectively examined the relationship between oral hygiene habits and PD-related peritonitis using a questionnaire survey. The findings obtained from this study indicate that there is a significant relationship between superior oral hygiene habits and overall PD-related peritonitis, and between superior oral hygiene habits and streptococcal peritonitis. To our knowledge, there has been little research into the relationship between oral hygiene habits and PD-related peritonitis.

Accordingly, the present study is the first report to demonstrate a significant relationship between oral hygiene habits and PD-related peritonitis. Since oral hygiene is a habit performed daily by most people, the current study may be regarded as hypothesis-generating research at best, because of the

nature of observational study. However, our results strongly lead us to believe that improvement in routine oral hygiene habits could reduce PD-related peritonitis in PD patients.

Importantly, PD patients with a lower incidence of PD-related peritonitis are less likely to have problems with exchange technique or exit-site care, and therefore may be more enthusiastic about oral hygiene. As such, our observation might be potentially confounded by patients' general attitudes towards their daily lives. To deal with this potential bias, prospective, placebo-controlled, interventional studies are desirable. However, it is ethically almost impossible to randomly allocate patients to groups that receive either routine or poor oral care. It may be possible to perform a prospective study examining additional oral care interventions to routine oral care, such as regular funded dental consultations with or without regular tooth cleaning. However, it is unlikely that a dramatic effect will be obtained by additional interventions when compared with daily oral hygiene. If it is difficult to verify the effectiveness of interventional studies, prospective observational studies can be employed as a suboptimal solution to strengthen the causal relationship. Accordingly, prospective observational studies, like the ORAL-D study (7,8), that examine the relationship between PD-related peritonitis and oral disease in addition to oral hygiene habits should be performed in the future.

The remaining two of the five questions did not show any relationship with peritonitis-free survival. The question about the timing of the last dental visit does not necessarily reflect good or bad oral health status. The reason for this is that there may be some patients who have already completed dental treatment and have not visited a dental clinic for a long time, and other patients who have had

relatively recent dental visits because of oral disease. Therefore, it is not surprising that there was no relationship between the timing of the last dental visit and PD-related peritonitis. In addition, the use of dental floss is generally considered a good oral hygiene habit; however, it can promote gingival bleeding and lead to bacteremia depending on how it is used (11,12). Although it is well-known that dental procedures can cause PD-related peritonitis via the bloodstream (6,13,14), the use of dental floss can also cause PD-related peritonitis via the local bloodstream. Based on this hypothesis, it is possible to explain why there was no significant association between the incidence of PD-related peritonitis and the use of dental floss.

The ISPD guidelines (9) state that streptococcal peritonitis frequently originates from the oral cavity (6). One of the reasons why *Streptococci* from the oral cavity are believed to cause PD-related peritonitis via the bloodstream is that *Streptococci* are a major causative organism of spontaneous bacterial peritonitis in cirrhotic patients (15). This is further supported by the fact that spontaneous bacterial peritonitis is never caused by exogenous pathogens in cirrhotic patients. However, it is unknown whether blood flow is the only mechanism responsible for oral streptococcal peritonitis, as in the case of secondary peritonitis associated with infective endocarditis (16,17). One possible hypothesis is that oral splash contamination could lead to PD-related peritonitis. There are reports that the most common bacteria cultured from a dental treatment-induced splash are *Streptococci*, followed by *Staphylococcus* species (18,19), which supports this hypothesis. To support the theory that oral splash contamination leads to PD-related peritonitis, it is necessary to prove that the incidence of

streptococcal peritonitis is reduced by fitting a face mask or using a connection device. However, since it has been reported that the proportion of streptococcal peritonitis cases increased following the introduction of the Y-set system (6), it is presumed that the main infection pathway of streptococcal peritonitis is still endogenous rather than by contamination. Nonetheless, for the prevention of PD-related peritonitis, especially exogenous peritonitis, we should recommend hand washing before exchange and wearing a face mask and interruption of talking during exchange although there are pros and cons of these procedures for reducing the incidence of peritonitis in PD patients (20–22).

While oral *Streptococci* are the most important causative bacteria of PD-related peritonitis in the oral cavity, it is also necessary to consider the possibility that other bacteria from the oral cavity could cause PD-related peritonitis. One report found that bacteremia following dental flossing was caused by *Neisseria* and *Corynebacterium* species as well as *Streptococci* (12). Furthermore, according to a very old report, Gram-negative Enterobacteriaceae were cultured at a rate of 1.2 to 3.2% when evaluating the bacterial flora of the tongue, saliva, and gingival sulcus (23). Therefore, not all Gram-negative Enterobacteriaceae are translocated from the gastrointestinal tract, but may also be causal organisms derived from the oral cavity. Considering these facts, we should take care in judging the infection route and mechanism of PD-related peritonitis from the microbiology of peritoneal effluent cultures.

Superior oral hygiene habits most likely correlate with a lower incidence of PD-related peritonitis because oral disease is reduced with good oral hygiene habits (24). Some potential mechanisms are proposed. Oral care with toothbrush, especially with soft bristles, can remove plaques and avoid

mucosal trauma (24). In addition, regular change of toothbrush within one month can help to reduce bacterial contamination (25). As a result, there are fewer bacteria present in the oral cavity and oral bacteria are less likely to enter the bloodstream. Aside from this mechanism, the relationship between oral hygiene, immune response, and nutritional status was recently identified as below, and this could also play a role in the reduction of PD-related peritonitis. Accumulated dental plaque drives neutrophil-based inflammation and may stimulate cytokine responses in the gingival epithelium (26,27). Additional causal pathways linking oral bacteria to systematic inflammation have been proposed, including bacteremia secondary to oral bacteria, circulating oral microbial toxins, and metastatic immunologic responses to oral microorganisms (28). Accordingly, it is plausible that dental care and oral hygiene interventions might modify the measurable systemic inflammatory response and malnutrition that are associated with dental plaque accumulation and gingivitis (29) through non-traditional mechanisms. Furthermore, it may also lead to a reduction in PD-related peritonitis.

In the present study, the beneficial impact of good oral hygiene on the peritonitis-free survival was observed only after six months. Someone may think that the beneficial effect of good oral hygiene may emerge much earlier than six month. Although we have no good biological explanation, the relatively low incidence rate of PD-related peritonitis in the current study might have contributed to the delayed benefit of good oral hygiene.

The limitations of the current study need to be considered when interpreting the findings. First, this was a single-center, small-number, retrospective study. Second, in multivariable analysis, only

age, sex, and history of DM were adjusted because of a small number of outcomes. Therefore, there may be some potential confounders affecting our observation such as prior exit-site infection or tunnel infection. Third, there could be some misclassification biases because of the nature of the questionnaire survey. In addition, several patients chose ‘I don’t remember’ as answers to Q1 and Q3. The presence of these answers suggests that the accuracy of the questionnaire results was not high. Fourth, the timing of the questionnaire-survey should have been performed before or during the enrollment of PD to confirm a causal relationship between oral hygiene habits and PD-related peritonitis. However, oral hygiene habits are often consistent for many years in general, and it is unlikely that the habits will be changed especially after PD initiation or occurrence of PD-related peritonitis. In addition, we urged patients who had already withdrawn from PD to remember the situation during PD and answer the questionnaire. Fifth, unfortunately, we did not have any information about the timing of oral care and bag exchanges in each patient. Since the amount of bacteria in the oral cavity is reported to be the largest at the time of awakening (30), the timing of tooth brushing and bag exchange in the morning may be associated with PD-related peritonitis caused by the pathogens in the oral cavity. Further detailed studies are needed to confirm this hypothesis. Finally, in this study, the culture-negative rate was higher than the recommended rate of less than 15% according to the 2016 ISPD guideline (9). Therefore, we adopted the culture method recommended by the 2010 ISPD guideline (31); however, the culture-negative rate did not decrease, demonstrating the potential difficulty in reducing the culture-negative rate. We have been educating our patients to visit

our hospital immediately once the peritoneal effluent appears cloudy. As a result, many of our patients who developed PD-related peritonitis were mildly symptomatic and the culture-negative rate might be high because of the small amount of bacteria contained in the peritoneal effluent. Despite these limitations, we believe a certain causal relationship exists between superior oral hygiene habits and PD-related peritonitis.

CONCLUSIONS

The present study showed a significant relationship between superior oral hygiene habits and PD-related peritonitis. Although these findings could not prove a causal relationship, our observations suggest that improvement in routine oral hygiene habits could reduce PD-related peritonitis in PD patients. Further large-scale, prospective, observational studies are needed to confirm the relationship between oral hygiene habits, oral disease, such as dental caries and periodontitis, and PD-related peritonitis.

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CONFLICTS OF INTEREST

304 The authors declare that they have no conflict of interest.

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Figure legends

FIG. 1. Self-administered questionnaire on oral hygiene habits. Oral hygiene data included questions about visits for dental care, tooth brushing, and dental flossing practices.

FIG. 2. Cumulative overall peritonitis-free survival for each oral hygiene measure. Of 75 PD patients, 37 patients developed PD-related peritonitis during the observation period. Log-rank test was used to determine the differences between two groups. A two-tailed *P*-value less than 0.05 was considered statistically significant. Abbreviations: PD, peritoneal dialysis.

FIG. 3. Cumulative peritonitis-free survival stratified by the total score of Q2, Q3 and Q5. Of 68 PD patients, (a) 32 patients developed PD-related peritonitis and (b) seven patients developed oral streptococcal peritonitis during the observation period. Log-rank test was used to determine the differences between two groups. A two-tailed *P*-value less than 0.05 was considered statistically significant. Abbreviations: PD, peritoneal dialysis.

TABLES

TABLE 1. Characteristics of 75 PD patients

Clinical characteristics	<i>N</i> = 75 (%)
Age at PD start, year	59 ± 13
Sex, male	43 (57)
Body weight, kg	56 ± 11
Body mass index, kg/m ²	22 ± 3
Diabetes mellitus	20 (27)
Original disease	
Chronic glomerulonephritis	32 (43)
Diabetic nephropathy	17 (23)
Hypertensive nephrosclerosis	17 (23)
Others	9 (12)
PD duration, months	52 ± 41
Use of automated PD	18 (24)
Use of machinery connection device	6 (8)

Note: Data are expressed as mean ± standard deviation or number (percentage). Abbreviations: PD, peritoneal dialysis.

397 **TABLE 2.** HRs of PD-related peritonitis for each oral hygiene variable

Oral hygiene habit variables		Unadjusted		Multivariable-adjusted ^a	
		HR (95% CI)	<i>P</i> value	HR (95% CI)	<i>P</i> value
Q1.	Last dental visit within 1 year	1.06 (0.55–2.08)	0.86	1.22 (0.61–2.45)	0.58
Q2.	Oral hygiene at least twice a day	0.57 (0.30–1.12)	0.10	0.56 (0.28–1.12)	0.10
Q3.	Oral hygiene over 2 minutes daily	0.42 (0.20–0.85)	<0.05	0.37 (0.18–0.77)	<0.01
Q4.	Use of dental floss	0.73 (0.27–1.65)	0.48	0.65 (0.24–1.50)	0.33
Q5.	Change a toothbrush at least 3 monthly	0.34 (0.17–0.67)	<0.01	0.35 (0.17–0.70)	<0.01

398 *Note:* ^a Multivariable-adjusted model was adjusted for age, sex, and history of diabetes mellitus. A two-tailed *P* <0.05 was considered statistically
399 significant. Abbreviations: CI, confidence interval; HR, hazard ratio; PD, peritoneal dialysis.

400

401 **TABLE 3.** Baseline characteristics and the data on PD-related peritonitis in PD patients with superior or inferior oral hygiene habits

	Overall <i>N</i> = 68	Superior hygiene group <i>n</i> = 43	Inferior hygiene group <i>n</i> = 25	<i>P</i> -value
Age at PD start, years	59 ± 13	58 ± 12	62 ± 14	0.21
Sex, male	41 (60)	21 (49)	20 (80)	<0.05
Diabetes mellitus	18 (26)	13 (30)	5 (20)	0.41
Overall peritonitis, episodes	53	23	30	0.13
Peritonitis rate, episodes per year	0.28	0.17	0.62	<0.05
Gram-positive cultures	24 (45)	12 (52)	12 (40)	0.08
<i>Staphylococcus</i> species	12 (23)	6 (26)	6 (20)	0.46
<i>Streptococcus</i> species	10 (19)	4 (17)	6 (20)	0.33
Oral <i>Streptococci</i>	9 (17)	4 (17)	5 (17)	0.38
Gram-negative cultures	11 (21)	4 (17)	7 (23)	0.49

<i>Candida</i>	2 (4)	0 (0)	2 (7)	
Culture-negative	16 (30)	7 (30)	9 (30)	1.0

402 *Note:* Data are expressed as mean $\pm$ standard deviation, number, or number (percentage). A two-tailed value of $P < 0.05$ was considered significant.

403 Abbreviations: PD, peritoneal dialysis.

404

TABLE 4. The basic characteristics and oral hygiene habits of the patients who developed streptococcal peritonitis

	Sex	Age	Microbiology	Q1	Q2 (score)	Q3 (score)	Q4	Q5 (score)	Total score of Q2, Q3 and Q5
Patient 1	F	61	<i>S. mitis</i>	less than 6 months ago	twice (2)	more than 2 minutes (3)	no	every 3 months (2)	7
Patient 2	F	56	<i>S. mitis</i>	over 1 year ago	once (1)	less than 2 minutes (2)	no	every 6 months (1)	4
Patient 3	F	71	<i>S. salivarius</i>	over 1 year ago	3 times (3)	less than 2 minutes (2)	no	every 3 months (2)	7
Patient 4	M	68	<i>S. mitis</i>	less than 1 year ago	twice (2)	less than 2 minutes (2)	no	every 6 months (1)	5
Patient 5	M	64	<i>S. salivarius</i>	less than 1 year ago	twice (2)	more than 2 minutes (3)	yes	every 3 months (2)	7
		66	<i>S. salivarius</i>						
Patient 6	M	57	<i>S. mitis</i>	over 1 year ago	once (1)	more than 2 minutes (3)	no	every 6 months (1)	5
Patient 7	M	82	<i>S. mitis</i>	less than 6 months ago	once (1)	more than 2 minutes (3)	no	less frequently than 6 monthly (0)	4
Patient 8	M	74	<i>S. salivarius</i>	less than 1 year ago	less than once (0)	less than 2 minutes (2)	yes	less frequently than 6 monthly (0)	2

Note: Abbreviations: F, female; M, male; *S*, *Streptococcus*.

FIG. 1. Oral hygiene habits questionnaire

* If you have already withdrawn from peritoneal dialysis, please recall the situation during peritoneal dialysis and answer the questionnaire.

Q1. When did you make the latest dental visit?

☐less than 6 months ago ☐less than 1 year ago

☐over 1 year ago ☐I don't remember

Q2. How many time, in a day, do you wash your teeth?

☐less than once ☐once

☐twice ☐3 times

Q3. How long do you take for oral hygiene a day?

☐less than 1 minute ☐less than 2 minutes

☐more than 2 minutes ☐I don't remember

Q4. Do you use dental floss?

☐yes ☐no

Q5. How often do you change your toothbrush?

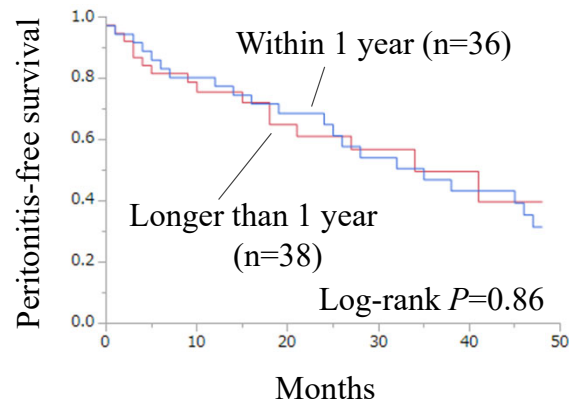
☐every 1 month ☐every 3 months

☐every 6 months

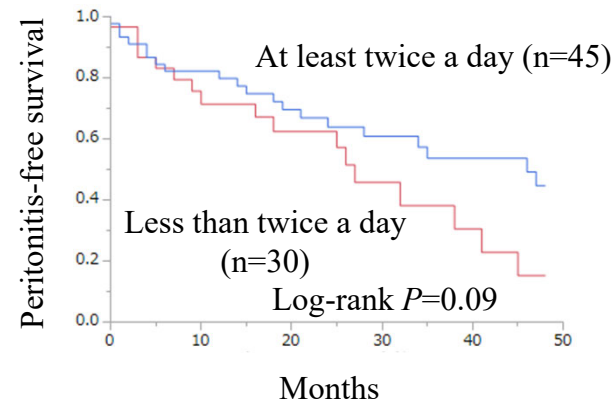
☐less frequently than 6 monthly

FIG. 2. Cumulative overall peritonitis-free survival for each oral hygiene measure

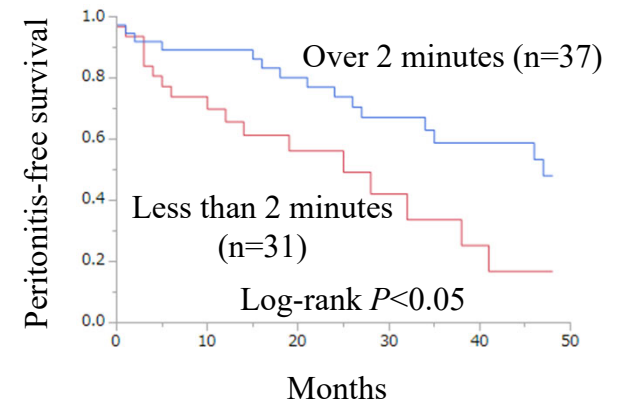
Q1. Time since last dental visit



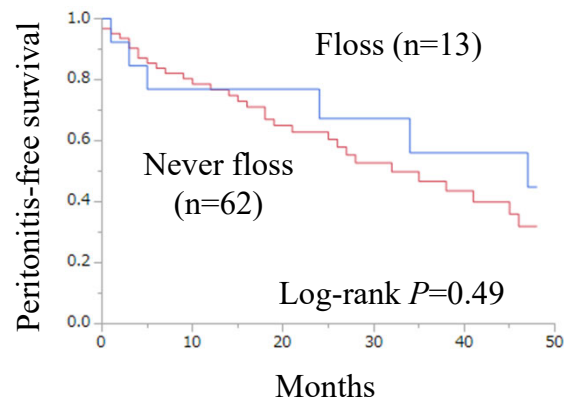
Q2. Number of oral hygiene



Q3. Time spent on oral hygiene daily



Q4. Dental floss



Q5. Frequency of changing a toothbrush

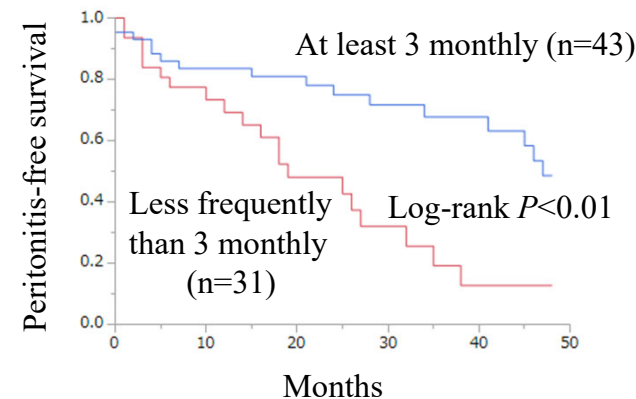
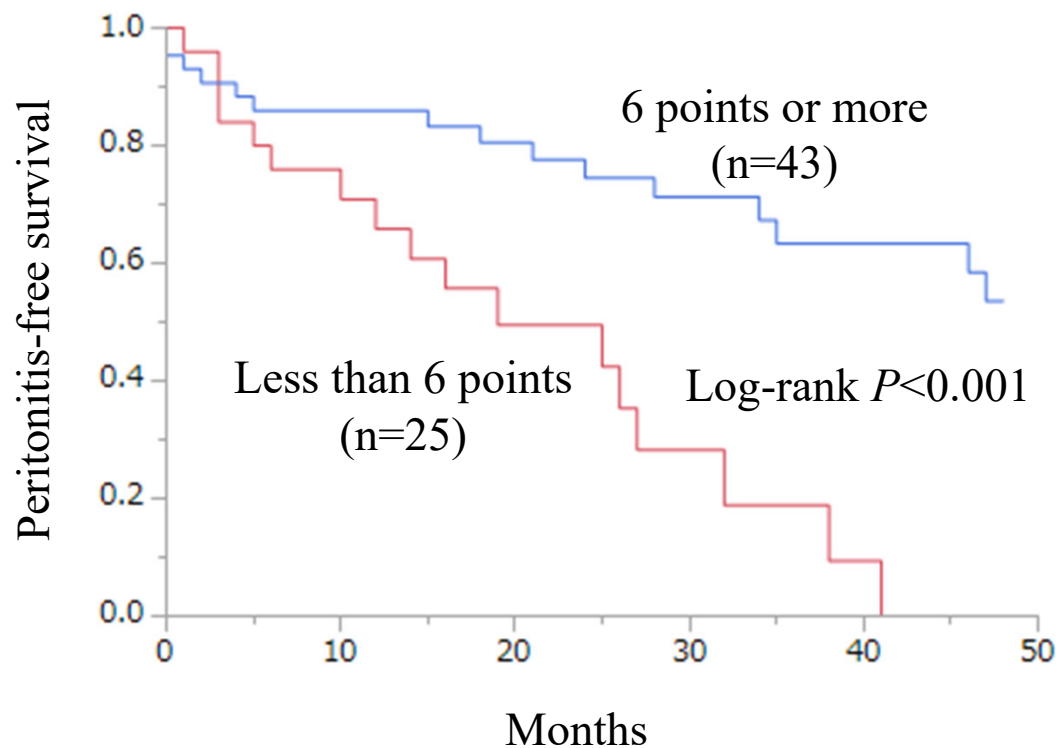


FIG. 3. Cumulative peritonitis-free survival for total score of Q2, Q3 and Q5

a. Overall PD-related peritonitis



b. Oral streptococcal peritonitis

