Nitta et al. Renal Replacement Therapy (2020) 6:51
https://doi.org/10.1186/s41100-020-00290-z

Renal Replacement Therapy

REVIEW Open Access

Annual dialysis data report 2018, JSDT Renal Data Registry: dialysis fluid quality, hemodialysis and hemodiafiltration, peritoneal dialysis, and diabetes

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Abstract

The annual survey questionnaires of the Japanese Society for Dialysis Therapy Renal Data Registry (JRDR) were sent to 4458 dialysis facilities at the end of 2018; 4402 facilities (98.7%) responded to the facility questionnaire, and 4222 facilities (94.7%) responded to the patient questionnaire. This paper reports the results obtained in regard to several issues: dialysis fluid quality, prescription of hemodialysis and hemodiafiltration, current status of peritoneal dialysis, and glycemic indices and treatment of diabetic patients.

Keywords: Dialysis fluid, Diabetes, Dialysis modality, Glycemic control, Hemodialysis, Peritoneal dialysis

Introduction

The 2018 Japanese Society for Dialysis Therapy (JSDT) surveys inquired about the management of dialysis fluid quality, prescription of hemodialysis (HD) and hemodiafiltration (HDF), peritoneal dialysis (PD), and diabetic patients on dialysis.

The chapter on the management of dialysis fluid quality reports the results of the investigation of the frequency of measurements of endotoxin (ET) level and total viable microbial count (TVC) in dialysis fluid on a facility basis. The rates of achievement of ultrapure dialysis fluid (UPD) and standard dialysis fluid were then calculated. The data for sources of dialysis water, i.e., tap water, groundwater, or both, and the frequency of measurement of residual chlorine and chemical contaminations of dialysis fluid are also reported.

The chapter on the prescription of HD and HDF and the current status of HDF in Japan reports the results of an analysis of the data obtained in the 2018 survey. The HDF modes include online HDF, offline HDF, push/pull HDF, acetate-free biofiltration (AFBF), and intermittent infusion hemodiafiltration (IHDF). The patient characteristics of the HD group and HDF group were compared, and dialysis treatment time per session and blood flow rate in the HD group and HDF group are compared.

The chapter on peritoneal dialysis (PD) reports the numbers of new and existing cases on PD, types of dialysis fluids, and incidence rates of peritonitis.

The chapter on diabetic patients on dialysis reports the results of the survey of the current status of diabetes patients on HD and PD. The indicators of glycemic control, i.e., glycated hemoglobin (HbA1c), glycated albumin

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(GA), or both, and their levels are reported. The 2018 survey also included casual plasma glucose levels. Finally, the results of the survey in regard to the types of antidiabetic agents, including insulin, dipeptidyl peptidase-4 (DPP-4) inhibitors, glucagon-like peptide-1 (GLP-1) receptor agonists, and others, are reported.

Management of dialysis fluid quality

Background and subjects

The 2006 JSDT survey was the first to investigate bacteriological dialysis fluid quality and its management status. Based on the results obtained, the bacteriological standard for dialysis fluid was revised in 2008 [1], and a chemical contamination standard was added in 2016 [2].

Compliance with these standards is assessed based on the bacteriological standard for dialysis fluid evaluated by measuring the endotoxin (ET) level and the total viable microbial count (TVC). Both are measured at least once a month. At least one dialysis console at each facility is tested every month, and all consoles are tested at least once a year. The minimum standard required for use in dialysis treatment is designated as "standard dialysis fluid," meaning that the ET level is under 0.05 EU/mL and TVC under 100 cfu/mL. Ultrapure dialysis fluid (UPD) is defined as dialysis fluid having an ET level under 0.001 EU/mL and TVC under 0.1 cfu/mL. The JSDT standard recommends the use of UPD for all dialysis treatments. Chemical contamination of dialysis fluid was inquired about for the first time in the 2017 survey.

The dialysis fluid standard management status data reported in this chapter were calculated from the data obtained from facilities having at least one dialysis console, and a total of 4388 facilities were included in the 2018 survey.

Dialysis fluid ET testing

The Limulus test is used to perform the dialysis fluid ET level test that is part of the JSDT standard [1, 2]. Since several ET measurement machines are relatively inexpensive and available over-the-counter in Japan, they are widely used by most dialysis facilities. However, it is quite rare in the rest of the world.

Of the 4458 facilities surveyed, 4371 responded to the question concerning the frequency of ET testing, and 3784, which was 86.6% of the total number that responded to this question, complied with the stipulated frequency of "at least once a month" (Fig. 1a, Supplementary Table 1). The annual changes in measurement frequency showed that 33.1% of the facilities performed the dialysis fluid ET test in 2008, the year the standard was implemented, but that the proportion had increased dramatically to 70.6% by 2010, the year in which the dialysis fluid standard additional fee was established, and it has steadily increased since then (Fig. 2a, Supplemental Table 2).

Responses regarding dialysis fluid ET levels were received from 4320 facilities, 3645 (84.4%) of which indicated that they met the UPD standard of under 0.001 EU/mL, and 4199 (97.2%) of them indicated that they met the standard for standard dialysis fluid of 0.05 EU/mL (Fig. 1b, Supplementary Table 1). The annual changes in dialysis fluid ET levels showed that both less than 0.001 EU/mL and 0.05 EU/mL standards are increasing annually (Fig. 2b, Supplementary Table 2). The absence of dialysis fluid ET concentration values in 2008 is attributable to the switch in dialysis fluid ET concentration units from EU/L to EU/mL based on international rules in the survey that year, and the switch resulted in many incorrect entries.

Dialysis fluid TVC testing

A total of 4361 facilities responded to the question regarding the frequency with which dialysis fluid TVC is

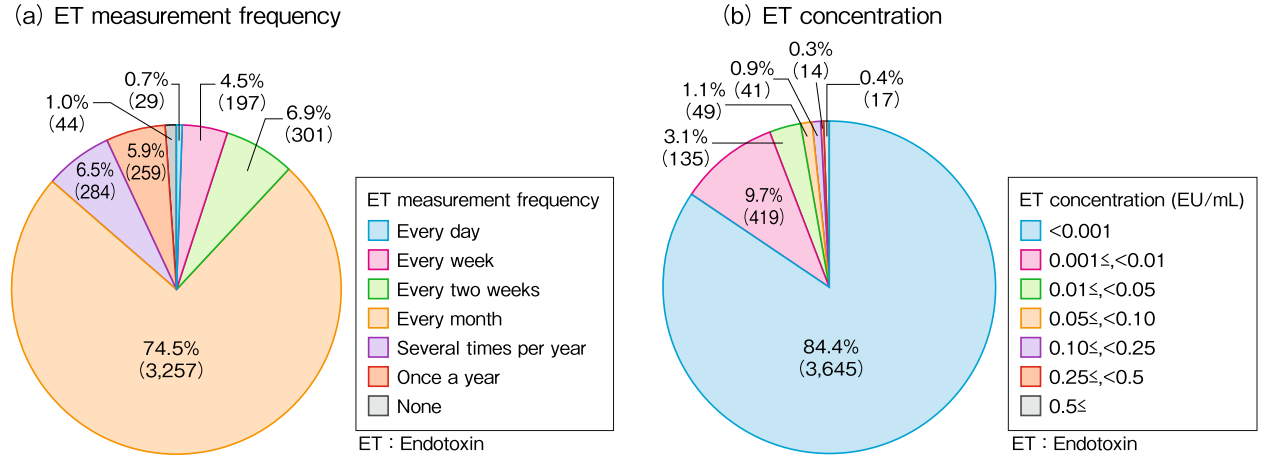

Fig. 1 Distribution of facilities according to ET measurement frequency and ET concentrations in 2018. **a** ET measurement frequency. **b** ET concentrations. ET, endotoxin

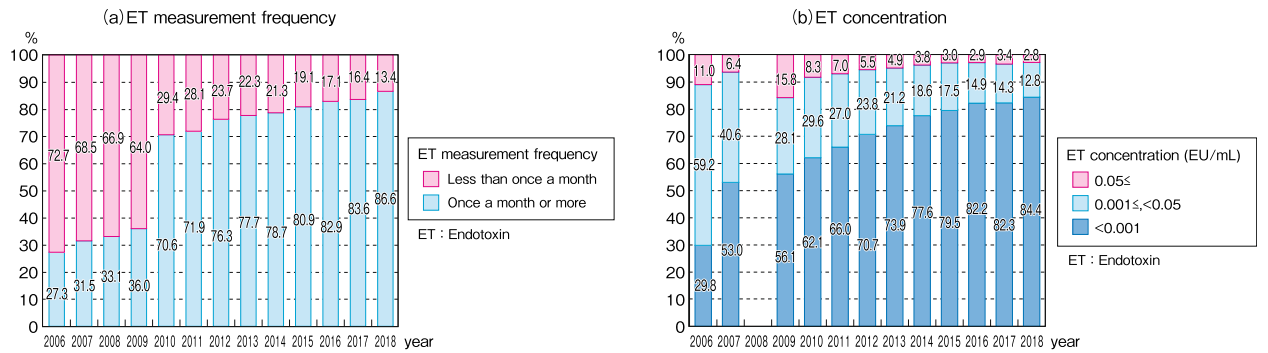

Fig. 2 Trends in ET measurement frequency and ET concentrations from 2006 to 2018. **a** ET measurement frequency. **b** ET concentrations. ET, endotoxin

measured, and 3718 of them, representing 85.3% of all facilities, reported testing at least once a month (Fig. 3a, Supplementary Table 3). The frequency of TVC measurement has been increasing annually, and although it increased markedly in 2010, the same as ET testing did, in all other years, the frequency of TVC measurement has been slightly lower than the frequency of ET testing (Fig. 4a, Supplementary Table 4).

Of the 4248 facilities that responded to the question regarding dialysis fluid TVC, 3361 facilities (79.1% overall) reported meeting the UPD standard of 0.1 cfu/mL, and 4214 facilities (99.2%) reported meeting the standard dialysis fluid standard of 100 cfu/mL (Fig. 3b, Supplementary Table 3). The percentage of facilities meeting the UPD standard and percentage meeting the standard dialysis fluid have been increasing annually (Fig. 4b, Supplementary Table 4).

Achievement quotient of UPD and standard dialysis fluid

Because the JSDT standard stipulates the bacteriological standard for dialysis fluid (both UPD and standard dialysis fluid), the numerical criteria for both dialysis fluid ET concentration and TVC must be met simultaneously [1, 2]. Of the 4244 facilities that responded to the questions about both dialysis fluid ET level and TVC, 3168 facilities (74.6% of those that responded) reported meeting the UPD standard (dialysis fluid ET level under 0.001 EU/mL and live bacteria count under 0.1 cfu/mL), and 4118 facilities (97.0% of those that responded) reported meeting the standard for standard dialysis fluid (dialysis fluid ET level under 0.05 EU/mL and TVC under 100 cfu/mL; Fig. 5, Supplementary Table 5). The achievement quotients for both UPD and standard dialysis fluid have been increasing over time, which suggests that the dialysis fluid purity level is increasing in Japan (Fig. 6, Supplementary Table 6).

Source of dialysis water and chemical contamination preventative measures

A total of 4373 facilities responded to the question in the 2018 survey regarding the source of dialysis water. The most common source was tap water, which was reported by 3700 facilities (84.6%), and it was followed by groundwater (391 facilities, 8.9%), and then by a combination of tap water and groundwater (273 facilities,

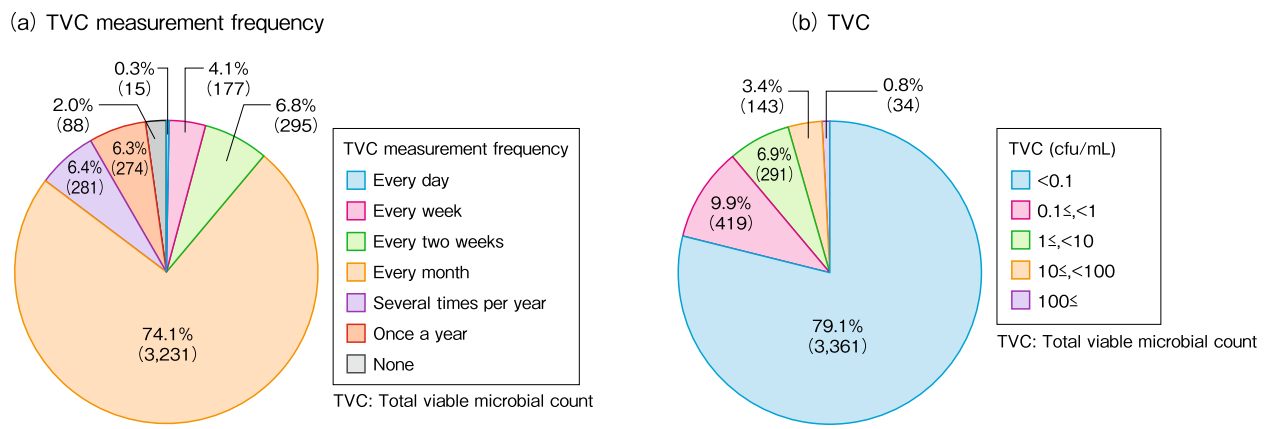

Fig. 3 Distribution of facilities according to TVC measurement frequency and TVC in 2018. **a** TVC measurement frequency. **b** TVC. TVC, total viable microbial count

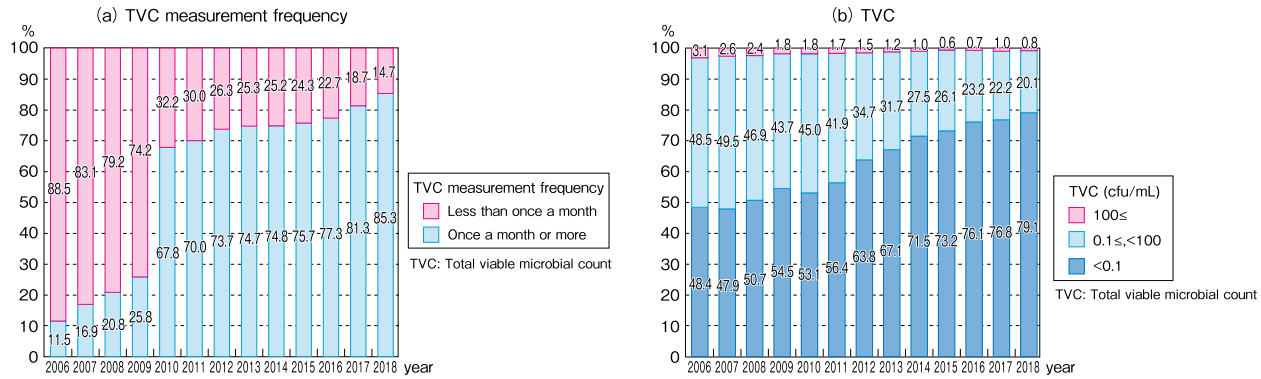

Fig. 4 Trends in TVC measurement frequency and TVC from 2006 to 2018. **a** TVC measurement frequency. **b** TVC. TVC, total viable microbial count

6.2%; Fig. 7 Supplementary Table 7). None of these percentages was significantly different from the percentages reported in the 2017 survey: tap water, 85.2%; groundwater, 8.8%; a combination, 5.8% [3].

A total of 4330 facilities responded to the question regarding the frequency of residual chlorine testing before hemodialysis treatment. "Every day" was the most common response (2587 facilities, 59.7%) and was followed by "once a week" (913 facilities, 21.1%) and then "once a month" (215 facilities, 5.0%; Fig. 8a, Supplementary Table 8). A total of 410 facilities (9.5%) reported that they do not measure residual chlorine. Measurement of residual chlorine has become more common than in the 2017 survey, in which the corresponding data were 55.7%, 21.7%, 5.3%, and 12.0%, respectively. Routine measurement of residual chlorine should be promoted.

A total of 4087 facilities responded to the question regarding their residual chlorine measurement method, with most (1652, 40.4%) reporting that their method measured "free chlorine only," and they were followed by 1494 facilities (36.6%) that reported using a method

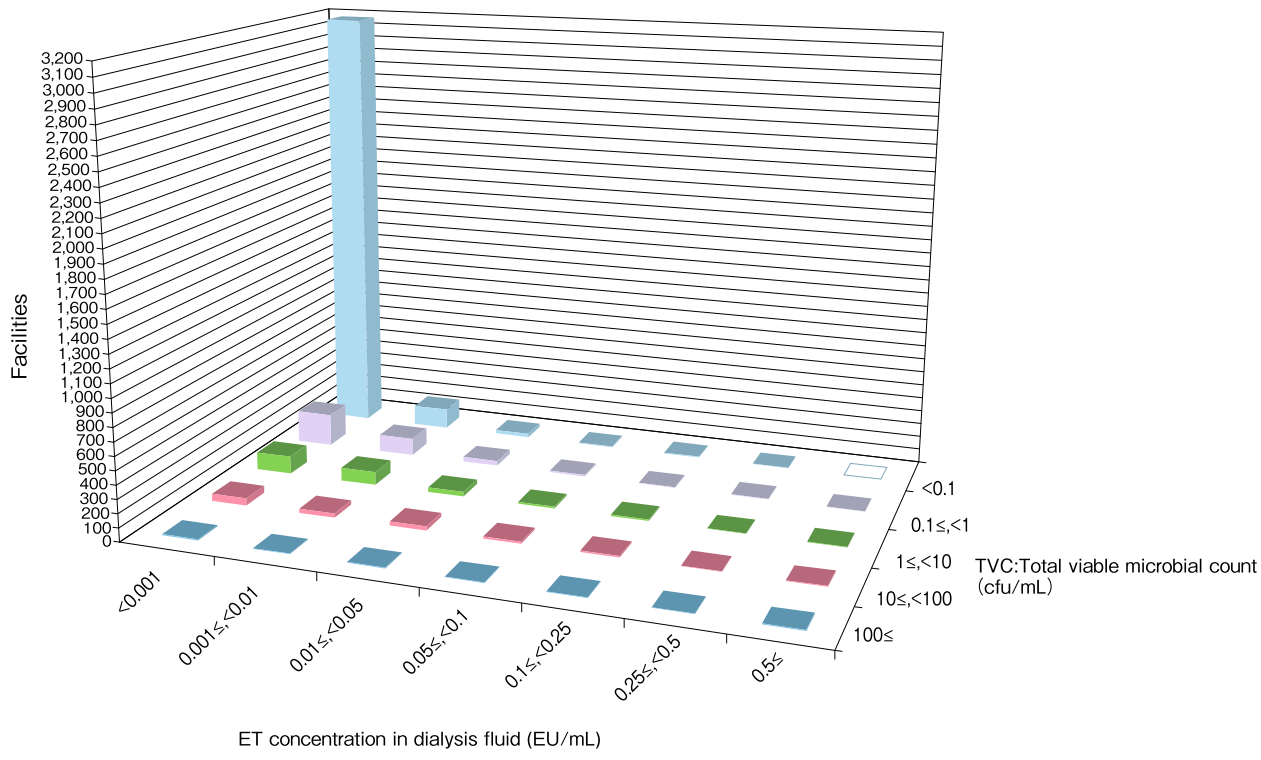

Fig. 5 Distribution of facilities according to ET concentration and TVC in 2018. ET, endotoxin; TVC, total viable microbial count

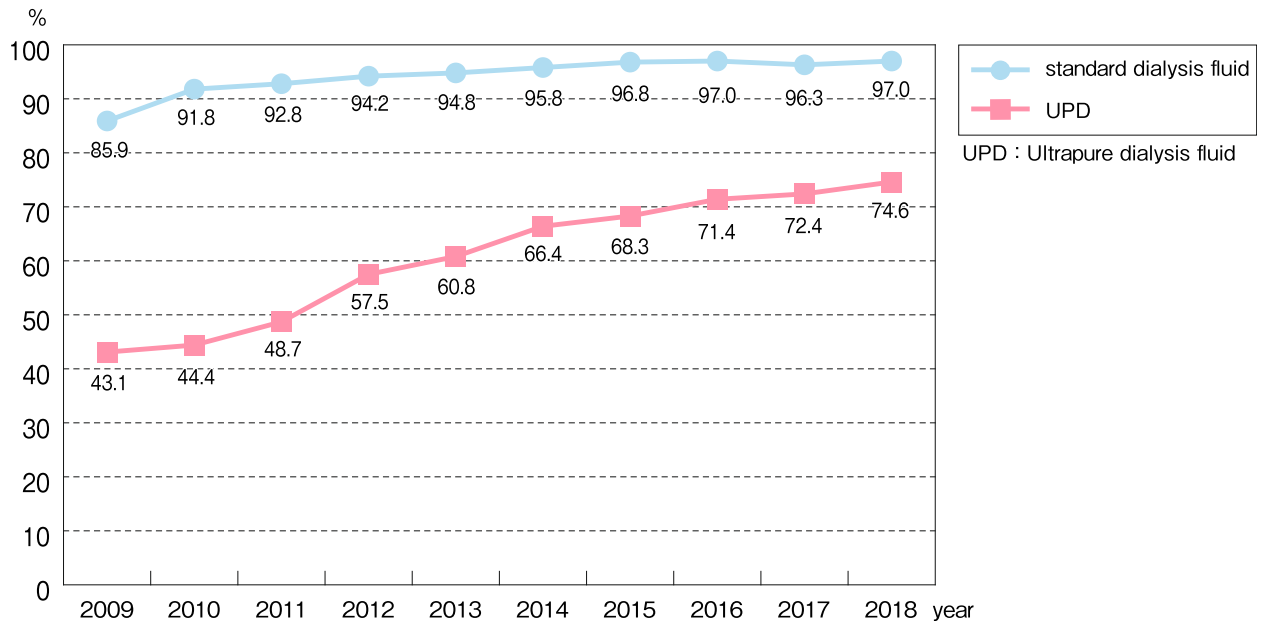

Fig. 6 Trends in the distribution of facilities according to the achievement of UPD and standard dialysis fluid from 2009 to 2018. UPD, ultrapure dialysis fluid

that measured "both free chlorine and total chlorine." A total of 880 facilities (21.5%) reported using a method that measured "total chlorine only" (Fig. 8b, Supplementary Table 8). The proportions of facilities that measured total chlorine had increased since the 2017 survey, when 45.7% measured "free chlorine only," 32.2% measured "both free chlorine and total chlorine," and 20.2% measured "total chlorine only."

A total of 4312 facilities reported familiarity with the JSDT chemical contamination standard [2], and 85.4% of 4312 facilities reporting either being "very familiar" or "familiar" (Fig. 9a, Supplementary Table 9). A total of 4157 facilities responded to the question regarding the frequency with which they measured chemical contamination as stipulated by the standard; 1769 facilities of 4157 facilities (42.6%) reported "once a year," while 1124 facilities (27.0%) reported that they do not measure chemical contamination (Fig. 9b, Supplementary Table 9). In the 2017 survey, 37.6% of the facilities measured chemical contamination and 32.8% of them did not. Awareness of chemical contaminants has gradually been promoted by JSDT. Measurements of chemical contamination of dialysis fluid in dialysis facilities have generally been improving, and a survey of chemical contaminations

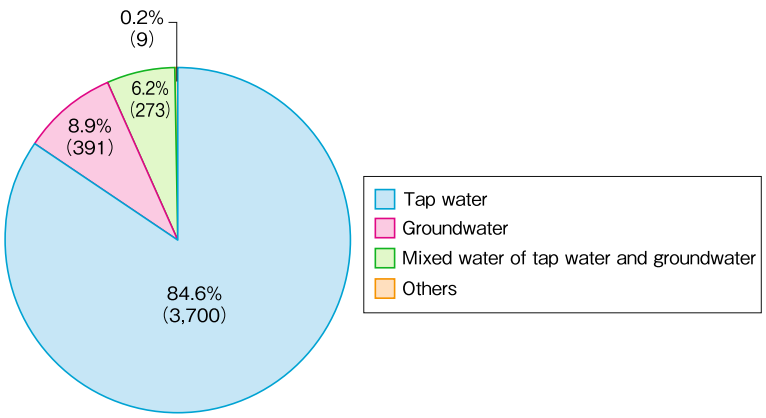

Fig. 7 Distribution of facilities according to the source of dialysis water

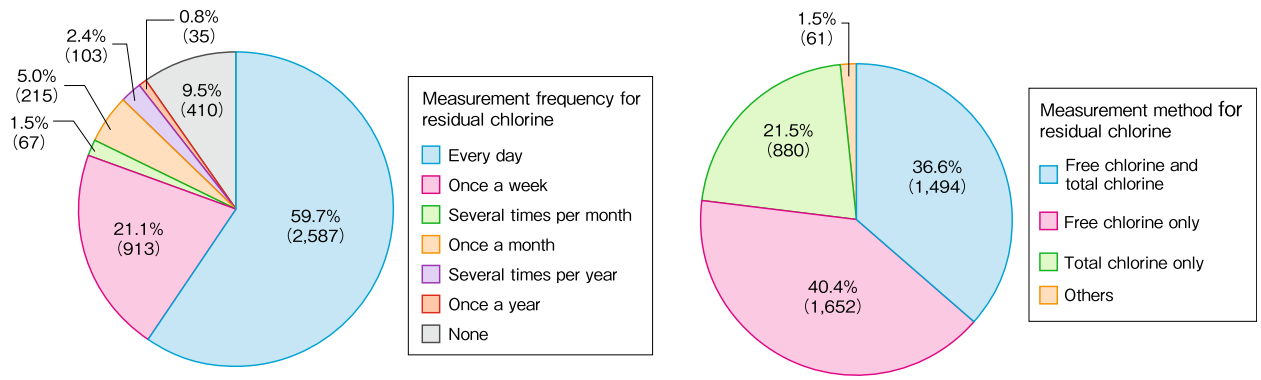

Fig. 8 Distribution of facilities according to the frequency of residual chlorine measurements and measurement method. **a** Frequency of residual chlorine measurements. **b** Method of measuring residual chlorine

in dialysis fluid should be continued to improve compliance with the JSDT standard.

Prescription of HD and HDF

Current status of HDF in Japan

HDF includes the following modalities: online HDF, offline HDF, push/pull HDF, acetate-free biofiltration (AFBF), and intermittent infusion hemodiafiltration (IHDF).

The number of HDF patients in Japan has been rapidly increasing since 2012. Facility survey data at the end of 2018 showed that 125,793 patients had been treated by HDF, an increase of 30,653 patients over the end of 2017. The number of patients who were treated with HDF was 38.3% of the sum of HD and HDF patients, and the proportion had increased by 8.9% compared to the end of 2017 (Fig. 10).

The results of the 2018 survey showed that 121,634 patients on HDF at the end of 2018, of whom 86,231 patients had been on online HDF, accounting for 70.9% of the HDF patients, and they were followed by 31,681 patients who had been on IHDF, accounting for 26.0% of the HDF patients (Fig. 10, Supplementary Table 10).

The mean age of the HDF patients was 67.2 years old (males: 66.4 years old, females: 68.7 years old), whereas the mean age of the HD patients was 70.0 years old (males: 69.2 years old, females: 71.5 years old) and was approximately 3 years older (Fig. 11, Supplementary Table 11).

The mean dialysis vintage of the HDF patients was 8.4 years (males: 7.8 years, females: 9.7 years). Patients whose dialysis vintage was less than 5 years formed the largest group, accounting for 40.9% of the total (43.4% of the males, 36.2% of the females). The mean vintage of the HD patients was 6.7 years (males: 6.3 years, females: 7.5 years). Patients whose dialysis vintage was less than 5 years accounted for 50.7% of the total (52.7% of the

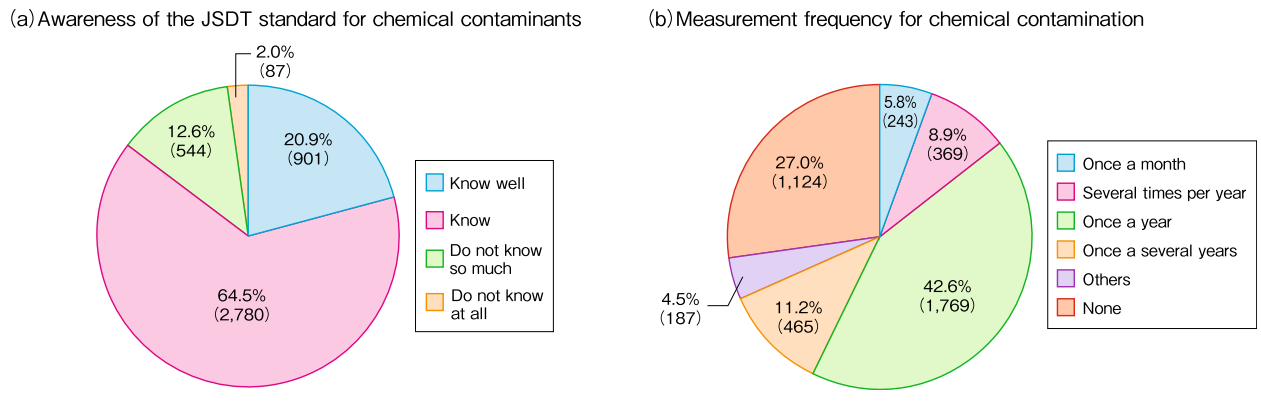

Fig. 9 Distribution of facilities according to awareness of the JSDT standard for chemical contaminants and frequency of measurements. **a** Awareness of the JSDT standard for chemical contaminants. **b** Frequency of measurements of chemical contamination. JSDT, Japanese Society for Dialysis Therapy

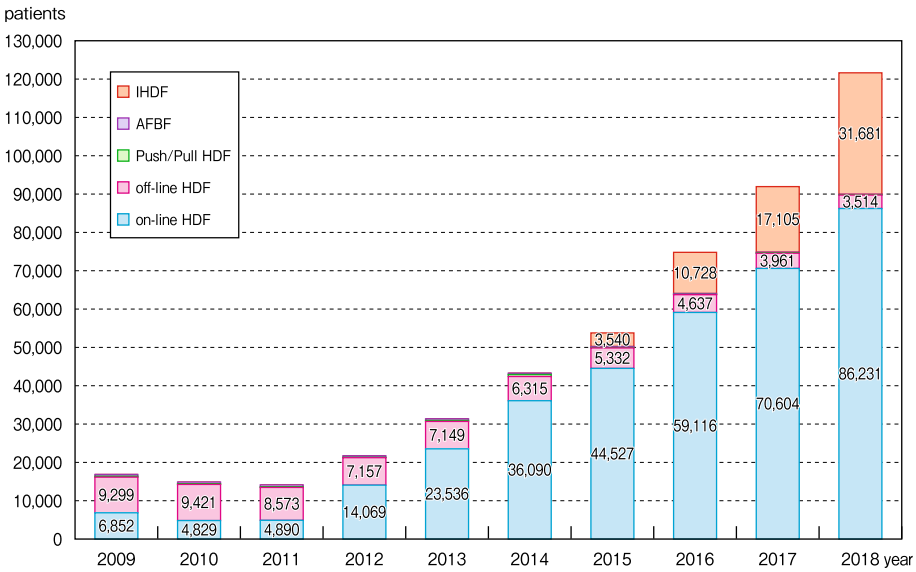

Fig. 10 HDF patient counts according to HDF modality from 2009 to 2018. AFBF, acetate-free biofiltration; HDF, hemodiafiltration; IHDF, intermittent infusion hemodiafiltration

males, 46.9% of the females). Patients on HDF have a longer dialysis vintage than patients on HD, and HDF indicated for relatively younger patients in Japan (Fig. 12, Supplementary Table 12).

Comparison between dialysis time and blood flow rate of HD patients and HDF patients

A total of 203,009 HD patients and 85,928 HDF patients responded to the question regarding dialysis time. The mean dialysis times of the HD patients and HDF patients were 239 min and 245 min, respectively, and thus, the HDF patients were treated approximately 6 min longer than the patients on HD. In both groups, the "≥ 240 min, < 270 min" group was the largest with 68.0% of the HD patients and 71.3% of the HDF patients (Fig. 13, Supplementary Table 13).

A total of 178,283 HD patients and 112,929 HDF patients responded to the question regarding blood flow

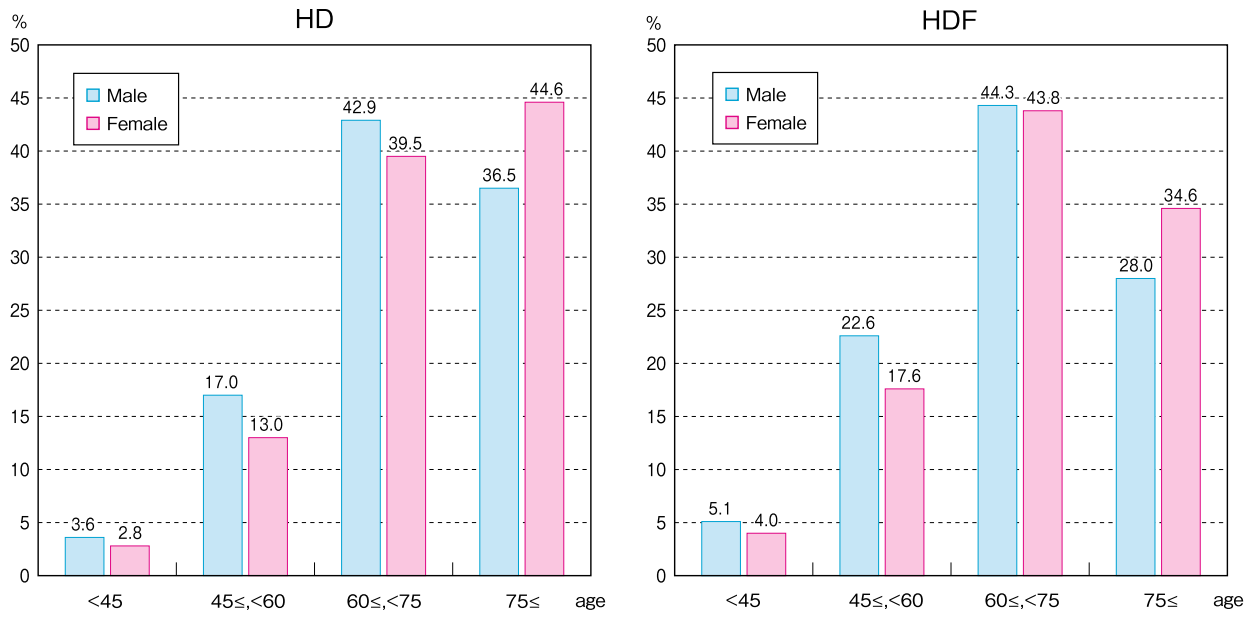

Fig. 11 Distribution of HD and HDF patients according to age and sex in 2018. HD, hemodialysis; HDF, hemodiafiltration

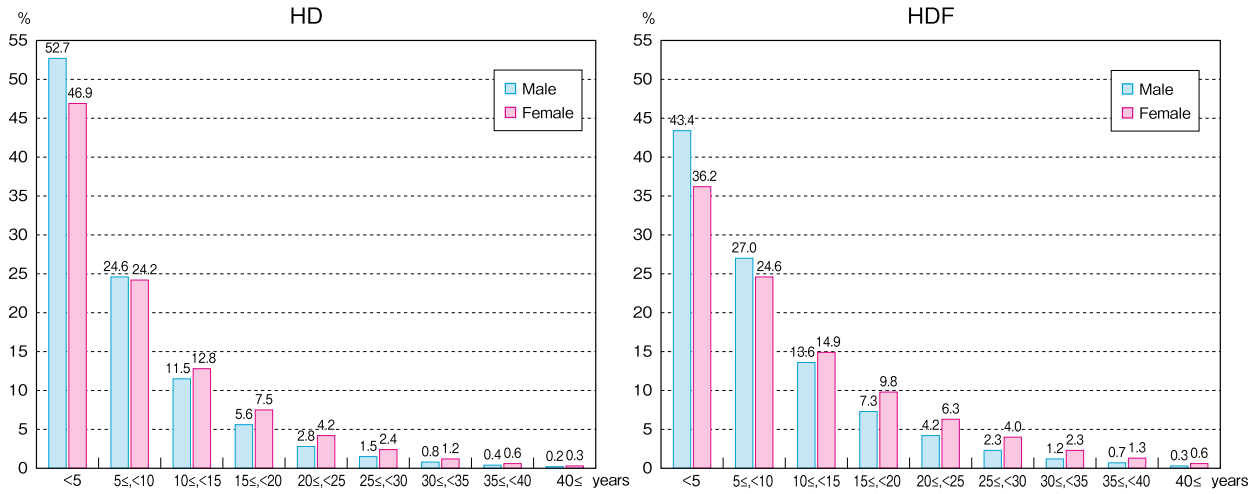

Fig. 12 Distribution of HD and HDF patients according to dialysis vintage and sex in 2018. HD, hemodialysis; HDF, hemodiafiltration

rate. The mean blood flow rate was 205 mL/min in the HD group and 224 mL/min in the HDF group, indicating that the HDF group had a higher blood flow rate. The blood flow rate category containing the largest proportion of patients in both groups was the "≥ 200 mL/min, < 220 mL/min" category, which accounted for 44.0% of the HD group and 34.4% of the HDF group (Fig. 14, Supplementary Table 14).

Peritoneal dialysis

Stock and flow of patients on peritoneal dialysis

On December 31, 2018, 9445 patients in Japan were on peritoneal dialysis (PD) according to the facility survey, representing an increase of 355 patients (3.9%) over December 31, 2017 (Table 1); 7582 patients (80.3%) were on PD alone, and the rest were receiving combination therapy with HD(F) (1621 once weekly, 142 twice weekly, 30 thrice weekly HD(F), while 70 were undergoing "other combined therapy").

The number of patients started on PD during the 2018 survey period was 2293, representing an increase of 8.3% over 2017 (Fig. 15, Supplementary Table 15). The age distribution of the PD patients by sex is shown in Fig. 16 (Supplementary Table 16). According to the patient survey, 65.9% of the 9069 PD patients were male.

PD vintage by sex is shown in Fig. 17 (Supplementary Table 17). Most of the 6257 PD patients who responded to the questions regarding PD vintage had shorter dialysis vintages, with 47.0% (males: 49.3%, females: 42.6%) having started dialysis less than 2 years before. Patients

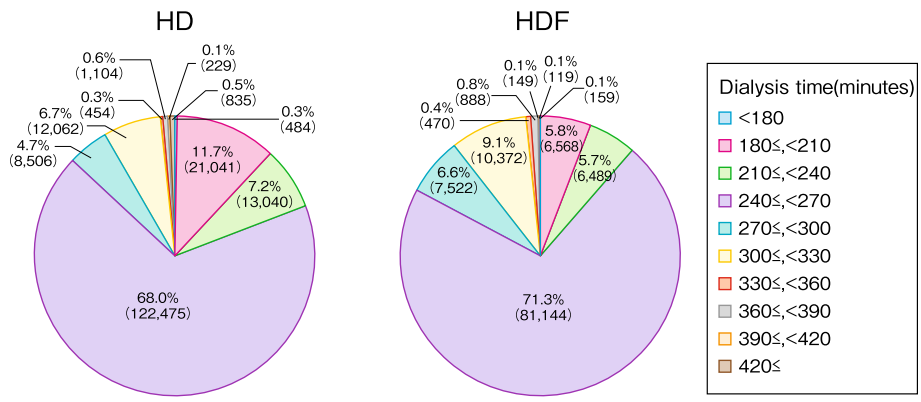

Fig. 13 Distribution of HD and HDF patients according to dialysis time in 2018. HD, hemodialysis; HDF, hemodiafiltration

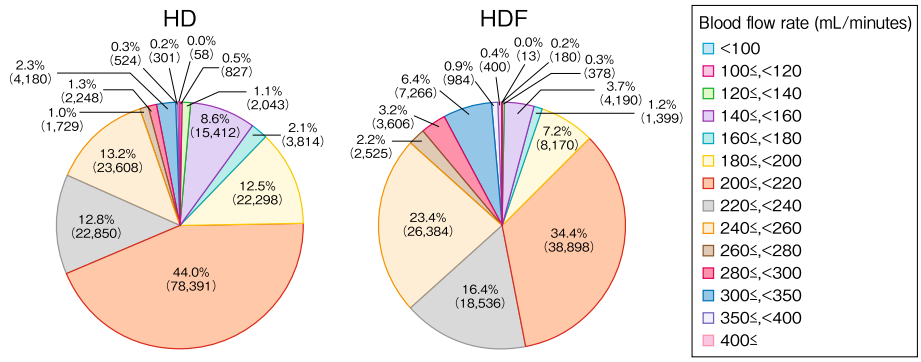

Fig. 14 Distribution of HD and HDF patients according to the blood flow rate in 2018. HD, hemodialysis; HDF, hemodiafiltration

on PD for more than 8 years accounted for 7.1% (males: 5.8%, females: 9.6%). The mean PD vintage was 3.07 years (males: 2.89 years, females: 3.40 years) (Fig. 17, Supplementary Table 17).

Peritoneal dialysis fluids

Figure 18 and Supplementary Table 18 show icodextrin use according to PD vintage at the end of 2018. Of the 5938 PD patients who responded to the questions regarding icodextrin use, 3236 (54.5%) used icodextrin PD solution. Icodextrin use was less common in both the group on PD for less than 2 years and the group on PD for 8 years or more.

Peritonitis

Figure 19 and Supplementary Table 19 report PD vintages and peritonitis rates calculated by dividing the number of episodes of peritonitis during 2018 by the total patient-months/12. Of the 6061 PD patients who responded to the questions regarding peritonitis, 5278 (87.1%) had never experienced peritonitis during 2018.

Diabetic patients on dialysis

The 2018 JSDT survey was the first survey since 2013 to include items related to glycemic control indicators [4]. The 2013 survey included only hemoglobin A1c (HbA1c) and glycated albumin (GA), whereas the 2018 survey also included casual plasma glucose.

The JSDT's "Best Practice for Diabetic Patients on Hemodialysis 2012" recommended GA instead of HbA1c as an indicator of glycemic control in dialysis patients [4]. About 6 years have passed since the "Best Practice for Diabetic Patients on Hemodialysis 2012" was published. In 2013, GA was measured in 53.5% of the patients, whereas 46.5% of the patients continued to undergo an assessment of glycemic control based on HbA1c values alone [4]. The analysis in 2018 included patients with a history of diabetes and patients with underlying diabetic nephropathy. The 2018 survey included 160,021 dialysis patients with diabetes, 124,081 of whom were monitored on the basis of GA and/or HbA1c measurements. Since 94,199 (75.9%) of the 124,081 patients in 2018 were monitored based on GA measurements and 54,567 (44.0%) based on HbA1c measurements, GA measurements had become much more common (Fig. 20, Supplementary Table 20). In this chapter, the term "hemodialysis patients" refers to patients on hemodialysis (HD), hemodiafiltration (HDF), hemofiltration, hemadsorption, and home hemodialysis as a whole.

Table 1 Treatment modalities of PD patients in 2018

Modality	Number
PD only	7582
PD + HD(F) once/week	1621
PD + HD(F) twice/week	142
PD + HD(F) thrice/week	30
Others	70
Total	9445

The data were obtained from the facility survey
HD(F) hemodialysis or hemodiafiltration

Glycemic indices

GA

The analysis at the end of 2018 included the 94,199 of the 160,021 diabetic dialysis patients whose GA levels were measured. In 2018, approximately 6 years following the publication of "Best Practice for Diabetic Patients on Hemodialysis 2012," GA was measured in large numbers of patients. The mean GA level in 2018 was 20.7% ± 5.0%, lower than the mean level of 21.2% ± 5.3% in the 2013 JSDT survey (Supplementary Table 21). In terms of modes, the PD group had a clearly lower mean GA level (16.9% ± 4.4%) than the HD group (HD 20.9% ± 5.1%, HDF 20.5% ± 5.0%) (Fig. 21).

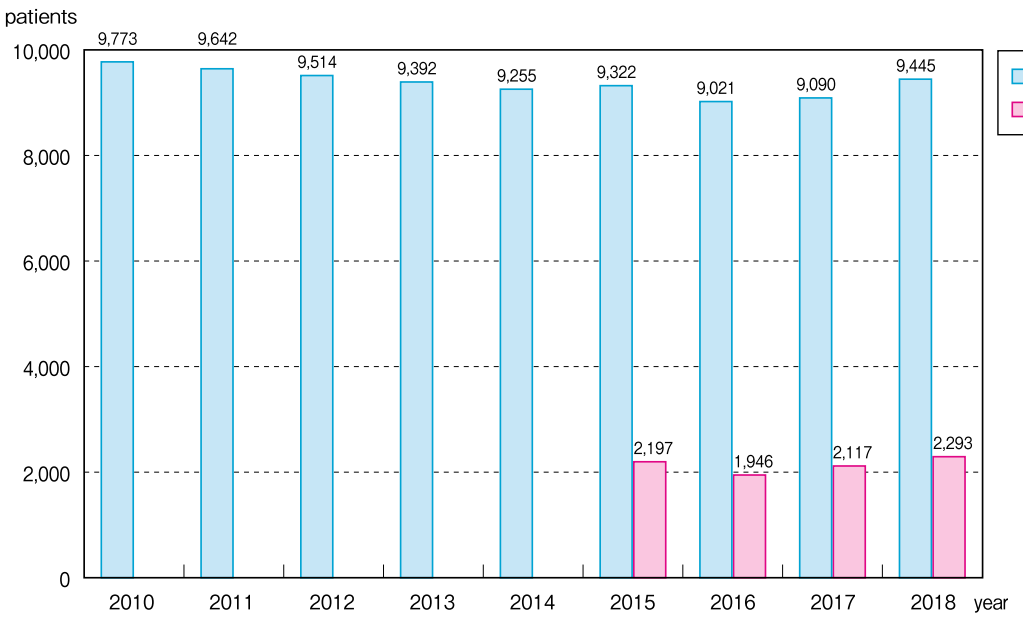

Fig. 15 Trends in the numbers of prevalent and incident PD patients from 2010 to 2018. PD, peritoneal dialysis

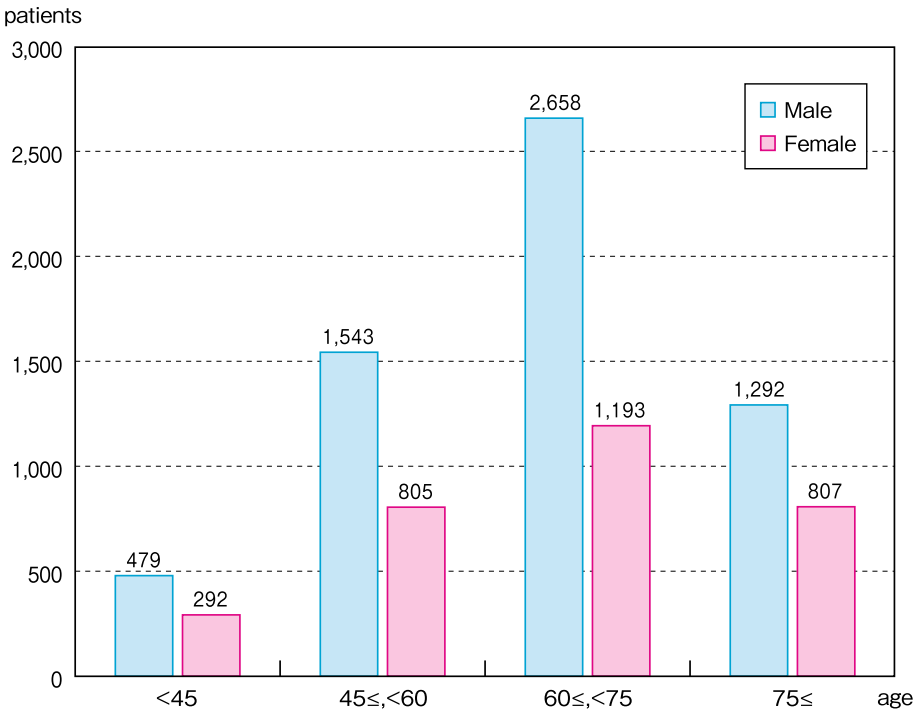

Fig. 16 Numbers of prevalent PD patients according to age and sex in 2018. PD, peritoneal dialysis

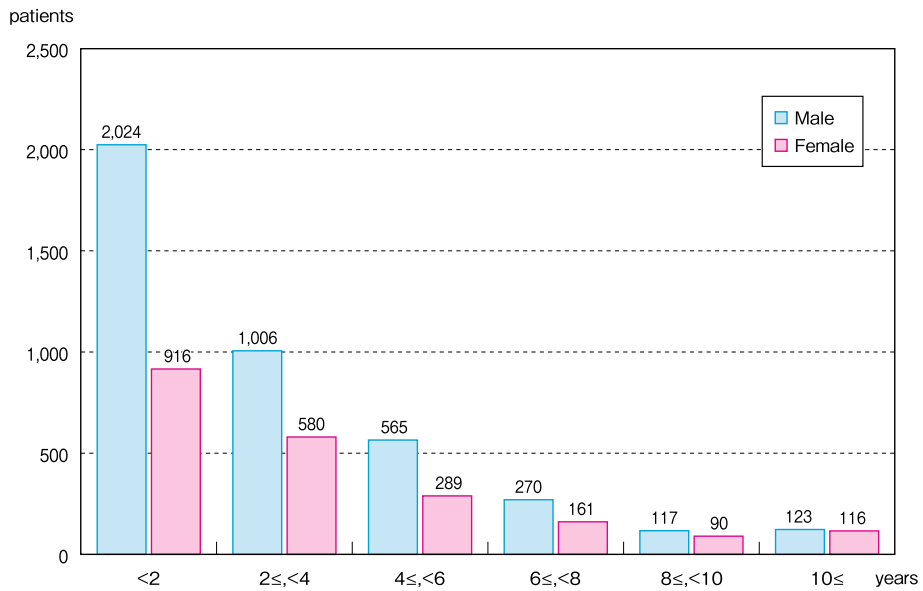

Fig. 17 Numbers of prevalent PD patients according to PD vintage and sex in 2018. PD, peritoneal dialysis

This finding may be explained by the fact that the results included the loss of albumin into PD fluid, and the patients on PD had lower casual plasma glucose levels than the patients on HD. By contrast, the mean GA levels of the HD group and HDF group were nearly identical. The provisional target GA level of < 20.0% prescribed in "Best Practice for Diabetic Patients on Hemodialysis 2012" was reached in 47,852 patients (51.4%), an improvement over the 46.6% in the 2013 JSDT survey. The target GA level for patients with a history of cardiovascular events and patients with hypoglycemic tendencies is < 24.0%, and it was reached in 74,811 patients (80.4%). This rate was also higher than in the 2013 survey (76.6%).

HbA1c

The HbA1c data of the 54,567 of the 160,021 diabetic dialysis patients whose HbA1c levels were measured were included in the analysis. Their mean HbA1c level was 6.19% ± 1.17%, and it was almost identical to the

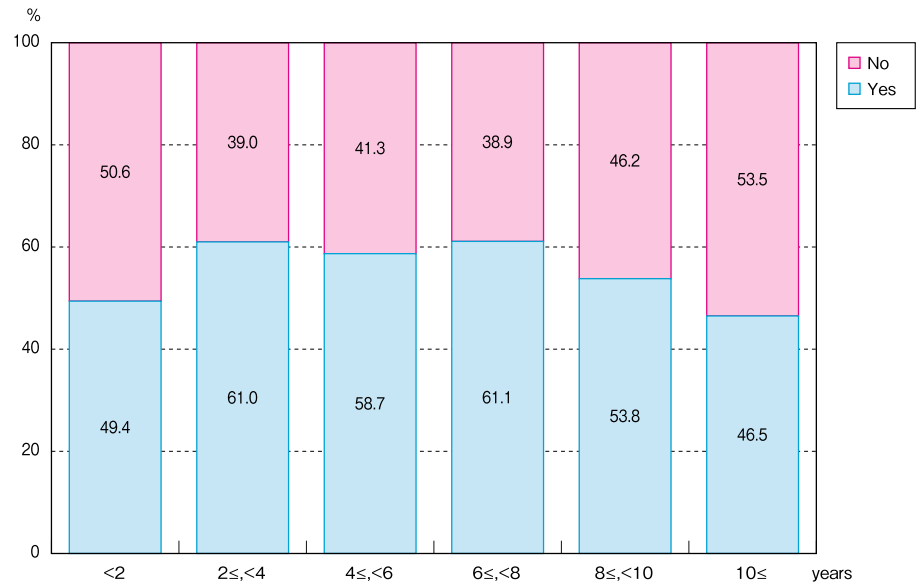

Fig. 18 Distribution of the prevalent PD patients according to PD vintage and icodextrin use in 2018. PD, peritoneal dialysis

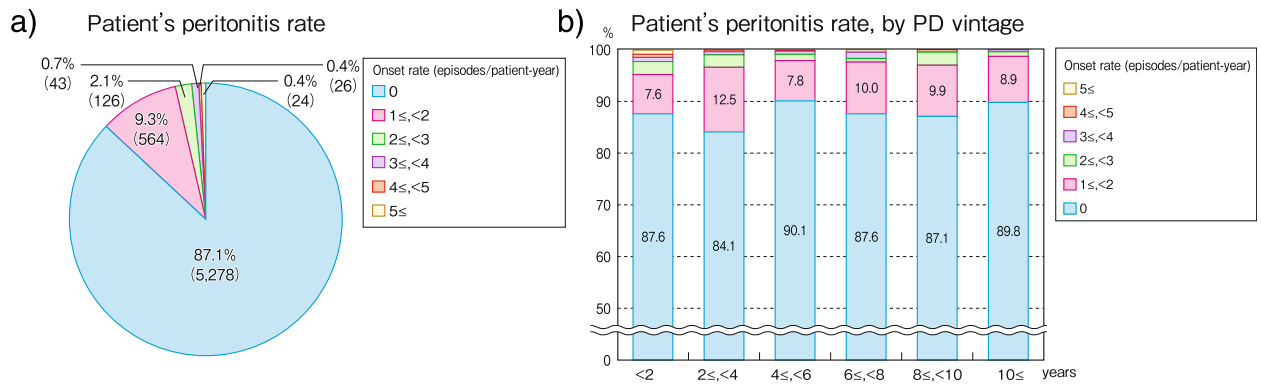

Fig. 19 Distribution of the prevalent PD patients according to peritonitis rate and PD vintage in 2018. **a** Peritonitis rate. **b** Peritonitis rate according to PD vintage. PD, peritoneal dialysis

6.19% ± 1.16% level in the 2013 survey (Supplementary Table 22). The mean HbA1c levels of the PD group, HD group, and HDF group were 6.14% ± 1.11%, 6.17% ± 1.16%, and 6.23% ± 1.19%, respectively. When the patients were divided into ten groups according to their HbA1c levels, the proportions of patients in each of the ten HD groups were similar to their proportions in the ten PD groups (Fig. 22).

Casual plasma glucose

This is the first time that the casual plasma glucose levels of dialysis patients were investigated in the JSDT survey. The subjects of the analysis were the 111,005 of the 160,021 diabetic dialysis patients whose casual plasma glucose levels had been measured. The casual plasma glucose levels in the HD group, HDF group, and PD group were 151.5 ± 56.1 mg/dL, 150.8 ± 55.4 mg/dL, and 140.3 ± 53.4 mg/dL, respectively. The mean casual plasma glucose level of the PD patients was lower than those of patients on HD and HDF (Supplementary Table 23). The provisional target level for a casual plasma glucose level of < 200 mg/dL prescribed in "Best Practice for Diabetic Patients on Hemodialysis 2012" was achieved in 84.4% of the dialysis patients (Fig. 23). Although no casual plasma glucose target level has been established for PD patients, 89.1% of the PD patients had a casual plasma glucose level of less than 200 mg/dL, which was higher than in the HD group. A casual plasma glucose level below 50 mg/dL, which suggested the presence of severe hypoglycemia, was found in 237 patients (0.2%).

Antidiabetic agents

Insulin injection therapy was used to treat diabetic dialysis patients prior to 2010, because many oral hypoglycemic agents were contraindicated for dialysis patients in Japan. However, dipeptidyl peptidase-4 (DPP-4) inhibitors, α-glucosidase inhibitors (α-GIs), and two fast-acting insulin secretagogues, i.e., mitiglinide and repaglinide, were approved for use in dialysis patients in Japan in 2013 [5]. In the first survey of 2013, 33.0% of

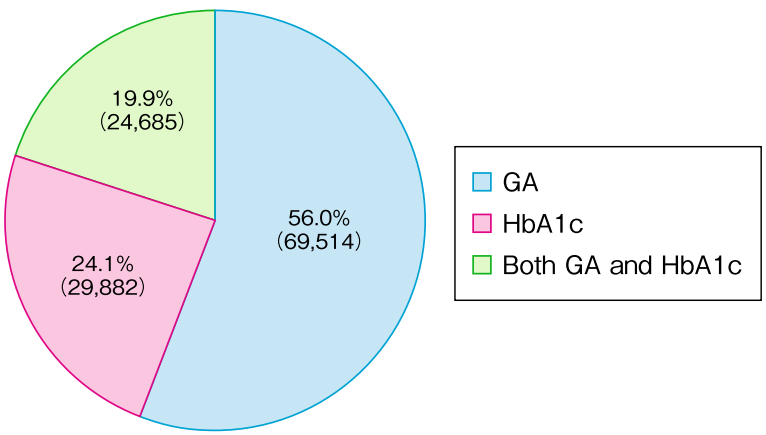

Fig. 20 Glycemic indices of diabetic patients on dialysis. GA, glycated albumin; HbA1c, glycated hemoglobin

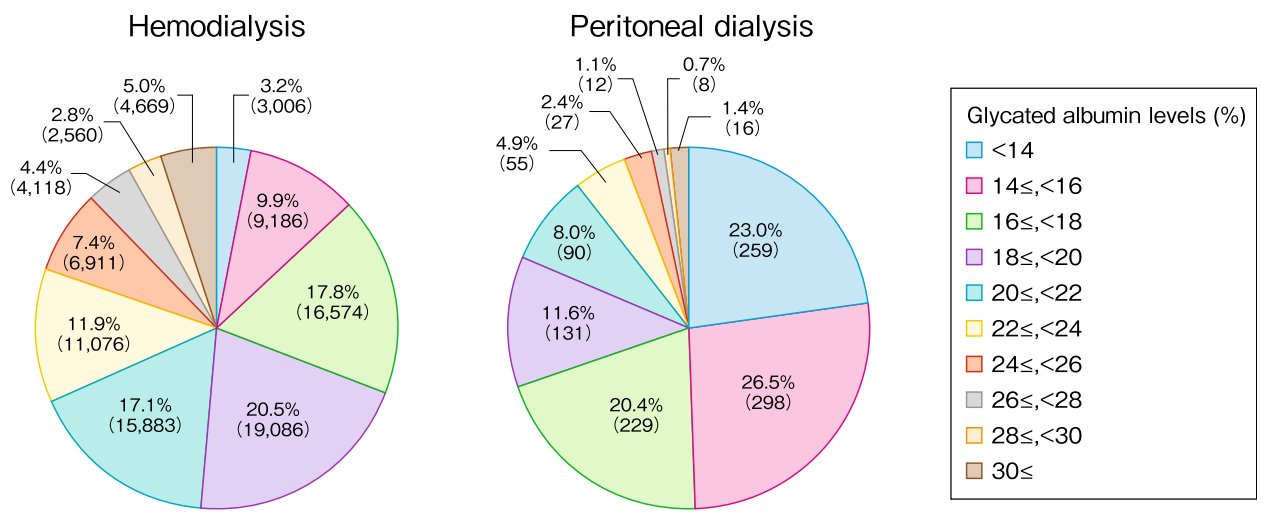

Fig. 21 GA levels of diabetic patients on hemodialysis and peritoneal dialysis in 2018. GA, glycated albumin

the diabetes patients on dialysis were treated with insulin, and they were followed by 27.6% treated with a DPP-4 inhibitor, and then 20.9% treated with another oral hypoglycemic agent, including α-GIs and fast-acting insulin secretagogues [4].

Insulin injection therapy

A total of 127,614 of the 160,021 diabetic patients on dialysis responded to the question regarding whether or not they were being treated with insulin. The results showed that the proportion of patients being treated with insulin injection therapy was 26.3%, and lower than the 33.0% in the 2013 survey (Supplementary Table 24). The increase in the proportion of patients being treated with a DPP-4 inhibitor or glucagon-like peptide-1 (GLP-1) receptor agonist may have contributed to the decrease in the proportion of patients on insulin injection therapy. The proportions of patients on insulin injection therapy in the HD group and PD group were 26.4% and 22.4%, respectively, and the proportion of HD patients on insulin injection therapy was higher than in the PD group (Fig. 24).

DPP-4 inhibitors

A total of 125,563 of the 160,021 diabetic patients on dialysis responded to the question regarding whether or not they were being treated with a DPP-4 inhibitor. The results showed that the proportion of patients being treated with a DPP-4 inhibitor was 39.7%, a much higher proportion than the 27.6% in the 2013 survey (Fig. 25, Supplementary Table 25). In 2012, five DPP-4 inhibitors were being marketed in Japan, whereas seven daily and

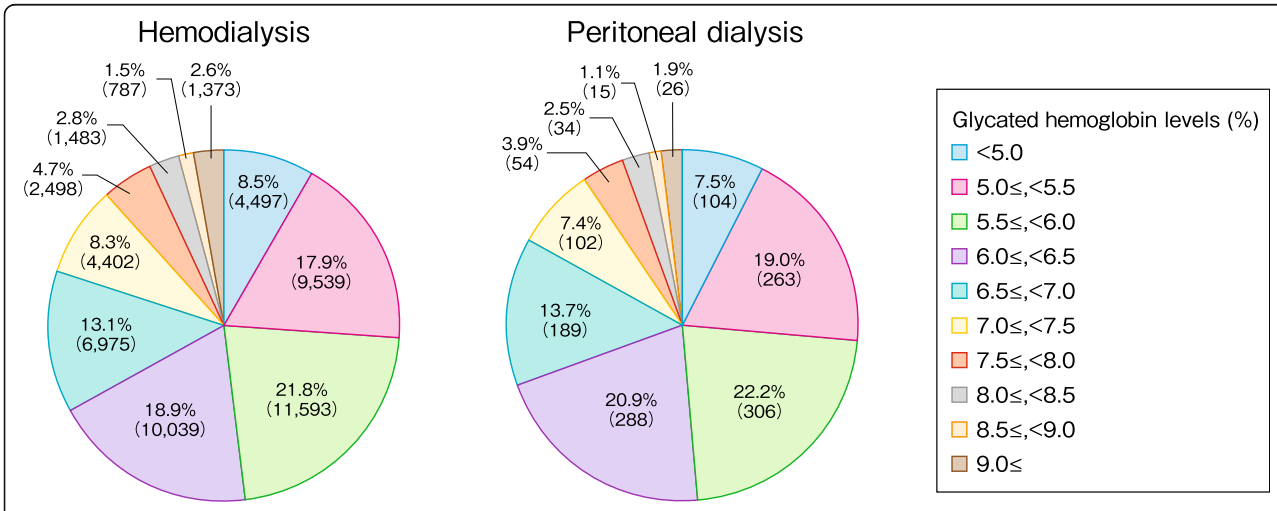

Fig. 22 HbA1c levels of diabetic patients on hemodialysis and peritoneal dialysis in 2018. HbA1c, glycated hemoglobin

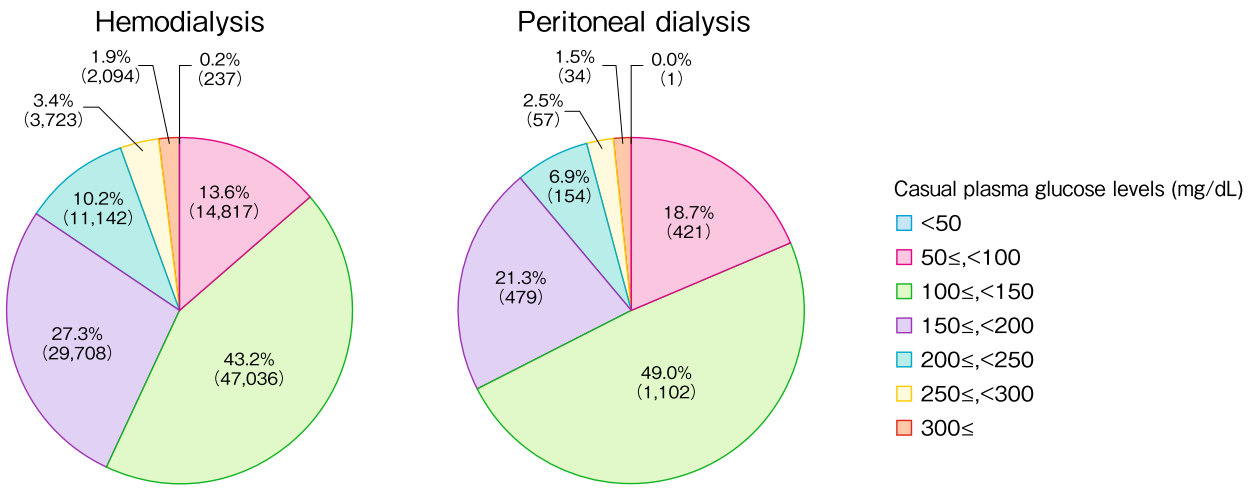

Fig. 23 Casual plasma glucose levels of diabetic patients on hemodialysis and peritoneal dialysis in 2018

two weekly DPP-4 inhibitor preparations are now available for the treatment of dialysis patients in Japan, and DPP-4 inhibitors are currently being widely used to treat dialysis patients in Japan.

GLP-1 receptor agonists

This is the first time that investigated the use of GLP-1 receptor agonists in dialysis patients in JSDT. A total of 123,545 of 160,021 diabetes patients on dialysis responded to the question regarding whether or not they were being treated with a GLP-1 receptor agonist, and the results showed that 5.4% of them were receiving a GLP-1 receptor agonist (Fig. 26, Supplementary Table 26). In 2012, only one GLP-1 receptor agonist was available in Japan, whereas today, two daily and one weekly GLP-1 receptor agonist preparation are available.

Other antidiabetic agents

A total of 123,052 of the 160,021 diabetic patients on dialysis responded to the question regarding whether or not they were being treated with another antidiabetic agent. In 2018, the oral antidiabetic agents that could be used to treat dialysis patients consisted of DPP-4 inhibitors, α-GIs, and fast-acting insulin secretagogues, and thus, patients being treated with "other antidiabetic agents" include patients being treated with α-GIs and/or fast-acting insulin secretagogues. This proportion being treated with other antidiabetic agents in 2018 was 17.4% and was lower than the 20.9% in the 2013 survey (Fig. 27, Supplementary Table 27).

Conclusion

The ET levels in dialysis fluid indicate that compliance with both the under 0.001 EU/mL standard and the under 0.05 EU/mL standard is increasing annually. The achievement quotients for both UPD and standard dialysis fluid have been increasing over time, suggesting that the dialysis fluid purity level is increasing in Japan. The number of HDF patients in Japan has been rapidly increasing, and they accounted for 38.3% of all

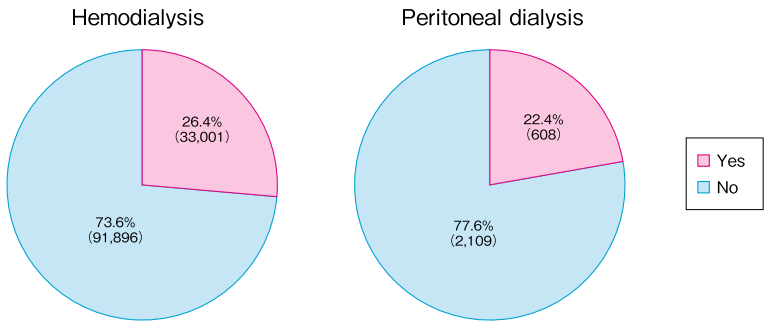

Fig. 24 Proportions of diabetic patients on hemodialysis and peritoneal dialysis who were treated with insulin injection therapy in 2018

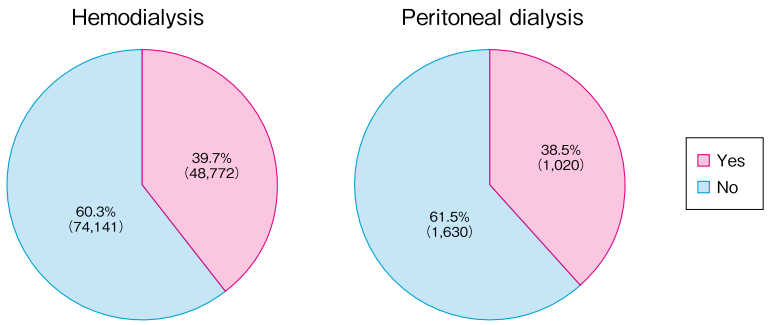

Fig. 25 Proportions of the diabetic patients on hemodialysis and peritoneal dialysis who were treated with a DPP-4 inhibitor in 2018. DPP-4, dipeptidyl peptidase-4

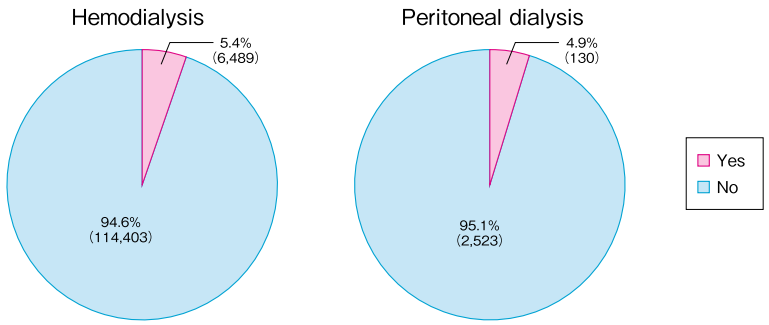

Fig. 26 Proportions of the diabetic patients on hemodialysis and peritoneal dialysis who were treated with a GLP-1 receptor agonist in 2018. GLP-1, glucagon-like peptide-1

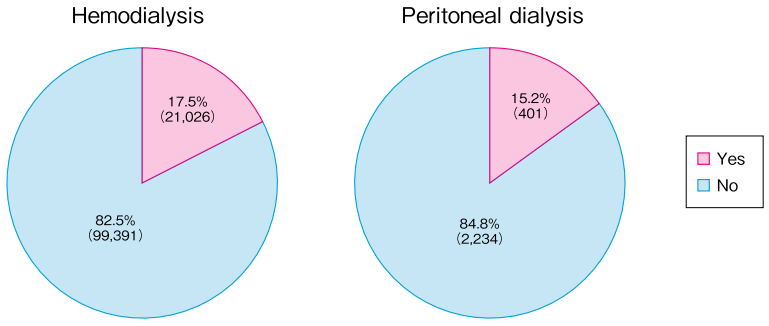

Fig. 27 Proportions of the diabetic patients on hemodialysis and peritoneal dialysis who were treated with other antidiabetic agents in 2018

HD and HDF patients. In 2018, 70.9% of the HDF patients were undergoing online HDF, and they were followed by 26.0% who were receiving IHDF. The mean HD dialysis time was 239 min. The mean blood flow rate was 205 mL/min, which was lower than in the US and European countries [6]. There were 9445 patients on PD, accounting for 2.8% of all dialysis patients, with 80% of them undergoing PD alone and the others undergoing combination therapy with HD. GA was the main indicator of glycemic control measured in Japan, and the mean GA, HbA1c, and casual plasma glucose levels in 2018 were 20.9%, 6.2%, and 151.5 mg/dL, respectively. The results of the 2018 survey showed that the proportion of patients on insulin injection therapy had decreased, and the proportion being treated with DPP-4 inhibitors had increased since the 2013 survey.

Supplementary information

The online version contains supplementary material available at https://doi.org/10.1186/s41100-020-00290-z.

Additional file 1. Supplementary tables. (DOCX 192 kb)

Abbreviations

α-GI: α-Glucosidase inhibitor; AFBF: Acetate-free biofiltration; DPP-4: Dipeptidyl peptidase-4; ET: Endotoxin; GA: Glycated albumin; GLP-1: Glucagon-like peptide-1; HbA1c: Glycated hemoglobin; HD: Hemodialysis; HDF: Hemodiafiltration; IHDF: Intermittent infusion hemodiafiltration; JSDT: Japanese Society for Dialysis Therapy; JRDR: JSDT Renal Data Registry; PD: Peritoneal dialysis; TVC: Total viable microbial count; UPD: Ultrapure dialysis fluid

Acknowledgements

We owe the completion of this survey to the efforts of the members of the subcommittee for JRDR Regional Cooperation, the members of which are mentioned below, and the staff members of the dialysis facilities who participated in the survey and responded to the questionnaires. We would like to express our deepest gratitude to all these people.
Subcommittee for JRDR Regional Cooperation: Kazuyuki Maeno, Tetsuya Kawata, Chikara Oyama, Koji Seino, Toshinobu Sato, Shigeru Sato, Minoru Ito, Junichiro Kazama, Atsushi Ueda, Osamu Saito, Tetsuo Ando, Tomonari Ogawa, Hiroo Kumagai, Hiroyuki Terawaki, Ryoichi Ando, Masanori Abe, Tetsuya Kashiwagi, Chieko Hamada, Yugo Shibagaki, Nobuhito Hirawa, Hisaki Shimada, Yoichi Ishida, Hitoshi Yokoyama, Ryoichi Miyazaki, Mizuya Fukasawa, Yuji Kamijyo, Teppei Matsuoka, Akihiko Kato, Noriko Mori, Yasuhiko Ito, Hirotake Kasuga, Sukenari Koyabu, Tetsuro Arimura, Tetsuya Hashimoto, Masaaki Inaba, Terumasa Hayashi, Tomoyuki Yamakawa, Shinichi Nishi, Akira Fujimori, Tatsuo Yoneda, Shigeo Negi, Akihisa Nakaoka, Takafumi Ito, Hitoshi Sugiyama, Takao Masaki, Yutaka Nitta, Kazuyoshi Okada, Masahito Yamanaka, Masaharu Kan, Kazumichi Ota, Masahito Tamura, Koji Mitsuiki, Yuji Ikeda, Masaharu Nishikido, Akira Miyata, Tadashi Tomo, Shoichi Fujimoto, Tsuyoshi Nosaki, and Yoshinori Oshiro

Authors' contributions

KN, IM, MT, MW, and MA finalized the results of the survey and prepared this manuscript. SN, NH, and AW designed the survey sheets and made a special program mounted in MS Excel worksheet for the convenience of the self-assessment of dialysis quality by each dialysis facility. T Hase, T Hama, JH, NJ, and SG were responsible for the data analysis. KY and IM were responsible for the ethics of the JRDR survey. HN was the president of JSDT in 2018, checked all the results from the 2018 JRDR survey, and approved their publication. All the authors have read and approved the final manuscript.

Funding

The present study did not receive any funding.
All efforts and costs for the 2018 JRDR survey and the creation of the ADR were provided by JSDT.

Availability of data and materials

1. For anyone wanting to use the data and materials from the current manuscript without modifications, all the data and materials will be freely available provided that "data from the JSDT" is stated.
2. For anyone wanting to use the data and materials from the current manuscript with modifications, any re-calculations etc. will require that the following sentence be included with their publication: "The data reported here have been provided by the Japanese Society for Dialysis Therapy (JSDT). The interpretation and reporting of these data are the responsibility of the authors and should in no way be seen as an official policy or interpretation of the JSDT."

Ethics approval and consent to participate

1. The JSDT Registry was approved by the ethics committee of the JSDT (approval no. 1).
2. The aims of the JSDT Renal Data Registry (JRDR) were well explained to the participating dialysis patients at the dialysis facilities.
3. Documented approval forms from the patients were not required because all the data had already been collected and there were no new interventions.
4. The original data was totally anonymized to avoid any risk of compromising the privacy of the dialysis facilities and the patients.
5. The data presented in the current manuscript does not contain any images, videos, or voice recordings that could be used to identify an individual.

Consent for publication

Not applicable

Competing interests

MA, NH, and HN are associate editors of the "Renal Replacement Therapy" journal. Other authors declare that they have no competing interests.

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Received: 5 August 2020 Accepted: 22 September 2020
Published online: 12 November 2020

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