Renal Replacement Therapy

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Annual dialysis data report for 2018, JSDT Renal Data Registry: survey methods, facility data, incidence, prevalence, and mortality

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Abstract

The annual survey of the Japanese Society for Dialysis Therapy Renal Data Registry (JRDR) was sent to 4458 dialysis facilities at the end of 2018; among these facilities, 4402 facilities (98.7%) responded to the facility questionnaire, and 4222 (94.7%) responded to the patient questionnaire. The number of chronic dialysis patients in Japan continues to increase every year; as of the end of 2018, it had reached 339,841 patients, representing 2688 patients per million population. Among the prevalent dialysis patients, the mean age was 68.75 years, and diabetic nephropathy was the most common primary disease among the prevalent dialysis patients (39.0%), followed by chronic glomerulonephritis (26.8%) and nephrosclerosis (10.8%). The number of incident dialysis patients was 40, 468, and a reduction by 491 from 2017. The mean age of the incident dialysis patients was 69.99 years old. Diabetic nephropathy was also the most common primary disease (42.3%), representing a 0.2 percent point reduction from 2017. The distribution of diabetic nephropathy appears to have reached a plateau. The number of deceased patients during 2018 was 33,863, and the crude annual death rate was 10.0%. Heart failure was the most common cause of death (23.5%), followed by infection (21.3%) and malignant tumor (8.4%); these causes were similar to
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The original Japanese report contained 11 chapters with 71 figures, 4 tables and 71 supplementary tables; as this report was too large to submit to *Renal Replacement Therapy*, we reconstructed it into three English manuscripts. This article is one of three manuscripts.
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those for 2017. The number of patients receiving hemodiafiltration has been increasing since 2012, reaching 125, 793 or 37.0% of all dialysis patients at the end of 2018. The number of patients receiving peritoneal dialysis has been gradually increasing since 2017, reaching 9445, and 19.7% of these patients were treated using a combination of peritoneal dialysis and hemodialysis or hemodiafiltration. The proportion of patients receiving combination therapy has remained at around 20% of all peritoneal dialysis patients. The number of patients undergoing home hemodialysis was 720, representing an increase of 36 patients from 2017. The 2018 JRDR survey included several topics such as the present status of the patient kinetics of chronic dialysis patients at the end of 2018, water treatment and hemodiafiltration, peritoneal dialysis, treatments for diabetes, mental and physical conditions, and the present status of viral hepatitis. In this paper, we describe the patient and facility kinetics.

Trial registration: The JRDR was approved by the ethics committee of the JSDT (approval number 1-3) and was registered in the "University hospital Medical Information Network (UMIN) Clinical Trials Registry" under the clinical trial ID of UMIN000018641 on August 8, 2015: (Accessed June 2, 2020)

Keywords: Dialysis modality, Hemodialysis, Peritoneal dialysis, Incidence, Prevalence, Mortality

Introduction

Since 1968, the Japanese Society for Dialysis Therapy (JSDT) has conducted a survey of the status of chronic dialysis treatment in Japan at the end of every year. This survey, known as the JSDT Renal Data Registry (JRDR), covers nearly all dialysis facilities throughout the country [1, 2]. Although these facilities participate voluntarily, the response rate is nearly 100%, which means that this survey represents the status of regular dialysis in Japan. The 2018 JRDR survey contained many topics such as the kinetics of chronic dialysis patients and dialysis facilities at the end of 2018, water treatment and hemodiafiltration, peritoneal dialysis, treatments for diabetes, mental and physical conditions, and the present status of viral hepatitis. In this article, we describe the method used to conduct this survey and the results of the patient and facility kinetics.

Methods

Sending and recovering the questionnaires

The JRDR annual surveys consist of two types of questionnaires: a facility-survey questionnaire and a patient-survey questionnaire. The facility-survey questionnaire includes the number of dialysis consoles, number of staff members, number of patients, and related information. The patient-survey questionnaire includes data such as dialysis prescriptions, laboratory data, and outcome factors for each patient at the dialysis facilities. For the 2018 survey, USB memory devices were mailed to dialysis facilities throughout Japan in December 2018. The devices contained the facility surveys and 2017 anonymized patient surveys in an Excel format. The dialysis facilities decoded the patient names using the decoding key in the USB memory device that was sent to them and then updated the patient data related to patient outcomes, including survival vs. death and transfer to another facility, as well as other data. They also registered incident patients into the system. Once all the patient records had been entered and the update tasks had been completed, they once again anonymized the data. After all the dialysis facilities had completely anonymized the patient data, only the USB memory device containing the questionnaires was returned to the administrative office of the JSDT. The initial deadline for the data was January 31, 2019, but facilities that had not returned data as of that date were encouraged to do so. To accommodate these facilities, a final deadline of June 18, 2019, was set, and the data collection for the end of 2018 was closed at this time.

Survey items

The following items were surveyed in 2018:

1. Facility survey

a) Overview and scope of facilities

i. Facility code, name of facility, and the date (month and year) that dialysis was begun at the facility
ii. Dialysis capabilities: simultaneous dialysis treatment capacity, and maximum dialysis treatment capacity
iii. Number of dialysis consoles, number of consoles with endotoxin retentive filters (ETRF)

b) Patient dynamics
   i. Number of prevalent dialysis patients at the end of 2018 (number of patients according to treatment modality, outpatient/inpatient)
   ii. Number of dialysis patients undergoing nightshift dialysis in 2018
   iii. Number of incident dialysis patients beginning hemodialysis (HD) or hemodiafiltration (HDF) and the number beginning peritoneal dialysis (PD) in 2018

iv. Number of deceased patients in 2018

c) Dialysis fluid quality control
   a. Frequency at which dialysis fluid endotoxin (ET) concentrations were measured and ET concentration
   b. Frequency at which the dialysis fluid total viable microbial count (TVC) was measured and the TVC
   c. Source of dialysis water
   d. Frequency of residual chlorine measurement before daily dialysis session and measurement technique

ii. Awareness of JSDT standard for dialysis fluid (chemical contamination standard) and frequency of measurement

2. Patient survey

   a. Patient basic information

   i. Sex, date of birth, year and month of start of dialysis, primary disease, residence (prefecture), year and month of transfer from another hospital, facility code before and after transfer, outcome category, outcome date (transfer, death, dropout, or transplantation), cause of death, change or revision of name or date of birth, dialysis modality, status of combined therapies involving PD with HD or HDF (etc.), PD experience, and number of kidney transplants

b) HD/HDF therapy conditions
   i. Frequency of dialysis session per week, dialysis time per session, and blood flow rate
   ii. HDF: dilution methods, substitution fluid volume per session
   iii. Body height, body weight before and after dialysis, systolic blood pressure before dialysis, diastolic blood pressure before dialysis, and pulse rate before dialysis
c) Laboratory findings
   i. Serum urea nitrogen (UN) before and after dialysis, serum creatinine concentration before

Table 1 Summary of chronic dialysis therapy in Japan, 2018*

Number of surveyed facilities		4458 facilities		(increase of 45 facilities,1.0% increase)			
Number of responded facilities		4402 facilities		(increase of 42 facilities,1.0% increase)			
Capacity	Number of bedside consoles	139,887 units		(increase of 2639 units,1.9% increase)			
	Capacity for simultaneous HD treatments	138,155 treatments		(increase of 2519 patients,1.9% increase)			
	Maximum capacity	458,597 patients		(increase of 7759 patients, 1.7% increase)			
Prevalent dialysis patients		**339,841 patients**		(increase of 5336 patients, 1.6% increase)			
		Outpatients		Inpatients		Total	
Hemodialysis	Hemodialysis (HD)	177,718	(57.6)	24,704	(79.4)	202,422	(59.6)
	Hemodiafiltration (HDF)	119,959	(38.9)	5,834	(18.8)	125,793	(37.0)
	Hemofiltration (HF)	11	(0.0)	3	(0.0)	14	(0.0)
	Blood adsorption dialysis	1401	(0.5)	46	(0.1)	1,447	(0.4)
	Home hemodialysis	703	(0.2)	17	(0.1)	720	(0.2)
Peritoneal dialysis	PD only	7140	(2.3)	442	(1.4)	7,582	(2.2)
	PD + HD 1/week	1583	(0.5)	38	(0.1)	1,621	(0.5)
	PD + HD 2/week	136	(0.0)	6	(0.0)	142	(0.0)
	PD + HD 3/week	26	(0.0)	4	(0.0)	30	(0.0)
	PD + HD other frequencies	68	(0.0)	2	(0.0)	70	(0.0)
	Subtotal	8953	(2.9)	492	(1.6)	9,445	(2.8)
Total		308,745	(100.0)	31,096	(100.0)	339,841	(100.0)
Per million of general population		2687.7 patients		(increase of 47.7 patients)			
Patients count in the night shift		31544 patients					
Incident dialysis patients		**40,468 patients**		(decrease of 491 patients,1.2% decrease)			
Incident hemodialysis patients (including HDF)		38,175 patients					
Incident peritoneal dialysis patients		2293 patients					
Deceased patients		**33,863 patients**		(increase of 1331 patients, 4.0% increase)			

PD + HD patients patients treated by the combination of PD and HD, *HDF* hemoadsorption, or hemofiltration (excluding those who underwent only peritoneal lavage)
*The above data were obtained from the facility survey.

and after dialysis, serum albumin concentration before dialysis, C-reactive protein (CRP) concentration before dialysis, serum calcium concentration before dialysis, serum phosphorus concentration before dialysis, serum parathyroid hormone (PTH) assay method, PTH level (intact or whole PTH), hemoglobin concentration before dialysis, serum total cholesterol concentration (total cholesterol), serum high-density-lipoprotein-cholesterol concentration (HDL-C), aspartate aminotransferase (AST), hepatitis B surface antigen, hepatitis C antibody, hepatitis C virus-ribonucleic acid (RNA), casual plasma glucose, glycated albumin, and hemoglobin A1c

d) Other outcome-related factors
   i. Antihypertensive drug use, smoking status, history of diabetes, history of ischemic heart disease, history of cerebral hemorrhage, history of cerebral infarction, history of limb amputation, history of proximal femur fracture, history of encapsulating peritoneal sclerosis (EPS), history of carpal tunnel syndrome operation, insulin use, dipeptidyl peptidase-4 (DPP-4) inhibitor use, glucagon-like peptide-1 (GLP-1) analog use, other anti-diabetes agent use, dementia, activity of daily life, exercise habits
e) Peritoneal dialysis (PD) survey

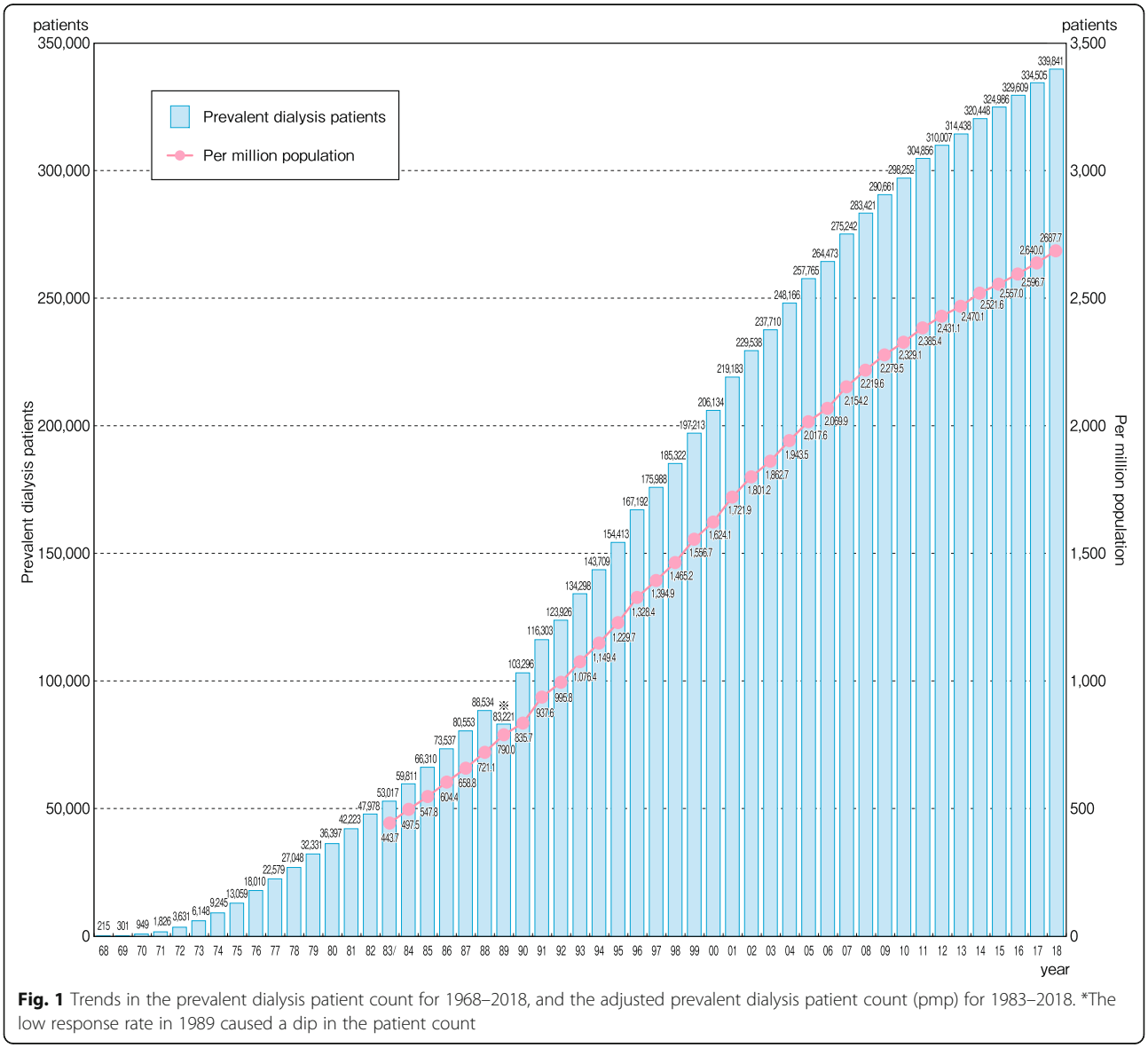

Fig. 1 Trends in the prevalent dialysis patient count for 1968–2018, and the adjusted prevalent dialysis patient count (pmp) for 1983–2018. *The low response rate in 1989 caused a dip in the patient count

i. Therapeutic history: dialysis vintage of current PD and number of months in which PD was performed in 2018
ii. Peritoneal function: implementation of peritoneal equilibration test (PET) and 4-h creatinine concentration dialysate/plasma ratio in PET (PET Cr D/P ratio)
iii. Dialysis prescription: type of PD fluid, volume of PD fluid per day, PD treatment time per day, daily urine volume, mean fluid removal volume per day, Kt/V by residual kidney function (residual kidney Kt/V), and Kt/V by PD (PD Kt/V)
iv. PD method: use of automated peritoneal dialysis (APD) machine and changing maneuver of PD fluid
v. PD-related infections: frequency of peritonitis during 2018 and number of exit-site infections during 2018

Ethical basis for the JRDR survey

The 2018 JRDR survey was conducted based on the "Ethical Guidelines for Medical and Health Research Involving Human Subjects," which was issued in December 2014 by the Ministry of Health, Labour ,and Welfare (MHLW) and the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) and was revised in Feb 2017 [3]. The 2018 JRDR survey protocol was also approved by the ethics committee of the JSDT (approval number 1-3) on January 28, 2019, and publicly released on the UMIN Clinical Trials Registry (UMIN000018641), and the results were fully released on the JSDT homepage [4].

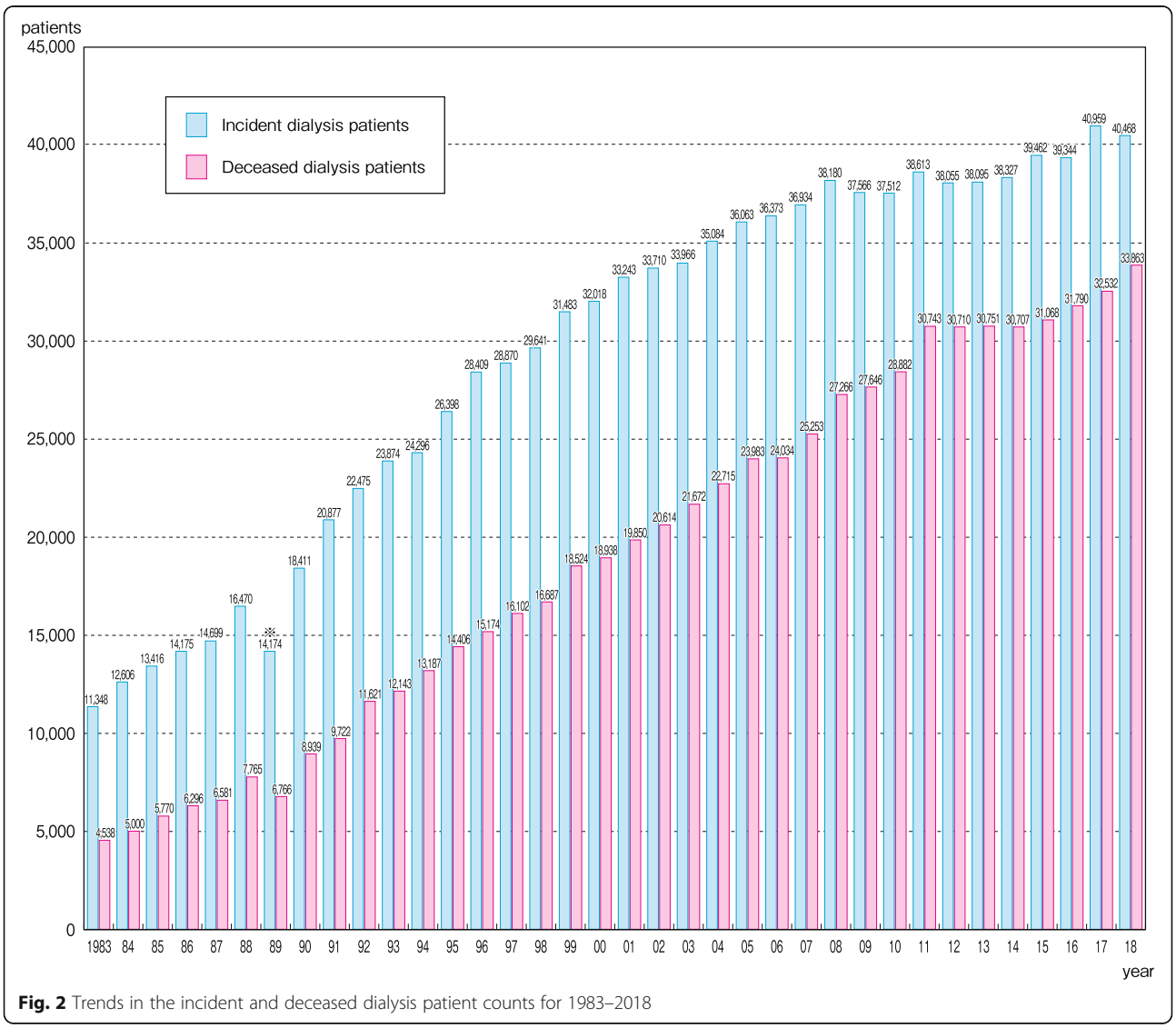

Fig. 2 Trends in the incident and deceased dialysis patient counts for 1983–2018

Table 2 Prevalent dialysis patient counts, by modality and prefecture, 2018*

Prefecture	Number of surveyed faciliteis	Number of responded facilities	Hemodialysis					Peritoneal dialysis					Total	Per million of general population**
			Hemodialysis	Hemodiafiltration	Hemofiltration	Blood adsorption filtration	Home hemodialysis	PD only	PD + HD 1/week	PD + HD 2/week	PD + HD 3/week	PD + HD other frequencies		
Hokkaido	261	257	8940	6524	0	85	9	397	90	3	1	11	16,060	3038.2
Aomori	41	40	1348	2177	0	5	3	69	12	1	0	0	3615	2862.2
Iwate	44	44	2610	432	0	10	0	84	11	0	0	0	3147	2535.9
Miyagi	65	65	3833	1967	0	13	4	96	12	1	1	2	5929	2560.0
Akita	42	42	1402	724	0	2	2	53	3	0	0	0	2186	2228.3
Yamagata	36	35	1666	948	0	5	12	44	8	1	2	0	2686	2464.2
Fukushima	70	68	2568	2,417	0	16	0	71	33	10	4	0	5119	2746.2
Ibaraki	86	86	5777	2,392	0	48	17	68	14	1	0	0	8317	2890.9
Tochigi	78	78	4250	2058	0	22	7	121	18	1	2	1	6480	3329.9
Gunma	63	62	4028	1942	0	0	13	56	18	1	0	0	6058	3103.5
Saitama	196	191	10044	8037	0	60	74	239	76	9	1	1	18,541	2529.5
Chiba	156	154	9365	5817	0	35	13	228	61	5	1	0	15,525	2482.0
Tokyo	442	435	17838	13,422	3	140	95	896	264	16	1	7	32,682	2364.5
Kanagawa	264	264	14113	6818	2	63	31	539	93	2	0	3	21,664	2360.7
Niigata	54	54	3794	1221	1	20	2	161	26	2	1	1	5229	2328.1
Toyama	42	42	1875	589	0	14	3	93	13	0	2	0	2589	2465.7
Ishikawa	41	41	1815	813	0	20	5	59	6	0	0	0	2718	2378.0
Fukui	25	25	1026	710	0	3	3	76	22	5	0	0	1845	2383.7
Yamanashi	33	33	1272	1020	0	6	2	21	14	0	0	0	2335	2858.0
Nagano	73	72	3063	2097	2	12	18	83	18	3	1	0	5297	2567.6
Gifu	72	72	3470	1486	0	22	28	70	19	1	0	0	5096	2551.8
Shizuoka	126	126	5707	5252	1	44	21	104	22	6	0	1	11,158	3049.5
Aichi	193	193	12,223	5728	1	80	46	611	91	2	0	1	18,783	2492.1
Mie	55	52	2849	1015	0	22	8	65	12	1	0	0	3972	2217.8
Shiga	40	39	1682	1370	0	33	35	97	18	0	0	0	3235	2291.1
Kyoto	81	79	3822	2507	0	80	11	138	74	8	0	1	6641	2563.1
Osaka	326	320	12,465	10,851	2	168	47	428	97	5	5	2	24,070	2731.2
Hyogo	201	199	7787	6213	0	122	72	167	26	3	0	0	14,390	2624.0
Nara	50	48	1762	1502	0	30	8	96	30	0	0	1	3429	2560.9
Wakayama	48	47	2299	612	0	11	27	58	8	0	0	0	3015	3224.6

Table 2 Prevalent dialysis patient counts, by modality and prefecture, 2018* *(Continued)*

Prefecture	Number of surveyed faciliteis	Number of responded facilities	Hemodialysis					Peritoneal dialysis					Total	Per million of general population**
			Hemodialysis	Hemodiafiltration	Hemofiltration	Blood adsorption filtration	Home hemodialysis	PD only	PD + HD 1/week	PD + HD 2/week	PD + HD 3/week	PD + HD other frequencies		
Tottori	26	26	668	812	0	2	4	51	9	1	0	1	1548	2764.3
Shimane	31	31	730	878	0	0	2	53	11	1	1	1	1677	2466.2
Okayama	67	67	2856	2087	0	27	5	180	14	6	0	1	5176	2727.1
Hiroshima	100	98	4128	3074	0	32	28	209	57	36	1	2	7567	2686.2
Yamaguchi	61	58	1760	1730	0	12	1	86	26	2	0	0	3617	2640.1
Tokushima	39	39	1355	1285	0	6	5	124	30	2	1	3	2811	3819.3
Kagawa	48	48	1277	1262	0	12	8	141	49	0	0	1	2750	2858.6
Ehime	54	54	2040	1826	0	16	0	95	34	0	1	9	4021	2974.1
Kochi	39	39	783	1690	0	9	0	18	2	0	0	2	2504	3546.7
Fukuoka	198	194	10,389	3954	1	37	19	691	43	0	1	2	15,137	2964.0
Saga	36	36	1809	739	0	7	1	8	7	0	0	0	2571	3139.2
Nagasaki	63	62	2708	1191	0	11	19	117	11	2	0	1	4060	3027.6
Kumamoto	90	89	4901	1511	0	30	4	130	26	0	0	2	6604	3758.7
Oita	70	68	2958	941	0	9	4	108	32	4	1	0	4057	3546.3
Miyazaki	65	65	2977	901	0	4	0	56	4	0	0	6	3948	3652.2
Kagoshima	95	95	4016	1305	1	22	2	153	30	0	0	6	5535	3429.4
Okinawa	72	70	2374	1946	0	20	2	74	27	1	2	1	4447	3071.1
Total	4,458	4,402	202,422 (59.6)	125,793 (37.0)	14 (0.0)	1,447 (0.4)	720 (0.2)	7,582 (2.2)	1,621 (0.5)	142 (0.0)	30 (0.0)	70 (0.0)	339,841 (100.0)	2687.7

*The above data were obtained from the facility survey.

**The numbers of dialysis patients were adjusted as per million population (pmp) by the annual governement report reference [7]

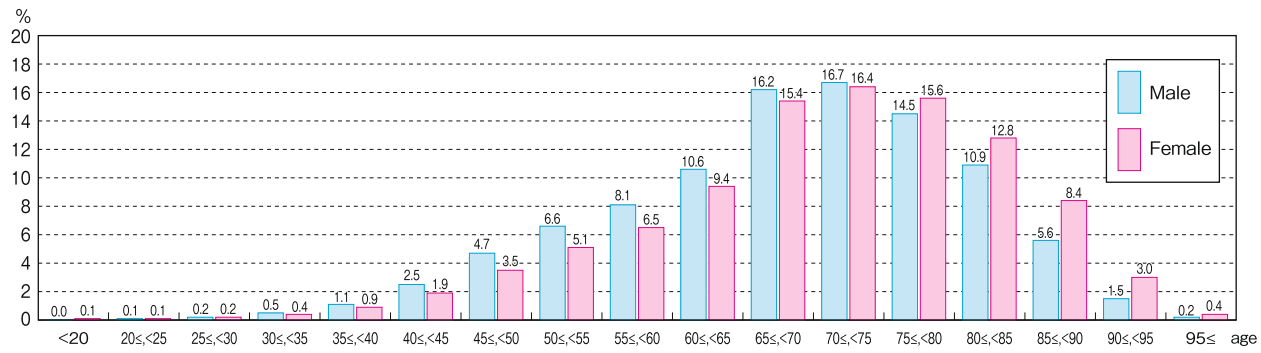

Fig. 3 Prevalent dialysis patient distribution by age and sex for 2018

Results

Basic demographics

Facility dynamics

The 2018 JRDR survey targeted 4458 facilities throughout Japan, and 4402 facilities (98.7%) responded to the facility-survey questionnaire. Although the number of facilities that returned facility-survey questionnaires fell temporarily in 2015, the number has increased again since 2016, and the number in 2018 increased by 42 facilities (1.0%) compared with 2017 (Table 1). The patient-survey questionnaire was returned from 4222 facilities (94.7%). Since 2015, the response rate for the patient-survey questionnaire has fallen from about 96 to about 95% because of the discontinuation of paper-based surveys in association with improved anonymization methods. The detail of response rate for each question is shown in Appendix.

The facility survey shows that there were 139,887 dialysis consoles, a simultaneous dialysis capacity of 138,155 patients, and a maximum dialysis treatment capacity of 458,597 patients, representing increases in 1.9%, 1.9%, and 1.7% over the previous year, respectively (Table 1). The number of dialysis consoles is also increasing annually (Supplementary Table 1).

Patient dynamics

According to the facility-survey questionnaire, the total number of patients undergoing chronic dialysis treatment at the end of 2018 was 339,841. This number indicates the prevalence of chronic kidney disease (CKD) patients undergoing regular dialysis treatment. Although the number of patients undergoing dialysis is increasing annually, the rate of increase has slowed in recent years. In 2018, there was an increase of 5336 patients, compared with the previous year (Fig. 1, Supplementary Table 1). A prediction of the number of dialysis patients conducted by Nakai et al. [5] in 2012 indicated that the number was expected to decline after reaching a peak of approximately 349,000 in 2021. In 2018, the total number of patients (N = 339,841) was below the expected peak number. The number of dialysis patients per million population (pmp) indicates the prevalence rate (Fig. 1, Supplementary Table 1). The prevalence rate has been increasing in recent years. In 2018, the rate was 2687.7 pmp, which means that one in 372.1 Japanese people is a dialysis patient. The prevalence rate of dialysis patients in Japan is the second highest in the world behind Taiwan, according to the 2018 United States Renal Data System (USRDS) Annual Data Report [6].

The number of new dialysis patients indicates the incidence of CKD patients undergoing dialysis treatment. Although this number had been increasing annually until 2008, the number in 2009 decreased compared with that for 2008. Since 2009, this number has fluctuated every year but has tended to increase overall. The incidence in 2018 was 40,468, representing a reduction

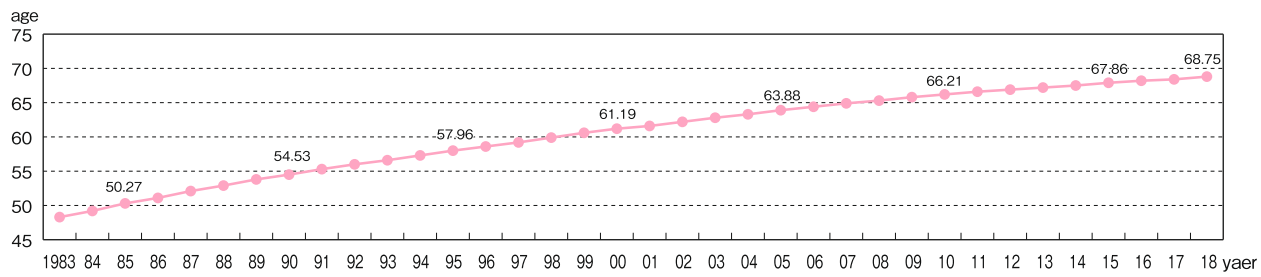

Fig. 4 Trend in the average age of the prevalent dialysis patients for 1983–2018

by 491 (− 1.2%) compared with 2017 (Fig. 2, Supplementary Table 2). Of these patients, 94.3% received HD(F) and 5.7% received PD (Table 1). The number of deceased patients has been increasing annually. Although the death rate almost plateaued between 2012 and 2014, the figure has once again been increasing since 2015, with 33,863 deceased patients in 2018; this number represents an increase of 1331 patients (+ 4.1%) compared with 2017 (Fig. 2, Supplementary Table 2). In general, the number of patients for any given year is calculated by adding the number of incident patients to the number of patients from the previous year and then subtracting the number of deceased patients. However, the number of patients thus calculated is not consistent with the actual number of patients. This may be because the calculated number does not include the number of patients who discontinue dialysis because of kidney transplantation, and there is a possibility that the number of new patients was overestimated and the number of deceased patients was underestimated.

The numbers of dialysis patients according to prefecture are shown in Table 2. The numbers in Table 2 were calculated based on the location of the facility where the patients undergo treatment and not the place of residence. The prevalence rate (number of dialysis patients per million population) differs considerably among prefectures. Since numerous confounding factors are involved in this difference, great caution is needed when comparing prefectures.

Dialysis modality dynamics

Hemodialysis (HD) accounted for 59.6% of all dialysis modalities during 2018, followed by hemodiafiltration (HDF) at 37.0%, hemofiltration (HF) at 0.004%, hemadsorption dialysis (HAD) at 0.4%, home hemodialysis (HHD) at 0.2%, and peritoneal dialysis (PD) at 2.8% (Table 1). The use of on-line HDF increased rapidly after a 2012 revision to the medical reimbursement system, and the number of HDF patients increased to 125,793 in 2018. The number of patients undergoing PD was 9445, which also represents an increase compared with the previous year (9090). Of these patients, 19.7% were treated with a combination of PD and HD(F). The number of HHD patients was 720, representing a slight increase. The

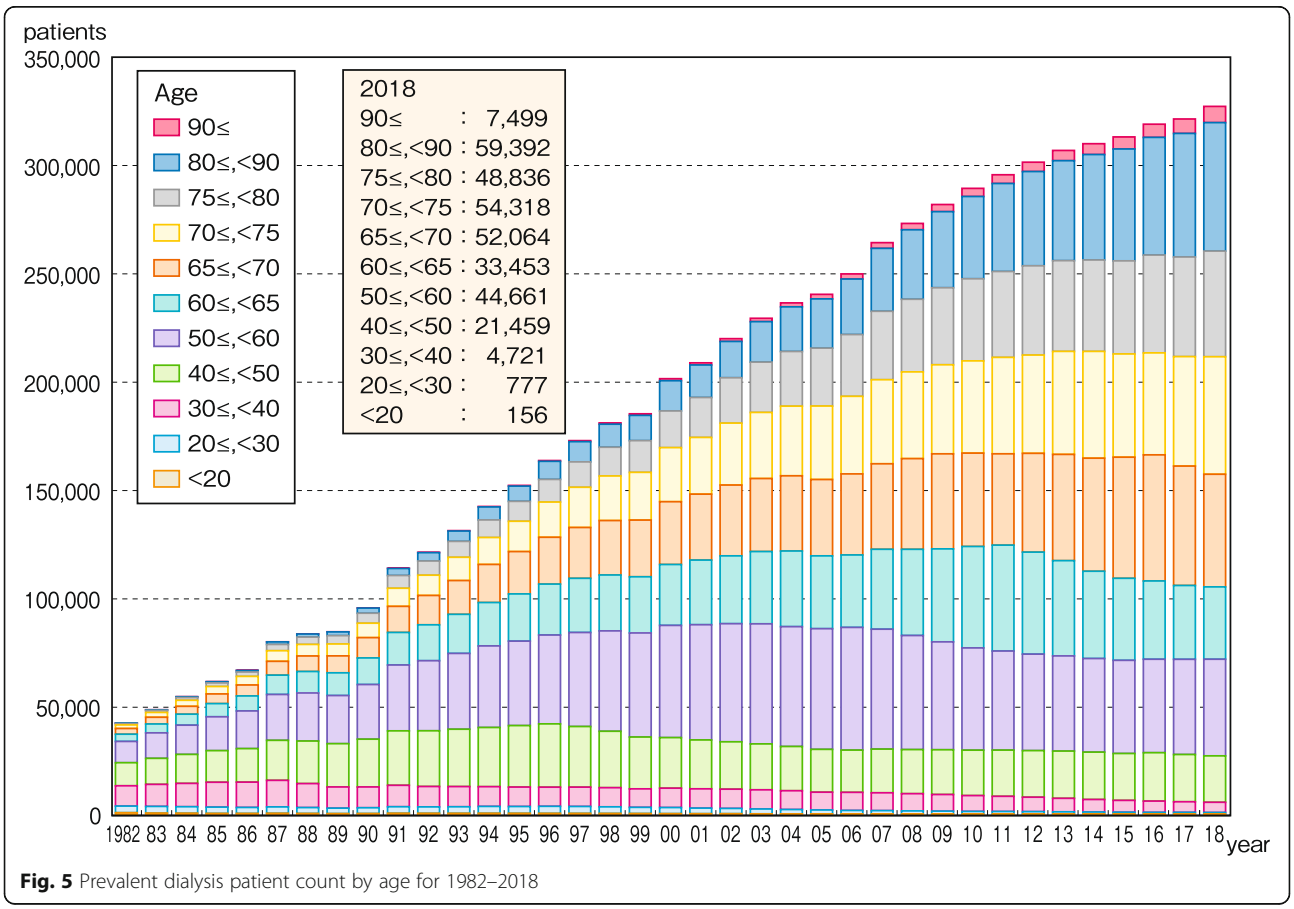

Fig. 5 Prevalent dialysis patient count by age for 1982–2018

total percentage of patients undergoing home dialysis, which is calculated by adding the number undergoing PD and HHD, was 3.0%. This figure is the lowest for this type of dialysis in the developed world [6]. Although there were regional differences in the dialysis modality data for each prefecture, the differences were affected by various regional factors (Table 2).

The number of patients undergoing nighttime dialysis at the end of 2018 was 31,544 (Table 1). Although this number had remained between 41,000 and 42,000 until the 2014 survey, the number decreased sharply to 33,370 in 2015. This change is likely to have been affected by the addition of the phrase "Dialysis during the time period recognized by the insurance system (start at 5 PM or later or finish after 9 PM or later)" to the definition of nighttime dialysis patients in the 2015 survey. The number of nighttime dialysis patients has decreased slightly since 2015, and the number in 2018 decreased by 372 patients, compared with the number in 2017.

Prevalent dialysis patient dynamics at the end of 2018

Clinical background

In the patient survey, data on age and sex were available for 327,336 patients. Among these patients, 214,078 were male, 113,258 were female, and the mean age was 68.75 years (Fig. 3, Supplementary Table 3). The mean age has been increasing annually (Fig. 4, Supplementary Table 4), and the age group of 70 to 74 years had the highest percentage of both males and females among the age groups. The number of patients under the age of 65 has decreased since 2012, while the number of patients under the age of 70 years has decreased since 2017. Expressed another way, these findings suggest that the increase in the number of prevalent dialysis patients in Japan has been caused by an increase in the number of patients aged 70 years and older (Fig. 5, Supplementary Table 5).

The mean dialysis period for chronic dialysis patients as of the end of 2018 was 6.82 years for males and 8.32

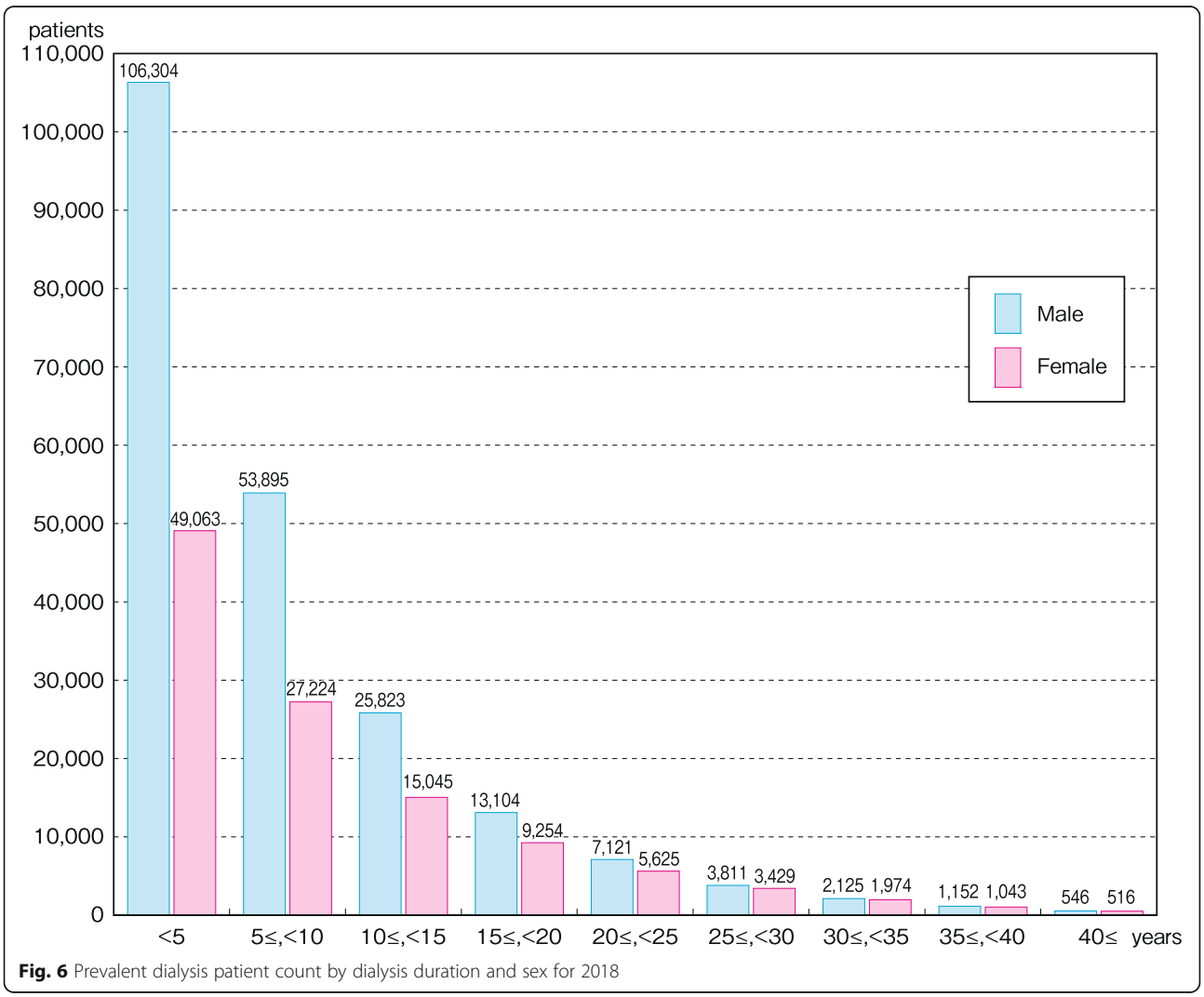

Fig. 6 Prevalent dialysis patient count by dialysis duration and sex for 2018

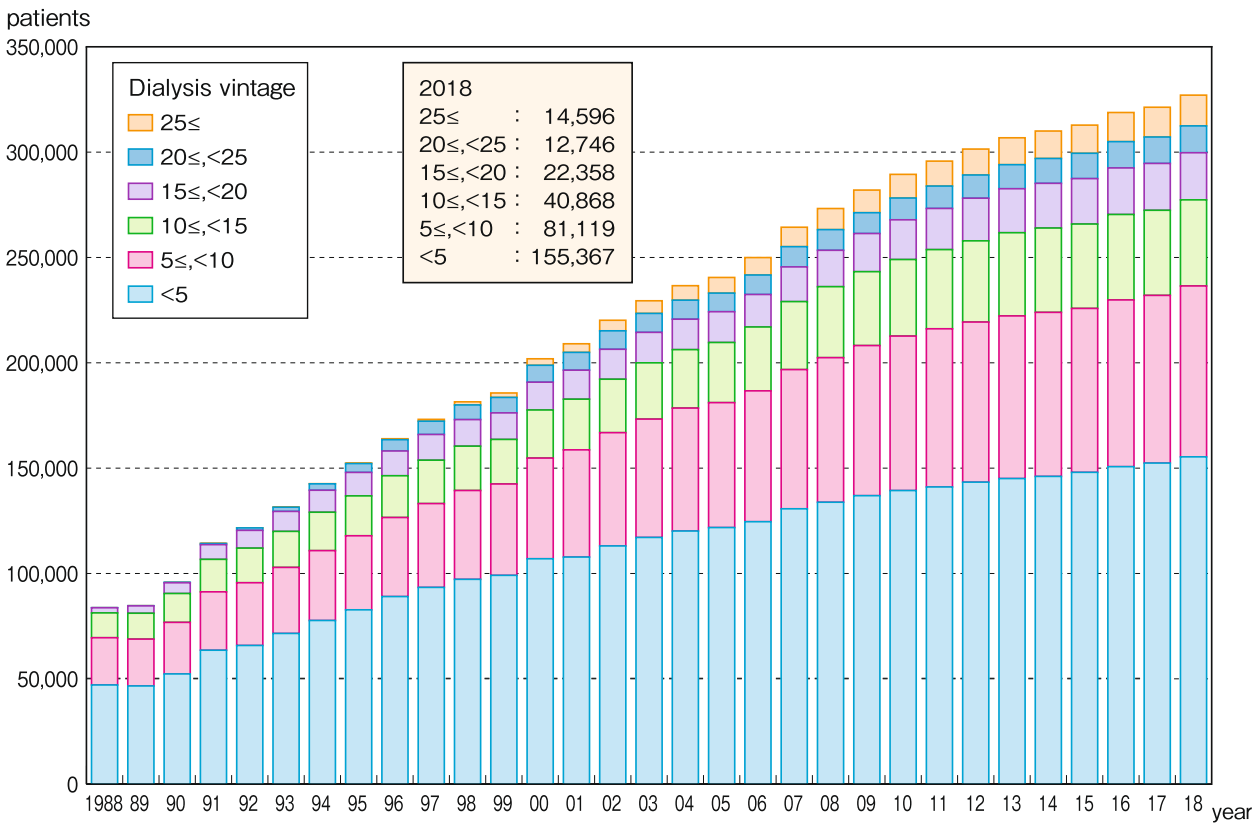

Fig. 7 Prevalent dialysis patient count by dialysis duration for 1988–2018

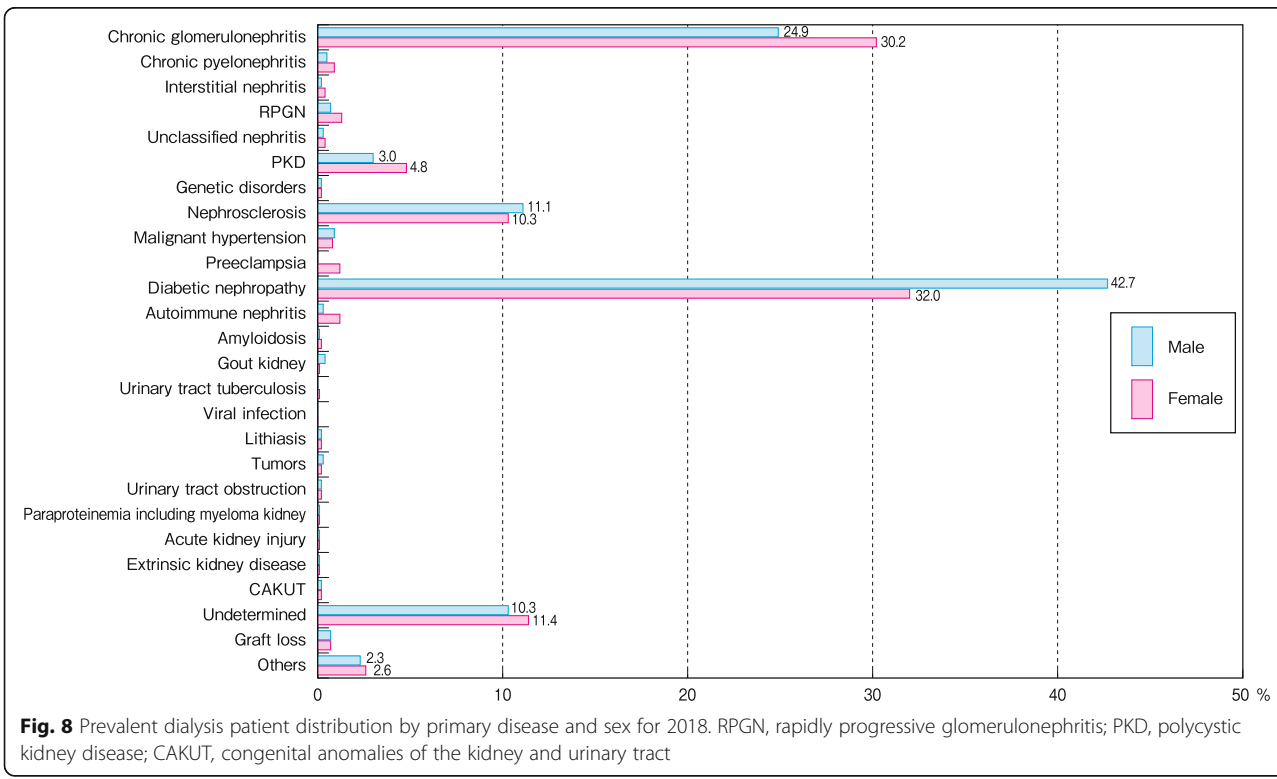

Fig. 8 Prevalent dialysis patient distribution by primary disease and sex for 2018. RPGN, rapidly progressive glomerulonephritis; PKD, polycystic kidney disease; CAKUT, congenital anomalies of the kidney and urinary tract

years for females (7.34 years overall). A comparison of dialysis period according to duration showed that 47.5% had a dialysis period of under 5 years, 8.4% had a period of 20 years or more, 2.2% had a period of 30 years or more, and 0.3% had a period of 40 years or more (Fig. 6, Supplementary Table 6). The longest duration was 50 years and 4 months. The number of patients with longer durations is increasing, with 27.7% of patients having received dialysis for 10 or more years. The percentage of patients with a dialysis period of 20 years or more, which was less than 1% at the end of 1992, reached 8.4% as of the end of 2018 (Fig. 7, Supplementary Table 7).

The most common primary disease among chronic dialysis patients at the end of 2018 was diabetic nephropathy at 39.0%, followed by chronic glomerulonephritis at 26.8% and nephrosclerosis at 10.8% (Fig. 8, Supplementary Table 8). Diabetic nephropathy replaced chronic glomerulonephritis as the most common primary disease in 2011. Although the percentage of diabetic nephropathy patients has increased continuously, the percentage has recently shown signs of reaching a plateau. The percentage of chronic glomerulonephritis patients has steadily declined, while the percentages of nephrosclerosis and "undetermined" patients have continuously increased (Fig. 9, Supplementary Table 9). However, caution is required when interpreting these results, because the primary disease code was revised as of the 2017 survey.

Causes of death

Although 33,863 deaths were reported in the 2018 facility-survey questionnaire, the number of patients whose cause of death was recorded in the patient-survey questionnaire according to sex was 31,117. The causes of death, in descending order, were heart failure, infectious disease, malignancy, and cerebrovascular disease (23.5%, 21.3%, 8.4%, and 6.0%, respectively). The "Other" category accounted for 10.6% overall. The percentage of patients in the "cardiovascular death" category, which includes heart failure, cerebrovascular disease, and myocardial infarction, was 33.1% (Fig. 10, Supplementary Table 10).

Heart failure has been the most common cause of death from 1983 onward, accounting for approximately 25% of all deaths from 1995 onward. Death caused by infectious disease, on the other hand, has been

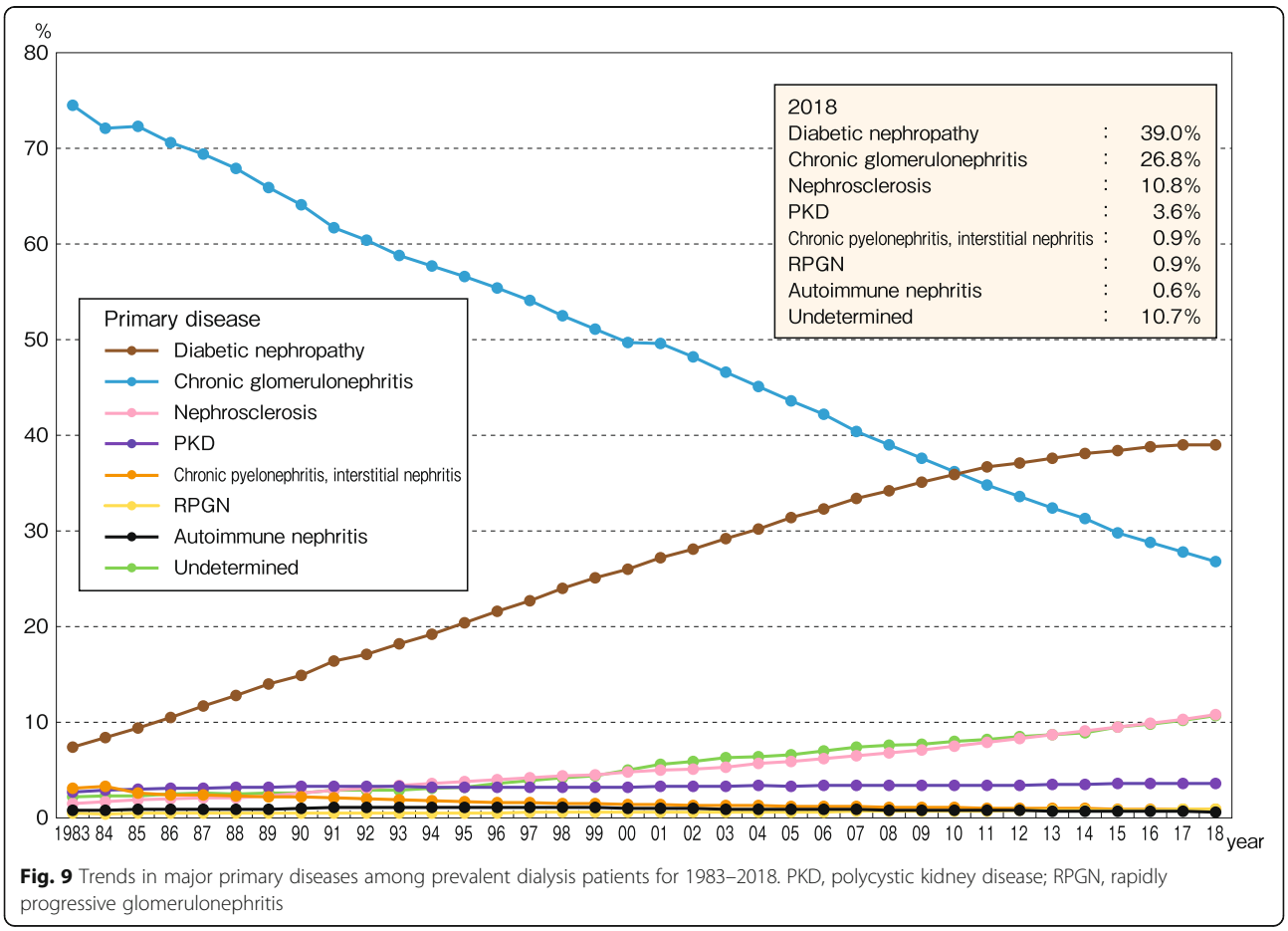

Fig. 9 Trends in major primary diseases among prevalent dialysis patients for 1983–2018. PKD, polycystic kidney disease; RPGN, rapidly progressive glomerulonephritis

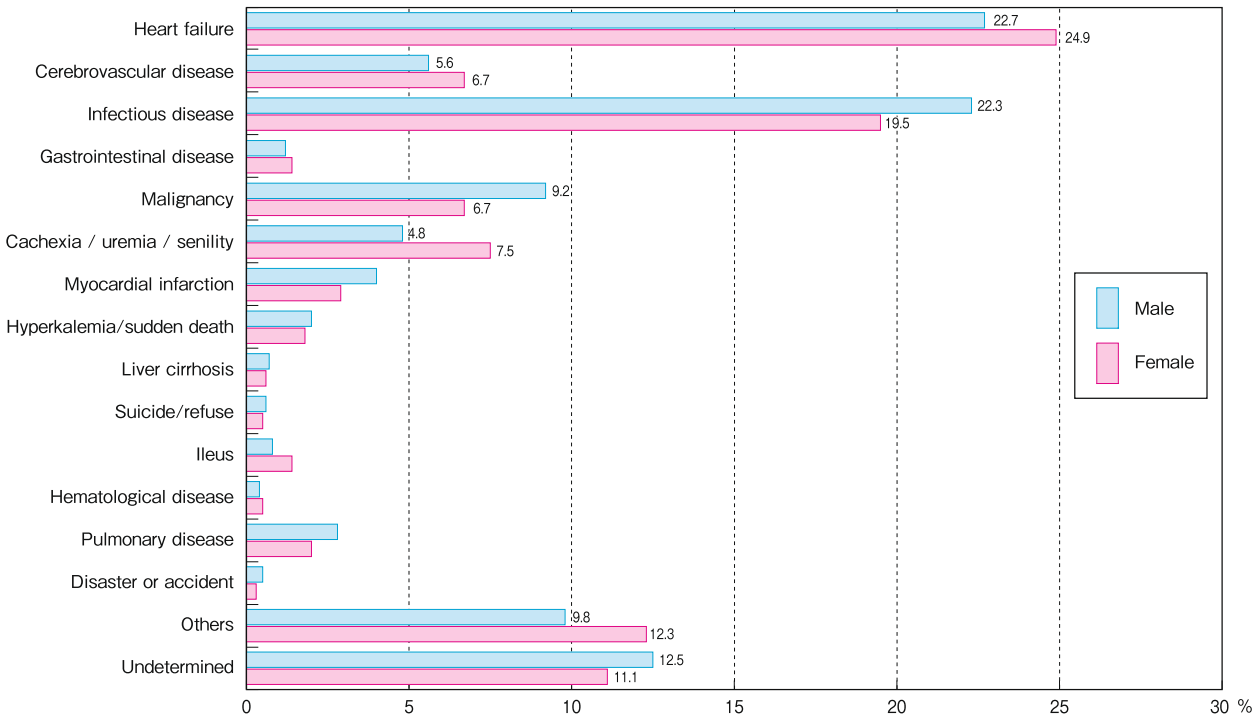

Fig. 10 Deceased dialysis patient distribution by cause of death and sex for 2018

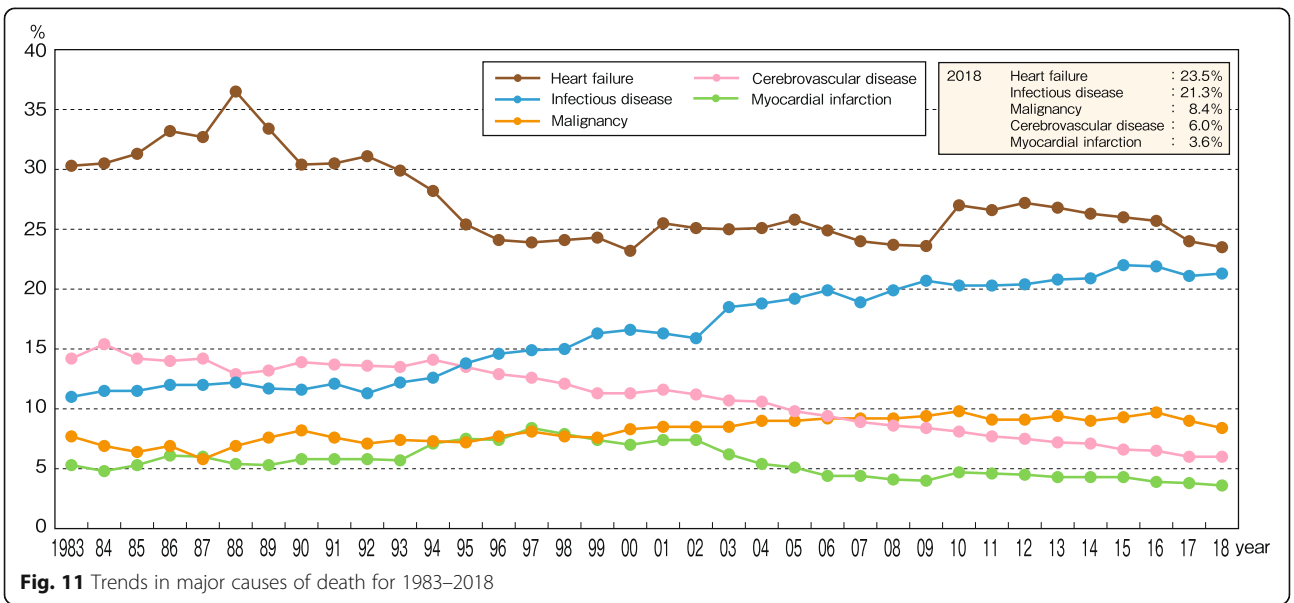

Fig. 11 Trends in major causes of death for 1983–2018

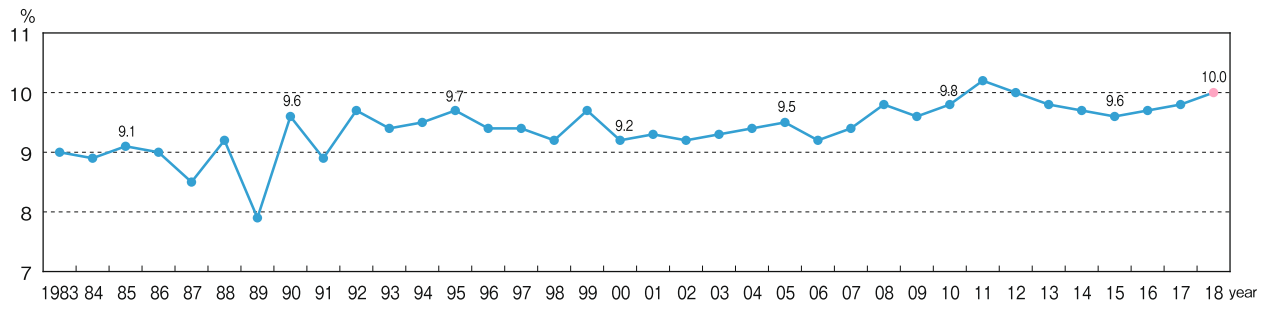

Fig. 12 Trend in annual crude death rate for 1983–2018

increasing since 1993. Cerebrovascular disease has been gradually decreasing since 1994. Deaths from myocardial infarction have been gradually decreasing since reaching a peak of 8.4% in 1997. Malignancy-related deaths were at their lowest in 1987 at 5.8%, and although they have increased slightly since then, they have remained at approximately 9.0% since 2004. The percentage of cardiovascular deaths mentioned above has consistently decreased since reaching a maximum of 54.8% in 1988, accounting for 33.1% of deaths in 2018 (Fig. 11, Supplementary Table 11). Caution is required when viewing these statistics, however, as the cause of death codes were revised three times at the end of 2003, 2010, and 2017 [7].

Crude death rate

The annual crude death rate was calculated using the patient dynamics reported in the facility survey as follows:

$$\text{Crude death rate} = \{\text{no.of deaths}/(\text{no.of patients, previous year} + \text{no.of patients, target year}) \div 2\} \times 100\ (\%)$$

The lowest crude death rate was 7.9% observed in 1989 (a year in which the questionnaire recovery rate was low). Generally, however, the rate has fluctuated between 9% and 10%. At the end of 2018, it was 10.0% (Fig. 12, Supplementary Table 12).

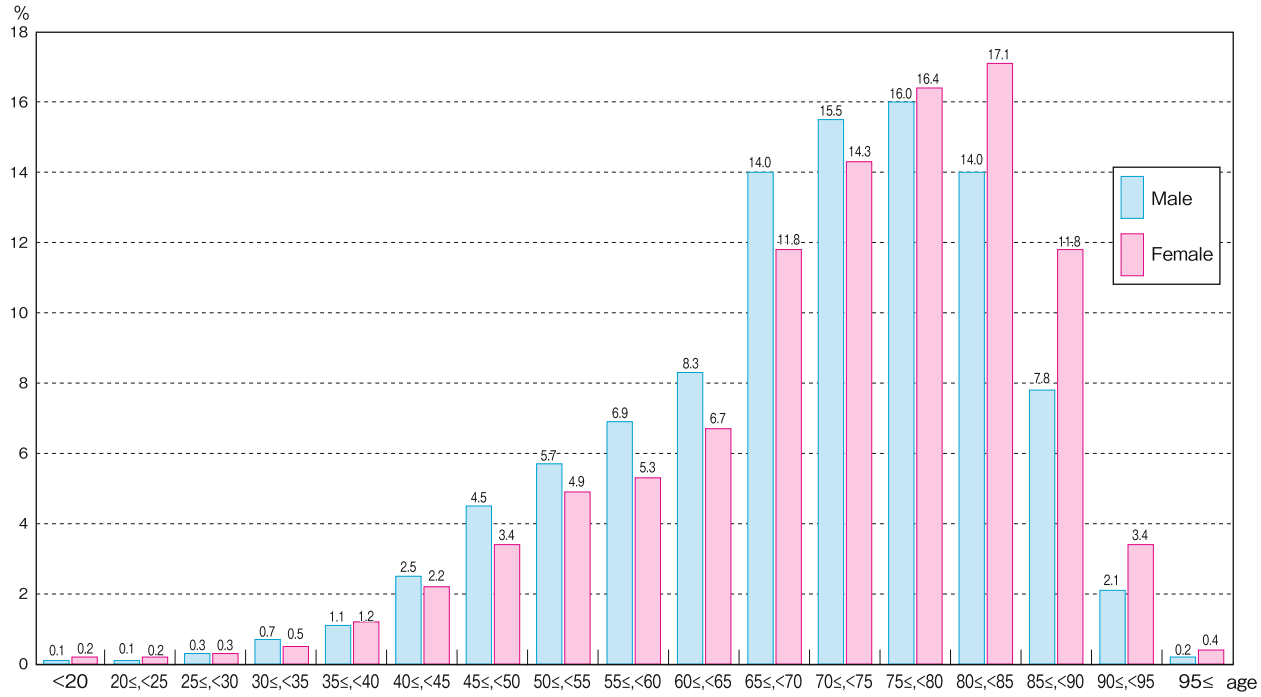

Fig. 13 Incident dialysis patient distribution by age and sex for 2018

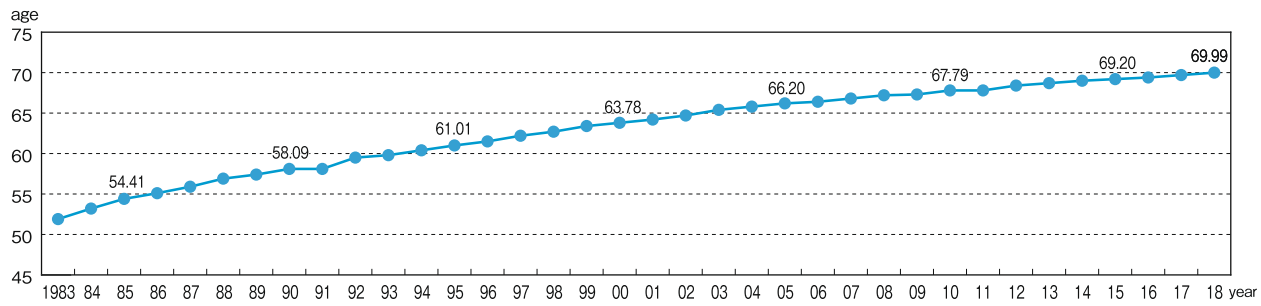

Fig. 14 Trend in average age of incident dialysis patients for 1983–2018

Incident dialysis patient dynamics in 2018

Clinical background

Of the 38,147 incident patients whose age and sex data were recorded in the patient survey, 26,397 were male and 11,750 were female (Fig. 13, Supplementary Table 13). The mean age of the incident patients was 69.99 years (males 69.27 years, females 71.61 years). The mean age has been increasing annually (Fig. 14, Supplementary Table 14). The incident patient age data for 5-year age groups showed that the higher age groups accounted for the largest percentages of patients, with the highest percentage of males observed in the 75–79-year age group and the highest percentage of females observed in the 80–84-year age group among all the age groups that were examined.

The most common primary disease among the incident patients in 2018 was diabetic nephropathy at 42.3%, followed by chronic glomerulonephritis at 15.6%, nephrosclerosis at 15.6%, and "undetermined" at 13.5% (Fig. 15, Supplementary Table 15). In 1998, diabetic nephropathy supplanted chronic glomerulonephritis as the most common primary disease among incident patients; the distribution of diabetic nephropathy has increased consistently ever since, but it has remained nearly the same for the past few years. In contrast, the percentages of patients with nephrosclerosis and "undetermined" have increased annually (Fig. 16, Supplementary Table 16).

Causes of death

In 2018, the most common cause of death among incident patients was infectious disease at 24.0%, followed by heart failure at 23.5%, malignancy at 10.9%, cachexia/uremia/senility at 5.1%, cerebrovascular disease at 4.7%,

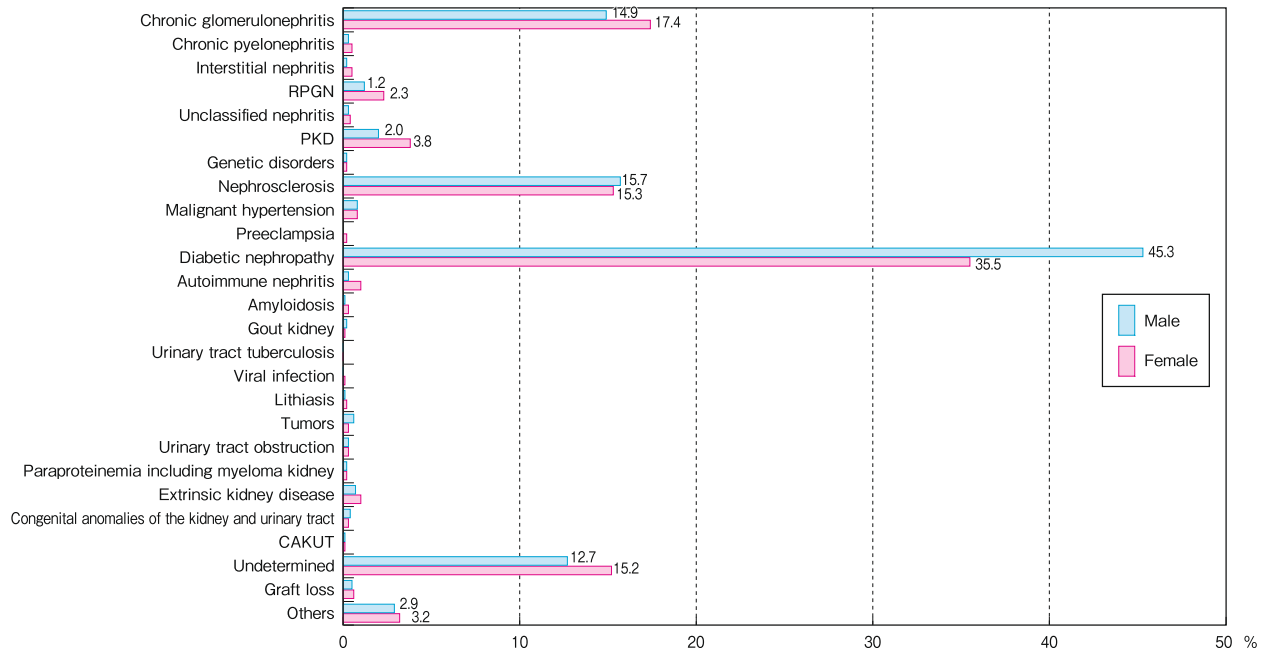

Fig. 15 Incident dialysis patient distribution by primary disease and sex for 2018. RPGN, rapidly progressive glomerulonephritis; PKD, polycystic kidney disease; CAKUT, congenital anomalies of the kidney and urinary tract

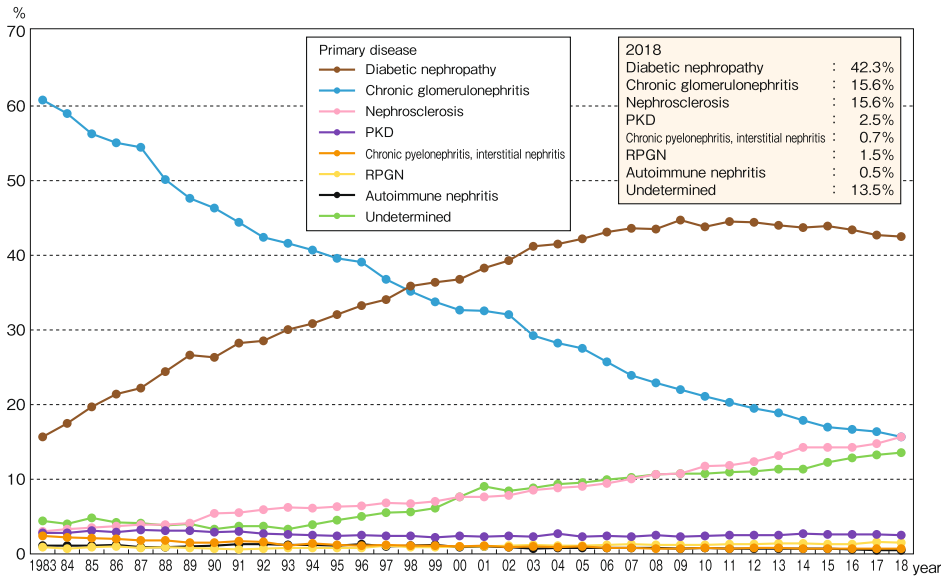

Fig. 16 Trends in major primary diseases of incident dialysis patients for 1983–2018. PKD, polycystic kidney disease; RPGN, rapidly progressive glomerulonephritis

pulmonary disease at 3.5%, and myocardial infarction at 2.7%. The total percentage of cardiovascular deaths was 30.9% (Fig. 17, Supplementary Table 17). The changes in causes of death within the dialysis incident year show that in the 1990s, heart failure was the most common, while infectious disease has gradually increased until it surpassed heart failure in 2006, at which time infectious disease became the most common cause of death among incident patients. Deaths due to malignancy have been increasing, and the percentage surpassed 10% in 2006. Deaths due to cerebrovascular disease have been gradually decreasing (Fig. 18, Supplementary Table 18).

Conclusion

An overview of the results of the 2018 JRDR indicated that the number of chronic dialysis patients and the number of dialysis facilities in Japan were still increasing. However, the rates of increase have been gradually slowing. No changes were observed in the primary diseases of the incident patients and the number of patients at

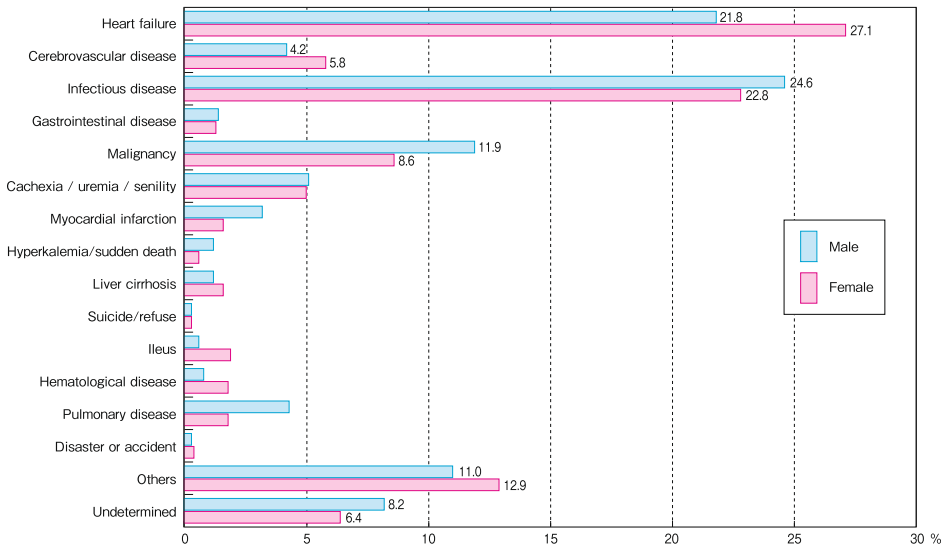

Fig. 17 Incident dialysis patient distribution by cause of death and sex for 2018

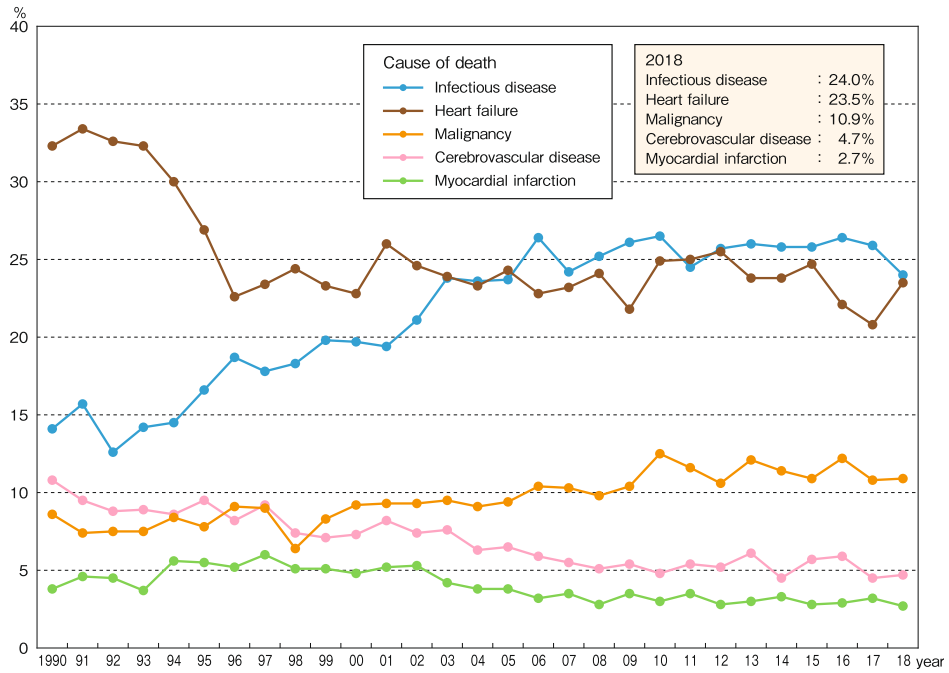

Fig. 18 Trends in major causes of death during the incident year for 1990–2018

the end of the year, with diabetes being the number one primary disease. However, the percentage of incident patients with diabetes has been at a plateau for several years. HDF treatment has increased rapidly since 2012 because of a revision to the medical reimbursement system, now accounting for 37.0% of all dialysis patients. Although the number of PD patients and home hemodialysis patients increased slightly over the numbers in 2016, the rate of home dialysis for both remains the lowest in the world at 3.0%.

Appendix

The list of response rates for each question is shown in in Supplementary Table 19.

Supplementary information

Supplementary information accompanies this paper at https://doi.org/10.1186/s41100-020-00286-9.

Additional file 1. Trends in the prevalent dialysis patient count for 1968-2018, and the adjusted prevalent dialysis patient count (pmp) for 1983-2018.

Additional file 2. Trends in the incident and deceased dialysis patient counts for 1983-2018

Additional file 3. Prevalent dialysis patient distribution by age and sex for 2018

Additional file 4. Trend in the average age of the prevalent dialysis patients for 1983-2018

Additional file 5. Prevalent dialysis patient count by age for 1982-2018

Additional file 6. Prevalent dialysis patient count by dialysis duration and sex for 2018

Additional file 7. Prevalent dialysis patient count by dialysis duration for 1988-2018

Additional file 8. Prevalent dialysis patient distribution by primary disease and sex for 2018

Additional file 9. Trends in major primary diseases among prevalent dialysis patients for 1983-2018

Additional file 10. Deceased dialysis patient distribution by cause of death and sex for 2018

Additional file 11. Trends in major causes of death for 1983-2018

Additional file 12. Trend in annual crude death rate for 1983-2018

Additional file 13. Incident dialysis patient distribution by age and sex for 2018

Additional file 14. Trend in average age of incident dialysis patients for 1983-2018

Additional file 15. Incident dialysis patient distribution by primary disease and sex for 2018

Additional file 16. Trends in major primary diseases of incident dialysis patients for 1983-2018

Additional file 17. Incident dialysis patient distribution by cause of death and sex for 2018

Additional file 18. Trends in major causes of death during the incident year for 1990-2018

Additional file 19. List of response rate for each question in the 2018 survey

Abbreviations

APD: Automated peritoneal dialysis; AST: Aspartate aminotransferase; CAKUT: Congenital anomalies of the kidney and urinary tract; CKD: Chronic kidney disease; CRP: C-reactive protein; D/P Cr ratio: Dialysate/plasma creatinine ratio; DPP-4: Dipeptidyl peptidase-4; EPS: Encapsulating peritoneal sclerosis; ET: Endotoxin; ETRF: Endotoxin retentive filter; GLP-1: Glucagon-like peptide-1; HAD: Hemadsorption dialysis; HD: Hemodialysis; HDL-C: High-density-lipoprotein-cholesterol concentration; HHD: Home hemodialysis; HDF: Hemodiafiltration; HF: Hemofiltration; IHDF: Intermittent infusion

hemodiafiltration; JSDT: Japanese Society for Dialysis Therapy; JRDR: The JSDT Renal Data Registry; Kt/V: Index for standardized dialysis dose defined as K: urea clearance, t: dialysis time, V: body fluid volume; MEXT: Ministry of Education, Culture, Sports, Science, and Technology; MHLW: Ministry of Health, Labour, and Welfare; PD: Peritoneal dialysis; PET: Peritoneal equilibration test; PKD: Polycystic kidney disease; pmp: Per million population; PTH: Parathyroid hormone; RNA: Ribonucleic acid; RPGN: Rapidly progressive glomerulonephritis; TVC: Total viable microbial count; UMIN: University hospital Medical Information Network; USB: Universal serial bus; USRDS: United States Renal Data System; UN: Urea nitrogen

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Authors' contributions
KN, IM, MT, and SG 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 MA 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.

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All efforts and costs for the 2018 JRDR survey and the creation of the ADR were provided by JSDT.

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

Consent for publication
Not applicable

Competing interests
The authors declare that they have no competing interests.

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References

1. Nakai S. The history of Japanese Society for Dialysis Therapy Registry. J Jpn Soc Dial Ther. 2010;43:119–52 (in Japanese).
2. Masakane I, Nakai S. Recent trends of chronic dialysis in Japan from the viewpoint of the JSDT Renal Data Registry. J Jpn Soc Dial Ther. 2016;49:211–8 (in Japanese).
3. Ministry of Health, Labour, and Welfare and Ministry of Education, Culture, Sports, Science, and Technology: ethical guidelines for medical and health research involving human subjects. (revised in 28, Feb, 2017) http://www.lifescience.mext.go.jp/files/pdf/n1859_01.pdf. (last accessed 15, Nov, 2019). (in Japanese).
4. Japanese Society for Dialysis Therapy. http://www.jsdt.or.jp/info/2308.html. (last accessed 15, Nov, 2019). (in Japanese).
5. Nakai S, Wakai K, Yamagata K, Iseki K, Tsubakihara Y. Prediction of dialysis patients in Japan: based on Japanese Society for Dialysis Therapy Registry. J Jpn Soc Dial Ther. 2012;45:599–613 (in Japanese).
6. Chapter 11: International Comparison, the 2018 USRDS Annual Data Report. Washington: United States Renal Data System, 2018. https://www.usrds.org/2018/view/v2_11.aspx (last accessed 3, Sep 2019).
7. Nakai S, Iseki K, Itami N, et al. An overview of regular dialysis treatment in Japan (as of December 31, 2010). Ther Apher Dial. 2012;16:483–521.

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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

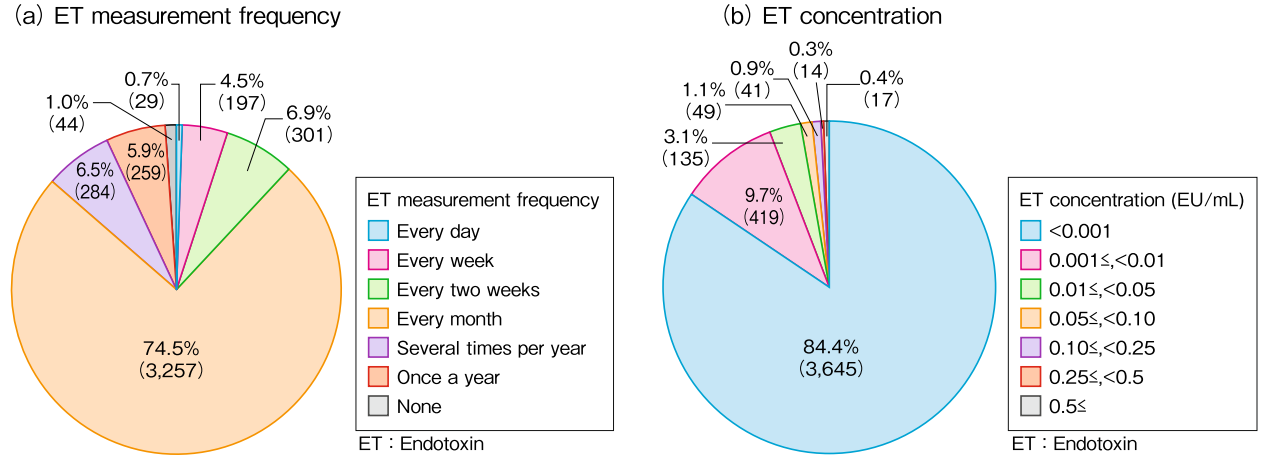

Fig. 1 Distribution of facilities according to ET measurement frequency and ET concentrations in 2018. **a** ET measurement frequency. **b** ET concentrations. ET, endotoxin

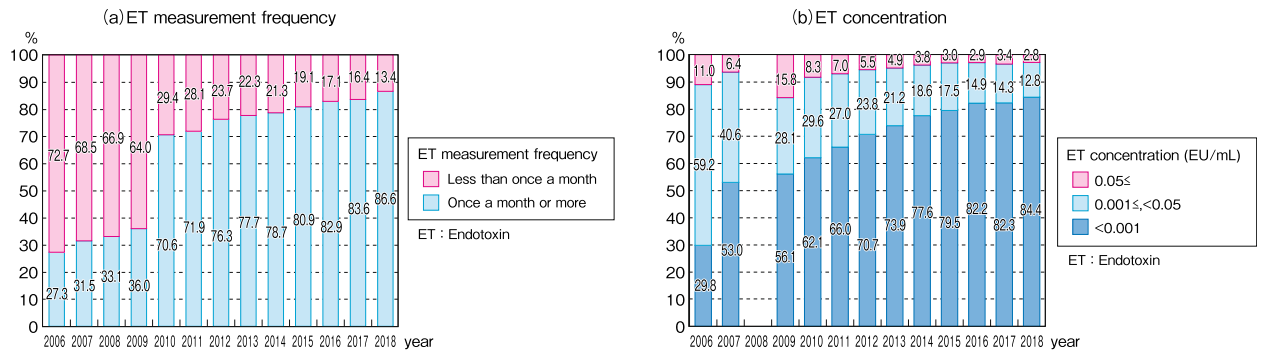

Fig. 2 Trends in ET measurement frequency and ET concentrations from 2006 to 2018. **a** ET measurement frequency. **b** ET concentrations. ET, endotoxin

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,

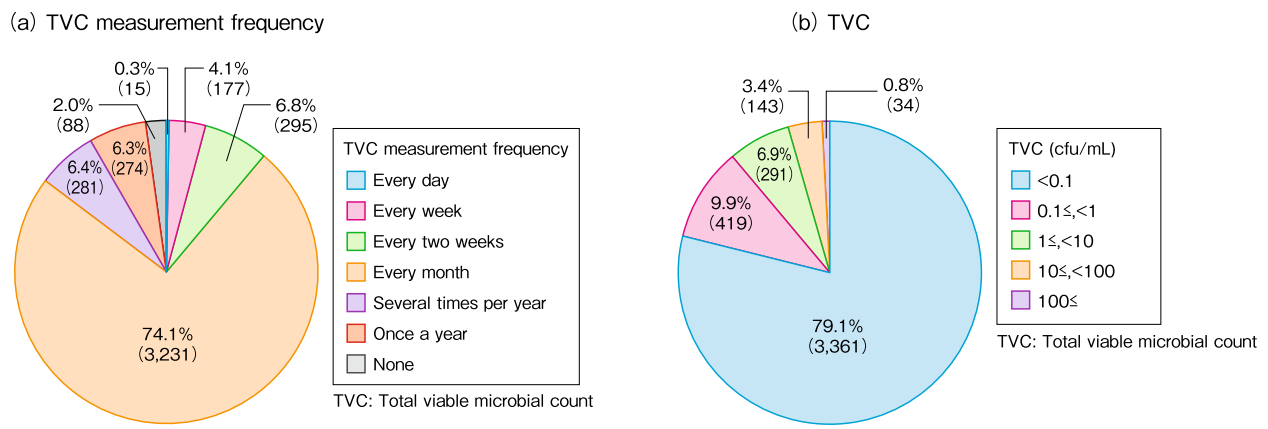

Fig. 3 Distribution of facilities according to TVC measurement frequency and TVC in 2018. **a** TVC measurement frequency. **b** TVC. TVC, total viable microbial count

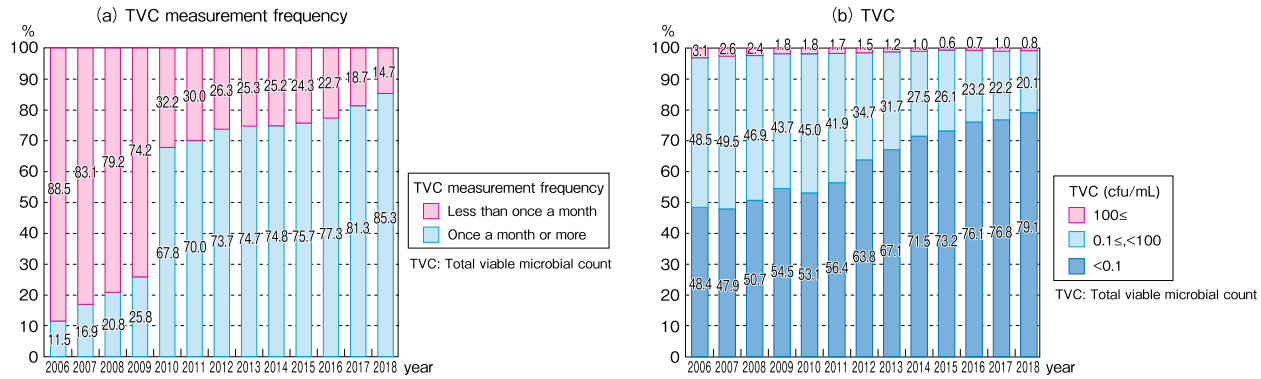

Fig. 4 Trends in TVC measurement frequency and TVC from 2006 to 2018. **a** TVC measurement frequency. **b** TVC. TVC, total viable microbial count

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

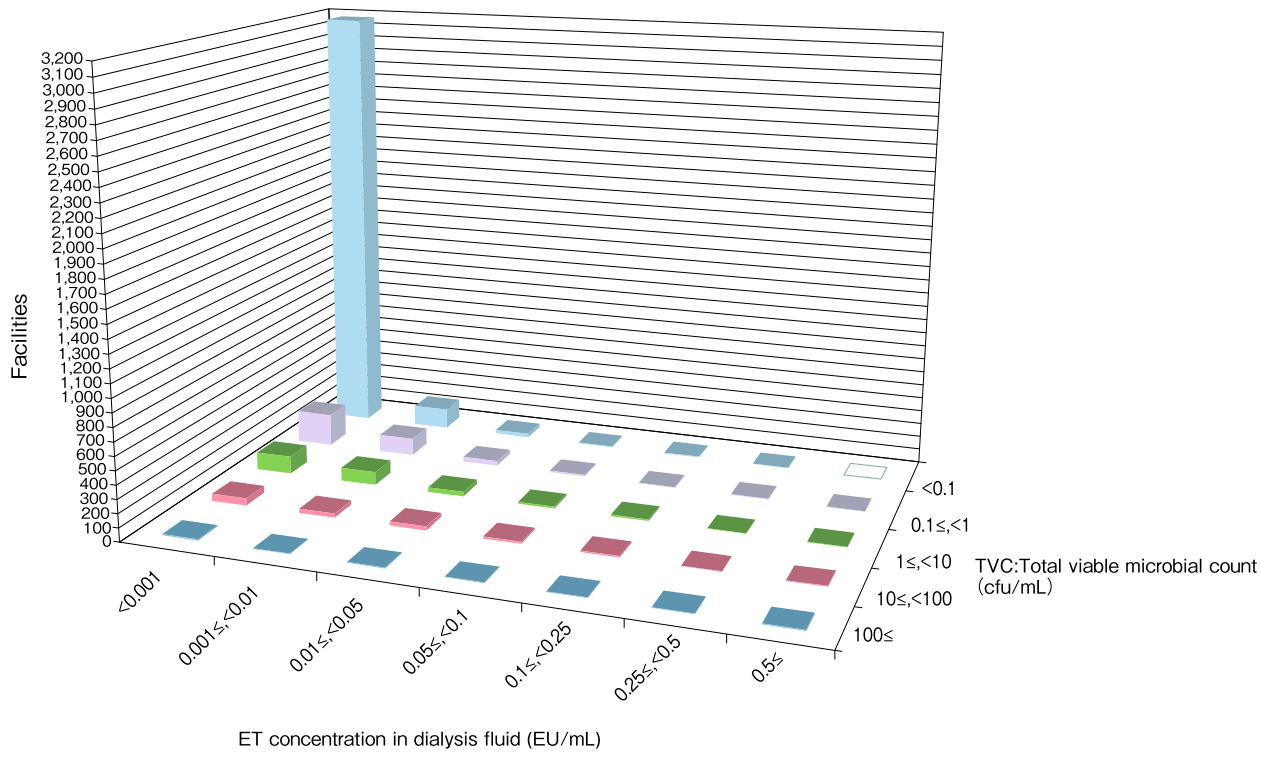

Fig. 5 Distribution of facilities according to ET concentration and TVC in 2018. ET, endotoxin; TVC, total viable microbial count

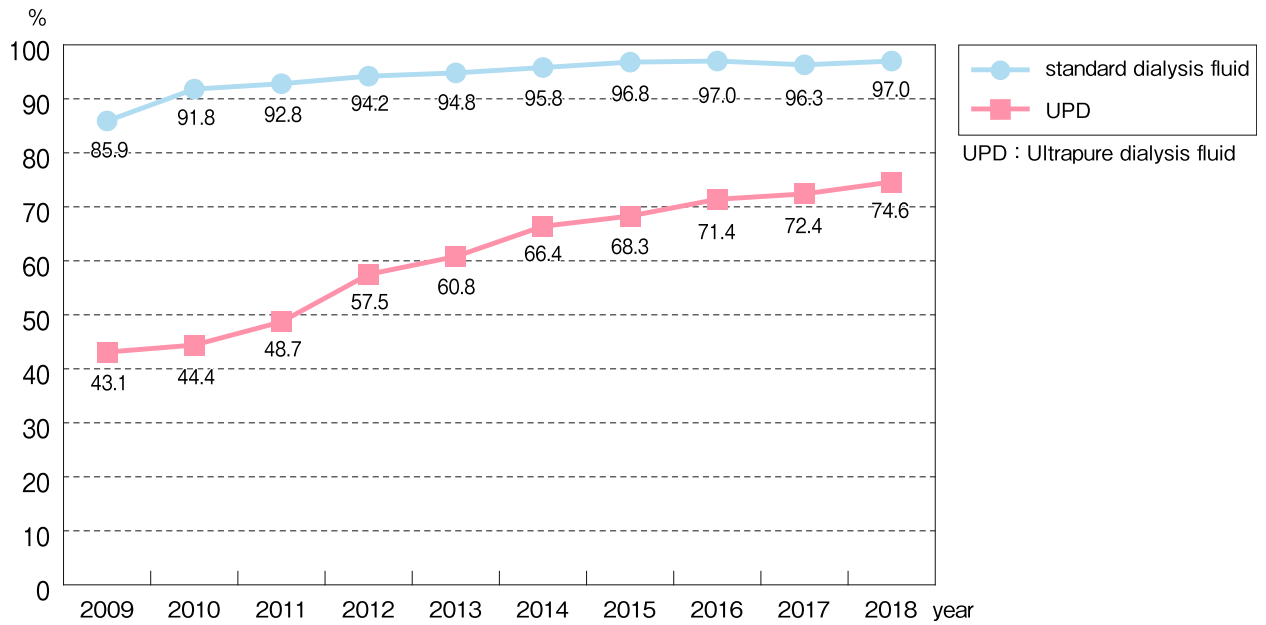

Fig. 6 Trends in the distribution of facilities according to the achievement of UPD and standard dialysis fluid from 2009 to 2018. UPD, ultrapure dialysis fluid

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

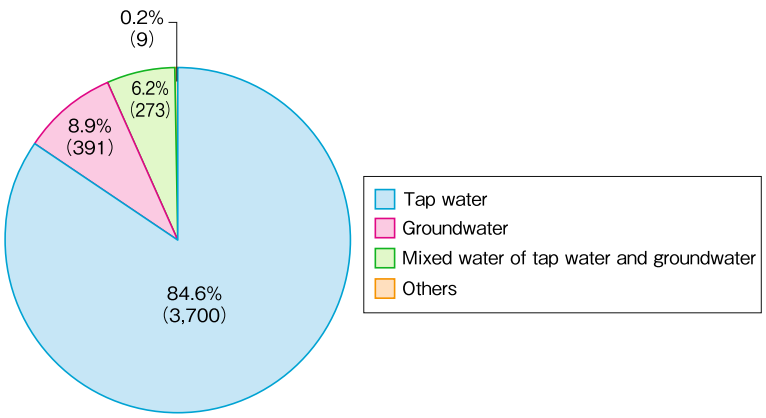

Fig. 7 Distribution of facilities according to the source of dialysis water

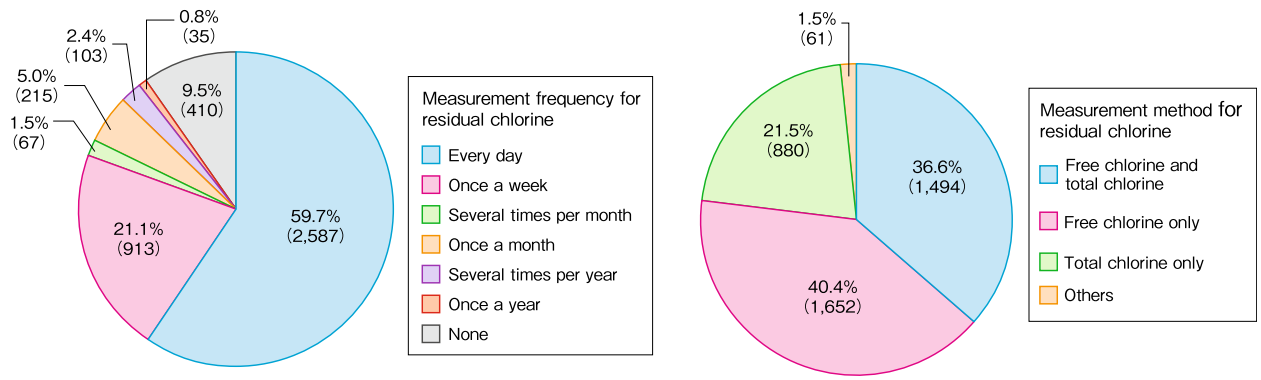

Fig. 8 Distribution of facilities according to the frequency of residual chlorine measurements and measurement method. **a** Frequency of residual chlorine measurements. **b** Method of measuring residual chlorine

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

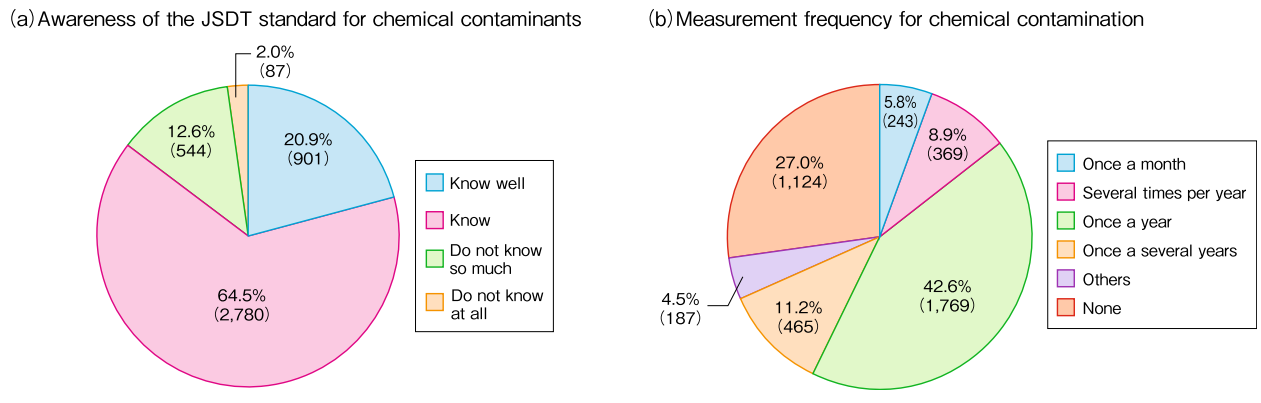

Fig. 9 Distribution of facilities according to awareness of the JSDT standard for chemical contaminants and frequency of measurements. **a** Awareness of the JSDT standard for chemical contaminants. **b** Frequency of measurements of chemical contamination. JSDT, Japanese Society for Dialysis Therapy

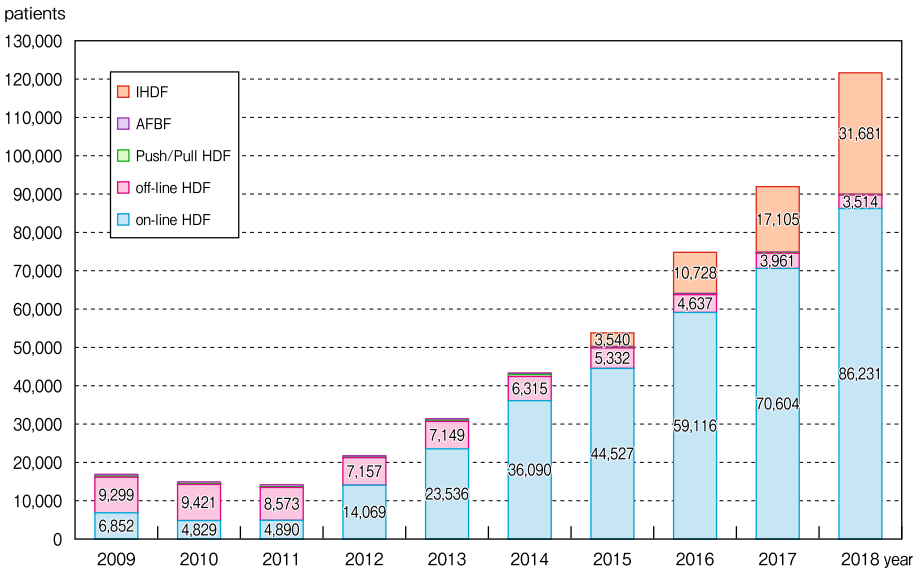

Fig. 10 HDF patient counts according to HDF modality from 2009 to 2018. AFBF, acetate-free biofiltration; HDF, hemodiafiltration; IHDF, intermittent infusion hemodiafiltration

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

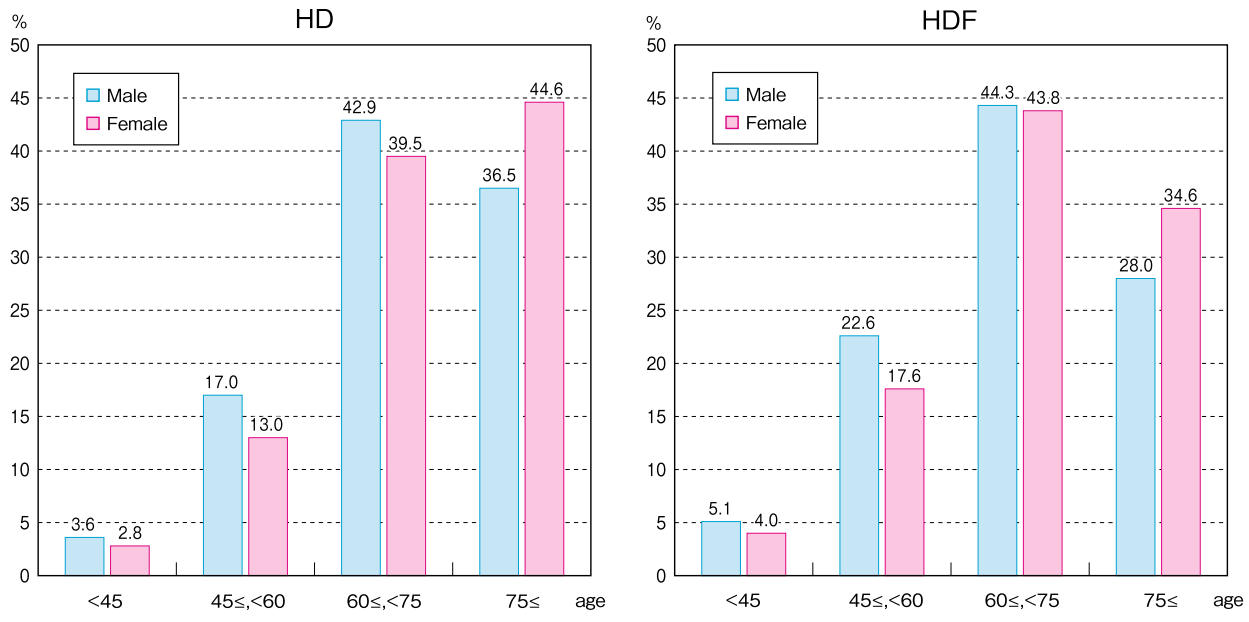

Fig. 11 Distribution of HD and HDF patients according to age and sex in 2018. HD, hemodialysis; HDF, hemodiafiltration

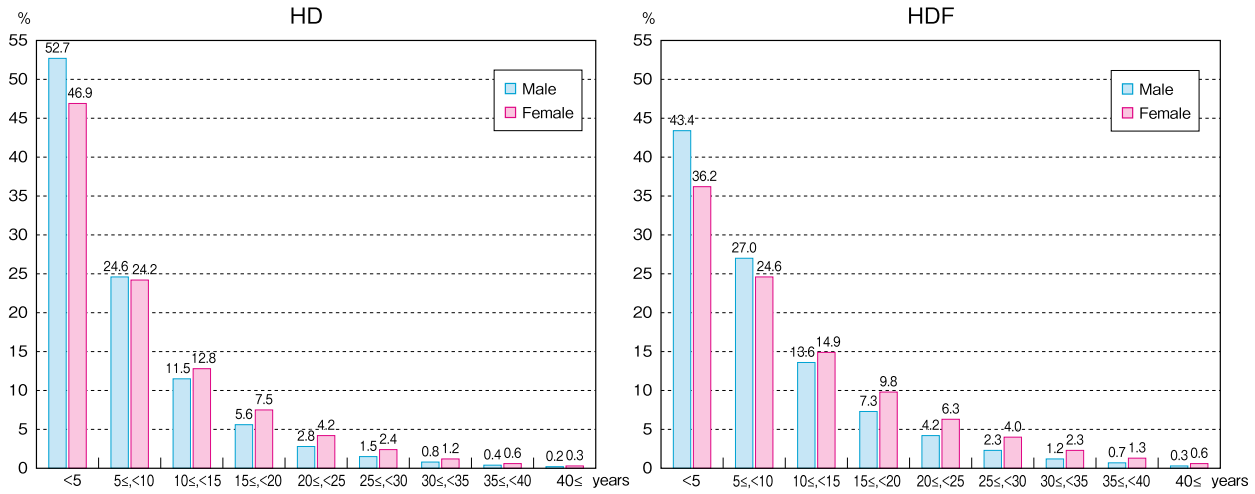

Fig. 12 Distribution of HD and HDF patients according to dialysis vintage and sex in 2018. HD, hemodialysis; HDF, hemodiafiltration

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

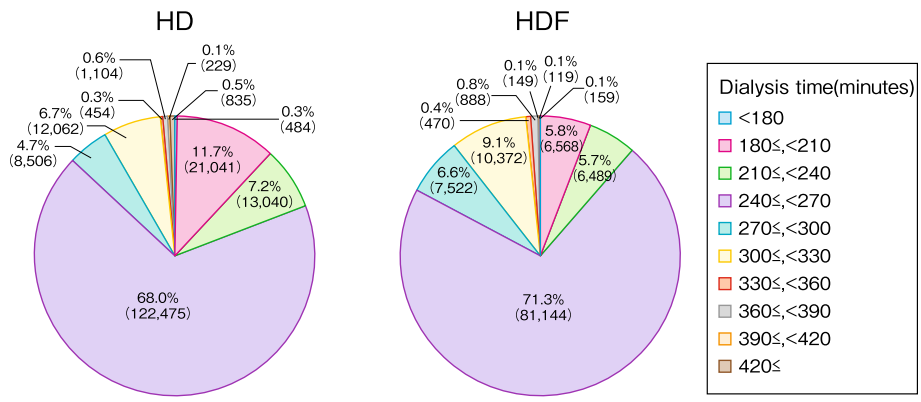

Fig. 13 Distribution of HD and HDF patients according to dialysis time in 2018. HD, hemodialysis; HDF, hemodiafiltration

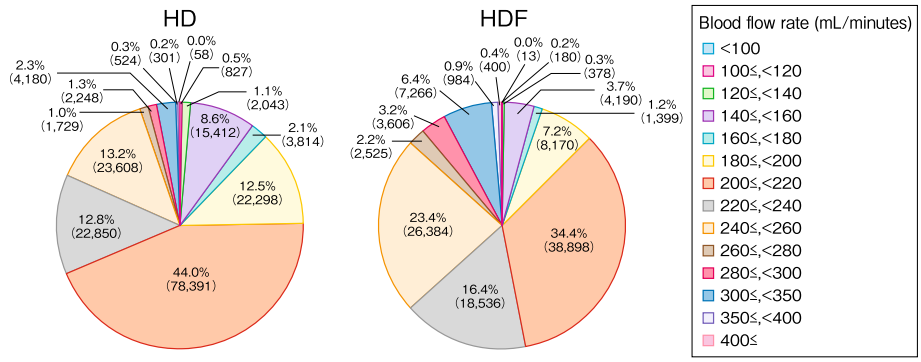

Fig. 14 Distribution of HD and HDF patients according to the blood flow rate in 2018. HD, hemodialysis; HDF, hemodiafiltration

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).

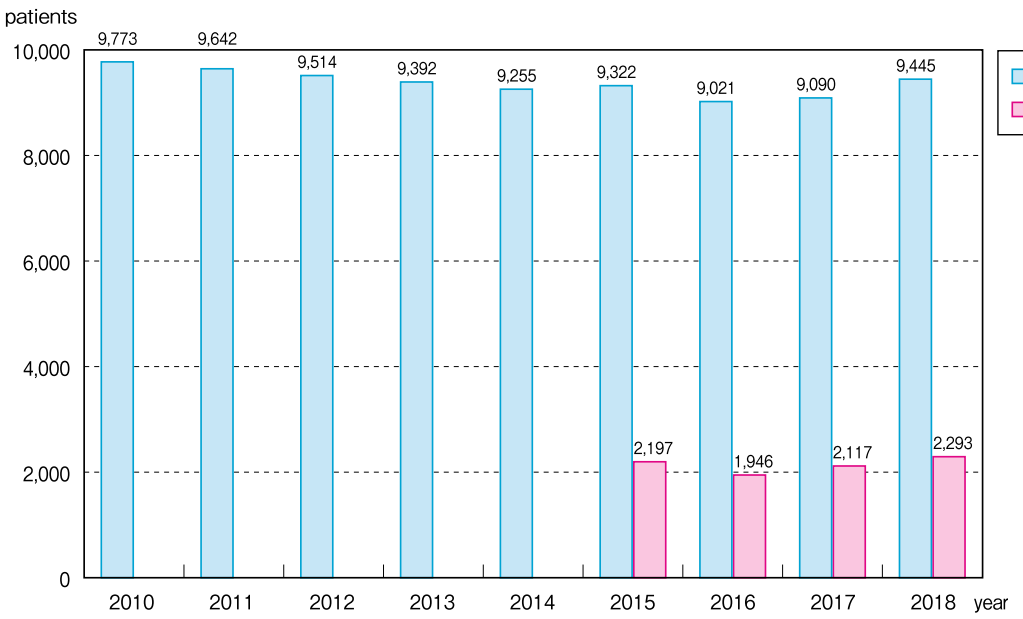

Fig. 15 Trends in the numbers of prevalent and incident PD patients from 2010 to 2018. PD, peritoneal dialysis

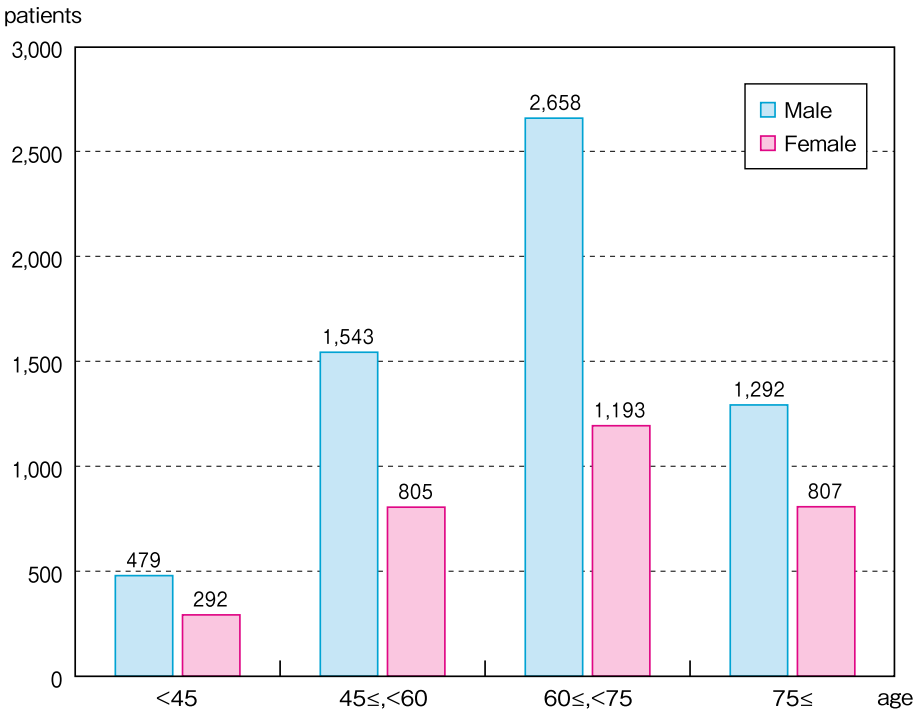

Fig. 16 Numbers of prevalent PD patients according to age and sex in 2018. PD, peritoneal dialysis

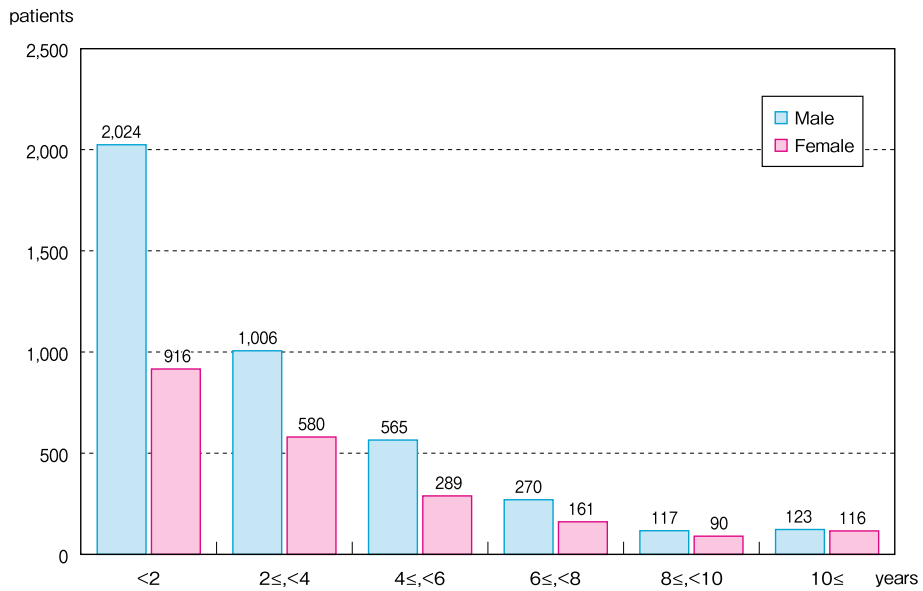

Fig. 17 Numbers of prevalent PD patients according to PD vintage and sex in 2018. PD, peritoneal dialysis

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

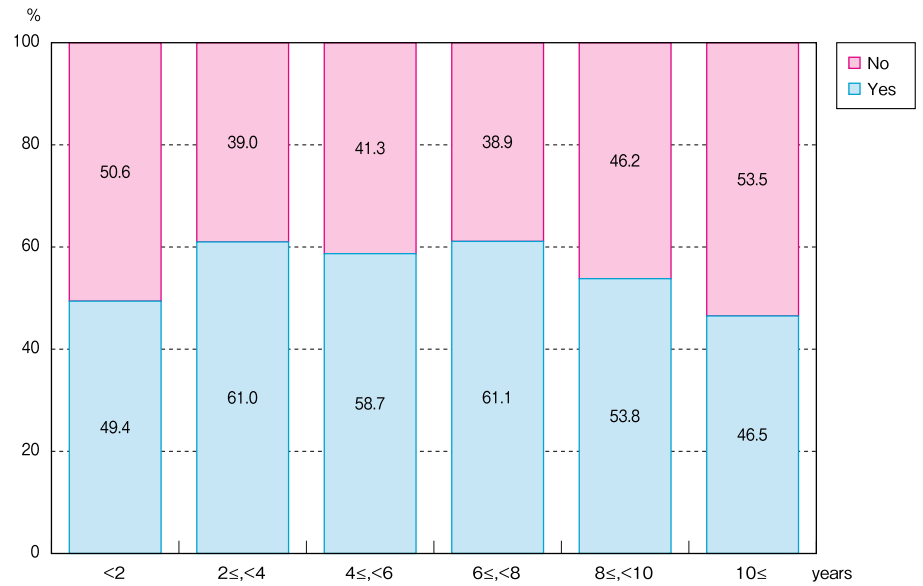

Fig. 18 Distribution of the prevalent PD patients according to PD vintage and icodextrin use in 2018. PD, peritoneal dialysis

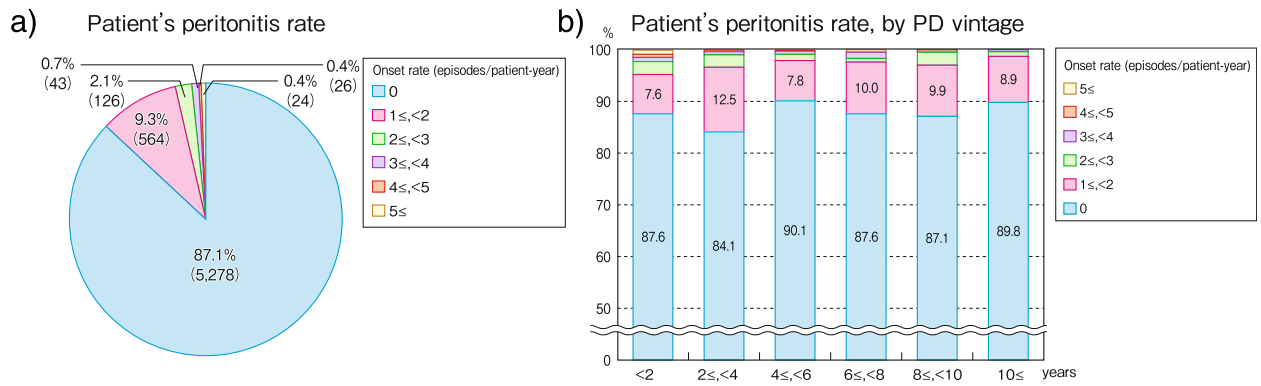

Fig. 19 Distribution of the prevalent PD patients according to peritonitis rate and PD vintage in 2018. **a** Peritonitis rate. **b** Peritonitis rate according to PD vintage. PD, peritoneal dialysis

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

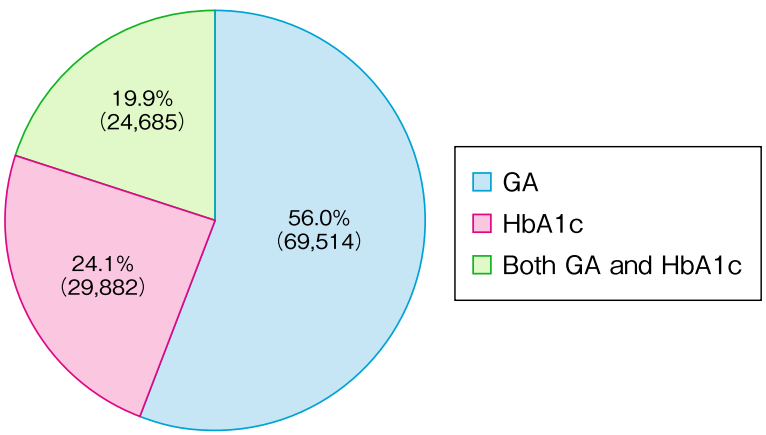

Fig. 20 Glycemic indices of diabetic patients on dialysis. GA, glycated albumin; HbA1c, glycated hemoglobin

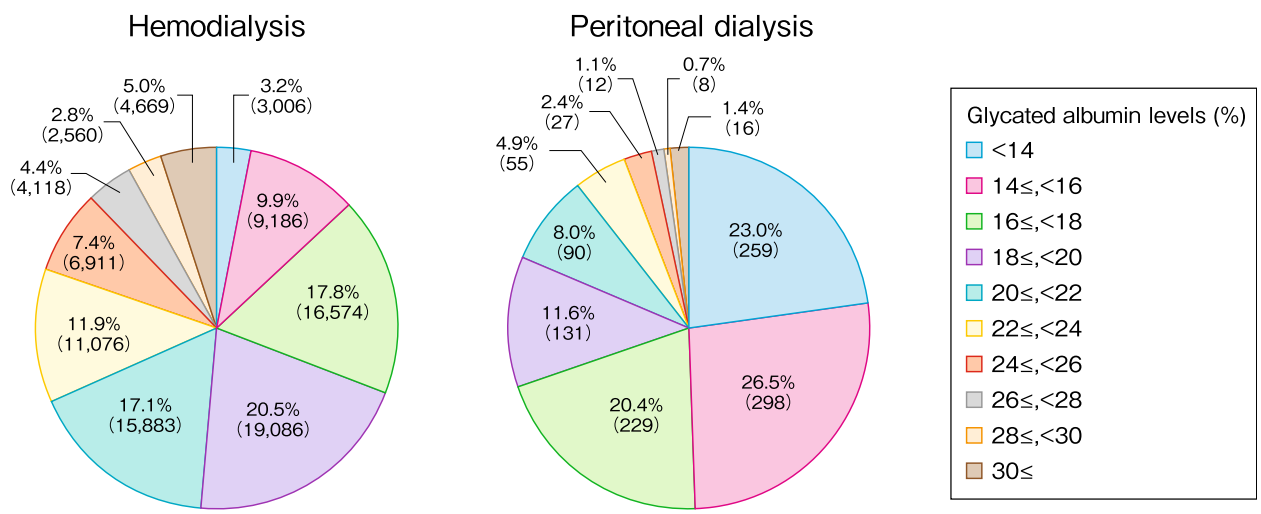

Fig. 21 GA levels of diabetic patients on hemodialysis and peritoneal dialysis in 2018. GA, glycated albumin

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

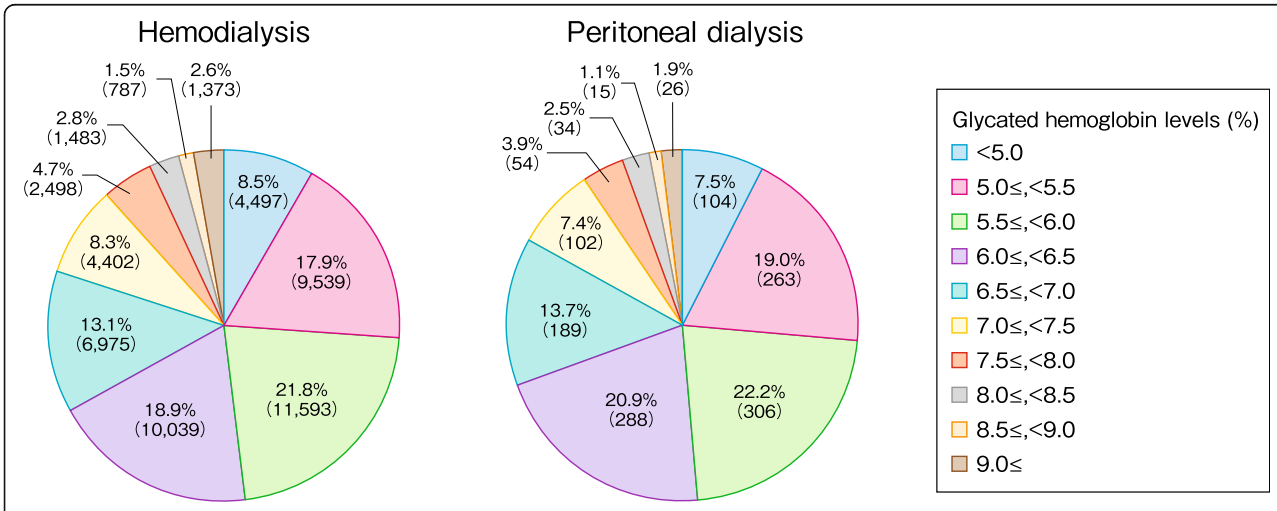

Fig. 22 HbA1c levels of diabetic patients on hemodialysis and peritoneal dialysis in 2018. HbA1c, glycated hemoglobin

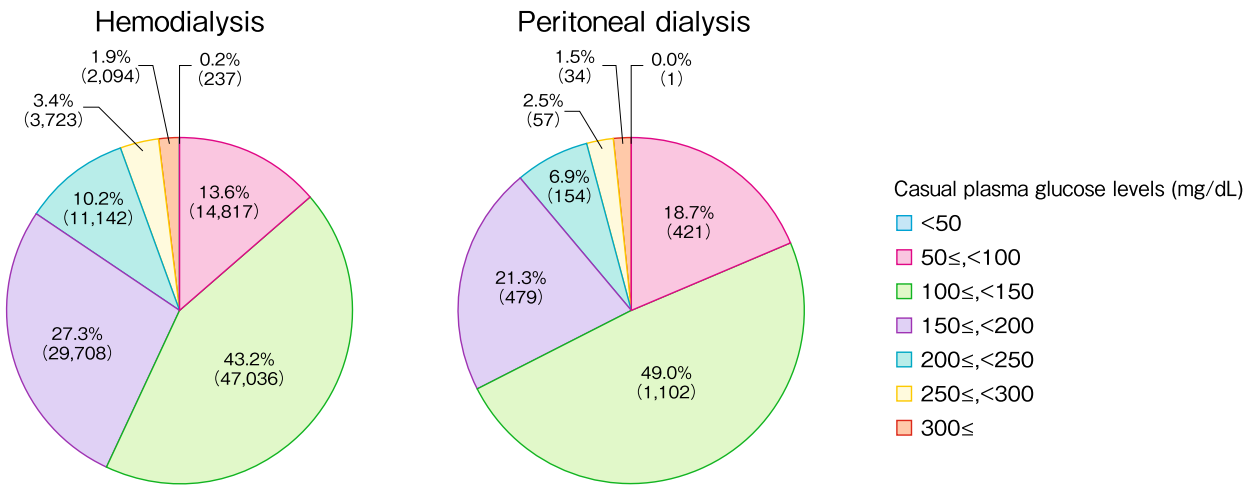

Fig. 23 Casual plasma glucose levels of diabetic patients on hemodialysis and peritoneal dialysis in 2018

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

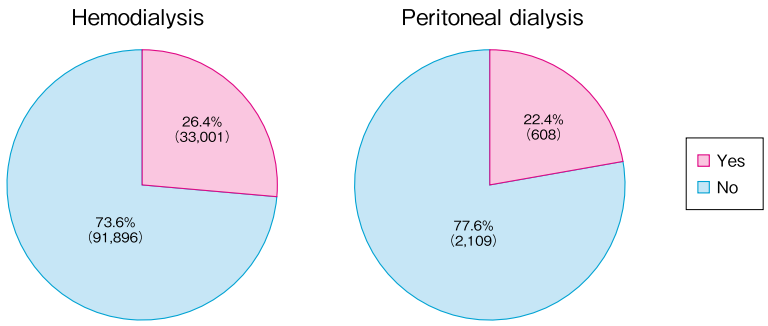

Fig. 24 Proportions of diabetic patients on hemodialysis and peritoneal dialysis who were treated with insulin injection therapy in 2018

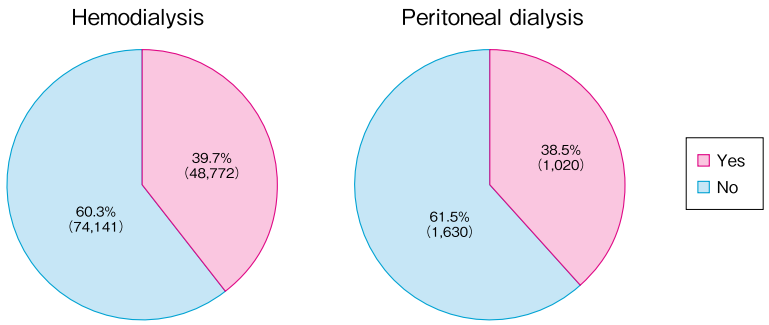

Fig. 25 Proportions of the diabetic patients on hemodialysis and peritoneal dialysis who were treated with a DPP-4 inhibitor in 2018. DPP-4, dipeptidyl peptidase-4

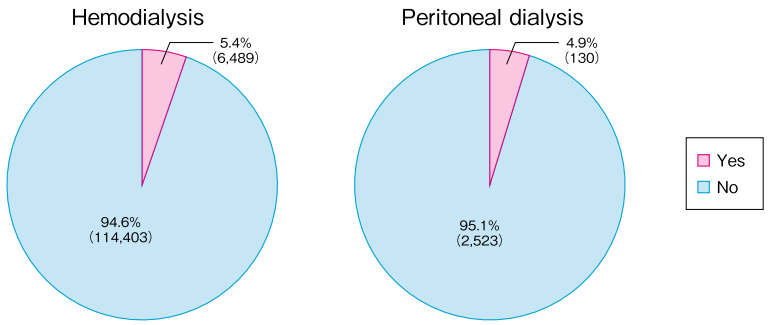

Fig. 26 Proportions of the diabetic patients on hemodialysis and peritoneal dialysis who were treated with a GLP-1 receptor agonist in 2018. GLP-1, glucagon-like peptide-1

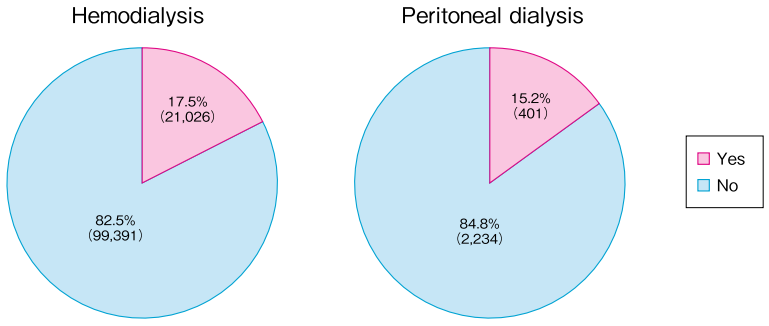

Fig. 27 Proportions of the diabetic patients on hemodialysis and peritoneal dialysis who were treated with other antidiabetic agents in 2018

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

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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.

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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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References

1. Kawanishi H, Akiba T, Masakane I, et al. Standard on microbiological management of fluids for hemodialysis and related therapies by the Japanese Society for Dialysis Therapy 2008. Ther Apher Dial. 2009;13:161–6.
2. Mineshima M, Kawanishi H, Abe T, et al. 2016 update Japanese Society for Dialysis Therapy Standard of fluids for hemodialysis and related therapies. Renal Replacement Therapy. 2018;4:15.
3. Nitta K, Masakane I, Hanafusa N, et al. Annual dialysis data report 2017. JSDT Renal Data Registry Renal Replacement Therapy. 2019;5:53.
4. Masakane I, Nakai S, Ogata S, et al. An overview of regular dialysis treatment in Japan (As of 31 December 2013). Ther Apher Dial. 2015;19:540–74.
5. Nakao T, Inaba M, Abe M, et al. Best practice for diabetic patients on hemodialysis 2012. Ther Apher Dial. 2015: 19 Suppl 1; 40-66.
6. Kimata N, Karaboyas A, Bieber BA, et al. Gender, low Kt/V, and mortality in Japanese hemodialysis patients: opportunities for improvement through modifiable practices. Hemodial Int. 2014;18:596–606.

Publisher's Note

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POSITION STATEMENT Open Access

Annual dialysis data report of the 2018 JSDT Renal Data Registry: dementia, performance status, and exercise habits

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Abstract

According to the annual survey of the Japanese Society for Dialysis Therapy Renal Data Registry (JRDR) conducted at the end of 2018, there were a total of 339,841 patients receiving dialysis (hereinafter, dialysis patients) in Japan. The survey included questions regarding the presence/absence of dementia, the performance status (PS), and the exercise habits of individual patients. The survey revealed that 10.8% of all dialysis patients had dementia (1.8% in the age group of less than 65 years, 6.8% in the age group of 65–74 years, and 22.7% in the age group of 75 years or older). These prevalences of dementia were approximately equal to those estimated from the survey conducted in 2010. Regarding PS, the percentage of patients with lower activity levels tended to be relatively high among patients who were less than 15 years old and those who were 60 years old or older. Concerning the exercise habits of dialysis patients, the percentage of patients who were classified as "not at all or hardly" in response to the question about exercise habit was the highest (60–80%) of all the exercise habit classifications in each of the age groups analyzed.

Keywords: Dialysis, Registry, Dementia, Performance status, Exercise habits

Introduction

Since 1968, the Japanese Society for Dialysis Therapy (JSDT) has conducted a survey examining the status of chronic dialysis treatment in Japan at the end of every year. This survey, known as the JSDT Renal Data Registry (JRDR), covers nearly all dialysis facilities in Japan [1, 2]. Although these facilities participate voluntarily, the response rate is nearly 100%, suggesting that this survey represents the real-world status of regular dialysis in Japan. The 2018 JRDR survey contains many topics such as the kinetics of chronic dialysis patients and dialysis facilities at the end of 2018, water treatment and hemodiafiltration, peritoneal dialysis, treatments for diabetes and mental and physical conditions, and the present status of viral hepatitis.

This basic research report was prepared to clarify the actual conditions of the prevalence of dementia, PS, and exercise habits among Japanese dialysis patients as of the end of 2018. The report also serves as an English translation of information regarding the presence/absence of dementia, performance status (PS), and exercise habits of dialysis patients in Japan obtained from the JRDR survey conducted at the end of 2018 and published, in

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Japanese, in the *Journal of the Japanese Society for Dialysis Therapy* [3, 4].

Materials and methods

Details of the survey conducted in 2018 are given in the report on the basic data from the survey [5]. In this survey, the presence/absence of dementia, PS, and exercise habits of dialysis patients were investigated. The patient survey included questions designed to investigate each survey item. Responses to the basic survey items included in the patient survey were collected from 327,336 patients.

Presence/absence of dementia

The survey of dialysis patients conducted in 2018 included questions to determine the presence/absence of dementia. The presence/absence of dementia at the time of the initiation of maintenance dialysis was first included as a question in the 2006 and 2007 surveys [6, 7]. In 2009 and 2010, the presence/absence of dementia was investigated for the entire survey population of dialysis patients [8, 9].

Dementia is defined as follows in the 10th version of the International Classification of Diseases, Injuries, and Causes of Death (ICD10): "dementia is a syndrome due to disease of the brain, usually of chronic or progressive nature, in which there is impairment of multiple higher cortical functions, including memory, thinking, orientation, calculation, learning capacity, language and judgement" [10]. For the diagnosis of dementia, it is necessary to evaluate the cognitive functions of the patient through interviews of the patient and his/her family members; scales such as the Mini Mental State Examination (MMSE) and Hasegawa dementia rating scale-revised (HDS-R) are usually used [11]. During the current survey, a questionnaire was mailed to each participating facility, requesting the facility to answer the questionnaire about the patients and to return the completed questionnaire to our society. Using this survey design, it was impossible to have experts confirm the dementia diagnoses of all the patients being managed at the participating facilities. Thus, the determination of the presence/absence of dementia in this survey was based solely on the inquiry described below and the answer choices contained in the questionnaire.

> Please indicate the presence or absence of dementia in the patient at the end of December 2018. *If the patient has not been diagnosed as having dementia by a dementia specialist, the diagnosis made by the patient's main physician based on the patient's status during dialysis treatments or consultations is acceptable.
> • Answer choices
> A. Without dementia
> B. With dementia
> Z. Unspecified

In response to the question regarding the presence/absence of dementia during this survey, 250,042 patients (76.4%) were classified as "Without dementia" or "With dementia."

The proportion of patients who were classified as "With dementia" among all the patients who responded to the question about the presence/absence of dementia

Table 1 Performance status [4]

A	(Score 0) Fully active, able to carry on all pre-disease performance without restriction.
B	(Score 1) Restricted in physically strenuous activity but ambulatory and able to carry out work of a light or sedentary nature, e.g., light housework, office work.
C	(Score 2) Ambulatory and capable of all self-care but unable to carry out any work activities. Up and about more than 50% of waking hours.
D	(Score 3) Capable of only limited self-care, confined to bed or chair more than 50% of waking hours.
E	(Score 4) Completely disabled. Cannot carry on any self-care. Totally confined to bed or chair.
Z	Unknown

Table 2 Age and dementia prevalence (all dialysis patients)

	Without dementia	With dementia	Total	Dementia unknown	No information available	Grand total	Dementia prevalence (%)
Age <65 years	79,339	1452	80,791	5858	18,578	105,227	1.8
Age 65–74 years	75,884	5503	81,387	6133	18,862	106,382	6.8
Age 75 years or older	67,932	19,932	87,864	7287	20,576	115,727	22.7
Total	223,155	26,887	250,042	19,278	58,016	327,336	10.8
Unspecified/no information available	0	0	0	0	0	0	
Grand total	223,155	26,887	250,042	19,278	58,016	327,336	10.8

The data were obtained from the patient survey

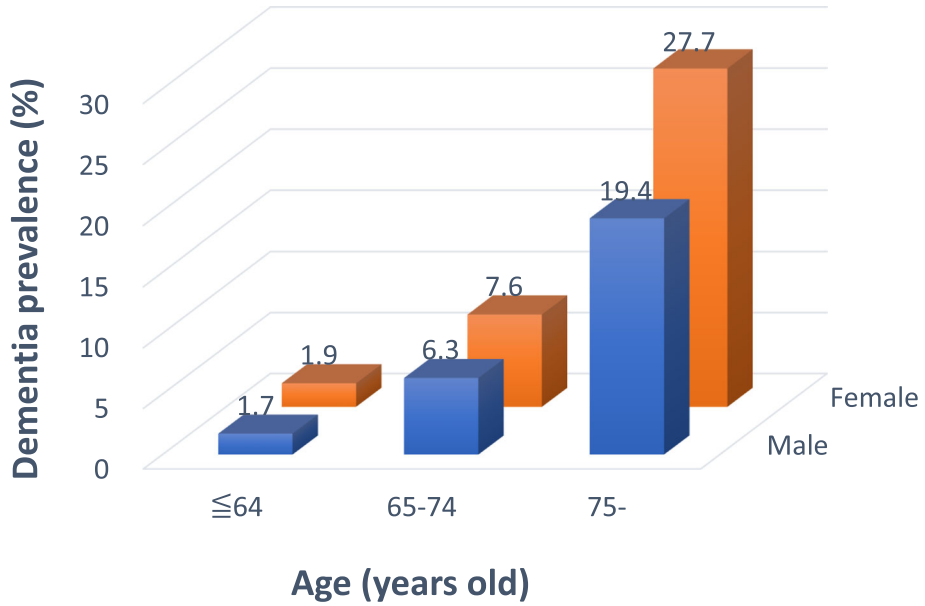

Fig. 1 Dementia prevalence sorted according to age and sex. Data were obtained from the patient survey

was adopted as the "dementia prevalence." The dementia prevalence was calculated using the equation shown below.

$$\text{Dementia prevalence}\,(\%) = [\text{number of patients who were classified as"With dementia"}] \div [\text{"number of patients who were classified as"With dementia"} + \text{number of patients who were classified as"Without dementia"}] \times 100$$

Performance status (PS)

The 2018 survey questionnaire contained questions designed to determine the Eastern Cooperative Oncology Group (ECOG) PS of the patients [4] (Table 1). According to this PS scale, a higher score means a lower physical activity level of the patient. Under this survey program, PS was first investigated in 1998 and was subsequently examined in 2002 and 2009 [8, 12, 13]. In the current survey, valid responses to the questions about PS were collected from 251,609 patients (76.9%).

Exercise habits

The 2018 survey questionnaire included, for the first time, questions designed to investigate the exercise habits of dialysis patients. Exercise habits had not been covered by any survey conducted previously within the framework of this survey program. Exercise habits were investigated using the

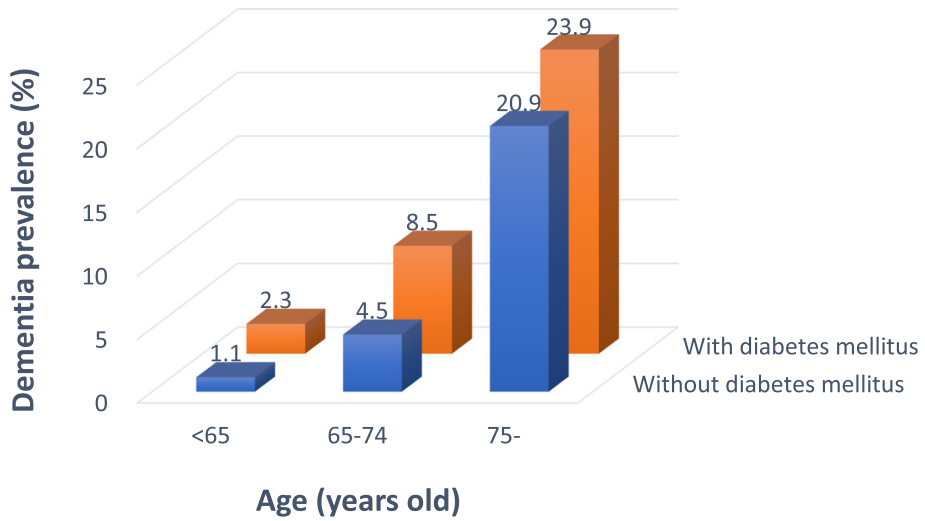

Fig. 2 Dementia prevalence sorted according to age and diabetic status. Data were obtained from the patient survey

Table 3 The prevalence of dementia sorted by age and main three kinds of treatment methods

	Facility hemodialysis							Hemodiafiltration							Peritoneal dialysis						
Age (years old)	Without dementia	With dementia	Subtotal	Unspecified	No data available	Total	Dementia prevalence (%)	Without dementia	With dementia	Subtotal	Unspecified	No data available	Total	Dementia prevalence (%)	Without dementia	With dementia	Subtotal	Unspecified	No data available	Total	Dementia prevalence (%)
<65	41,590	905	42,495	3043	9630	55,168	2.13	34,291	519	34,810	2635	7420	44,865	1.49	2723	22	2745	155	1370	4270	0.80
65≤, <75	44,895	3752	48,647	3448	10,769	62,864	7.71	28,587	1670	30,257	2544	7151	39,952	5.52	1732	66	1798	105	797	2700	3.67
75≤	44,341	14,338	58,679	4723	13,045	76,447	24.43	22,215	5328	27,543	2453	6821	36,817	19.34	1121	244	1365	90	644	2099	17.88
Subtotal	130,826	18,995	149,821	11,214	33,444	194,479	12.68	85,093	7517	92,610	7632	21,392	121,634	8.12	5576	332	5908	350	2811	9069	5.62
Unspecified	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	
No data available	0	0	0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	
Total	130,826	18,995	149,821	11,214	33,444	194,479	12.68	85,093	7517	92,610	7632	21,392	121,634	8.12	5576	332	5908	350	2811	9069	5.62
Mean	68.63	79.37	69.99	70.42	69.86	70.00		66.04	78.11	67.02	67.95	67.78	67.21		63.09	78.56	63.96	62.64	63.74	63.84	
S.D.*	12.10	8.37	12.23	12.45	12.36	12.26		12.26	9.18	12.48	12.18	12.38	12.45		14.07	8.96	14.29	17.66	14.67	14.55	

S.D. standard deviation
Data were obtained from the patient survey

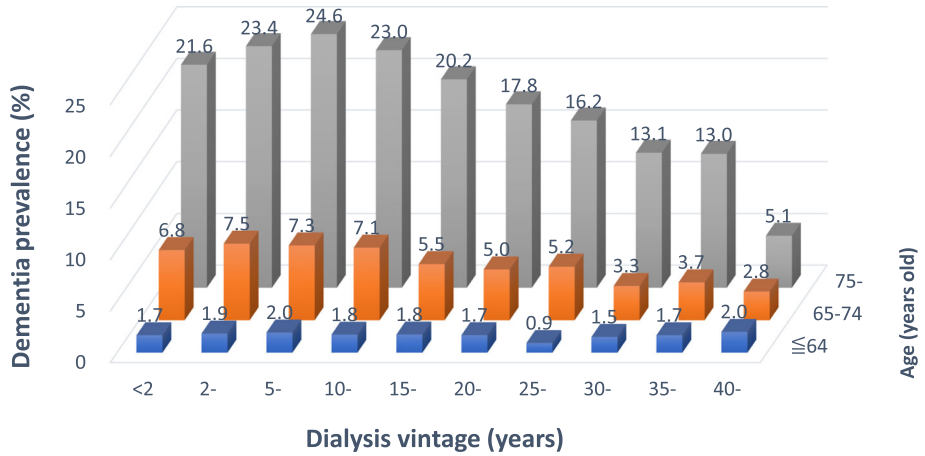

Fig. 3 Dementia prevalence sorted age and dialysis vintage. Data were obtained from the patient survey

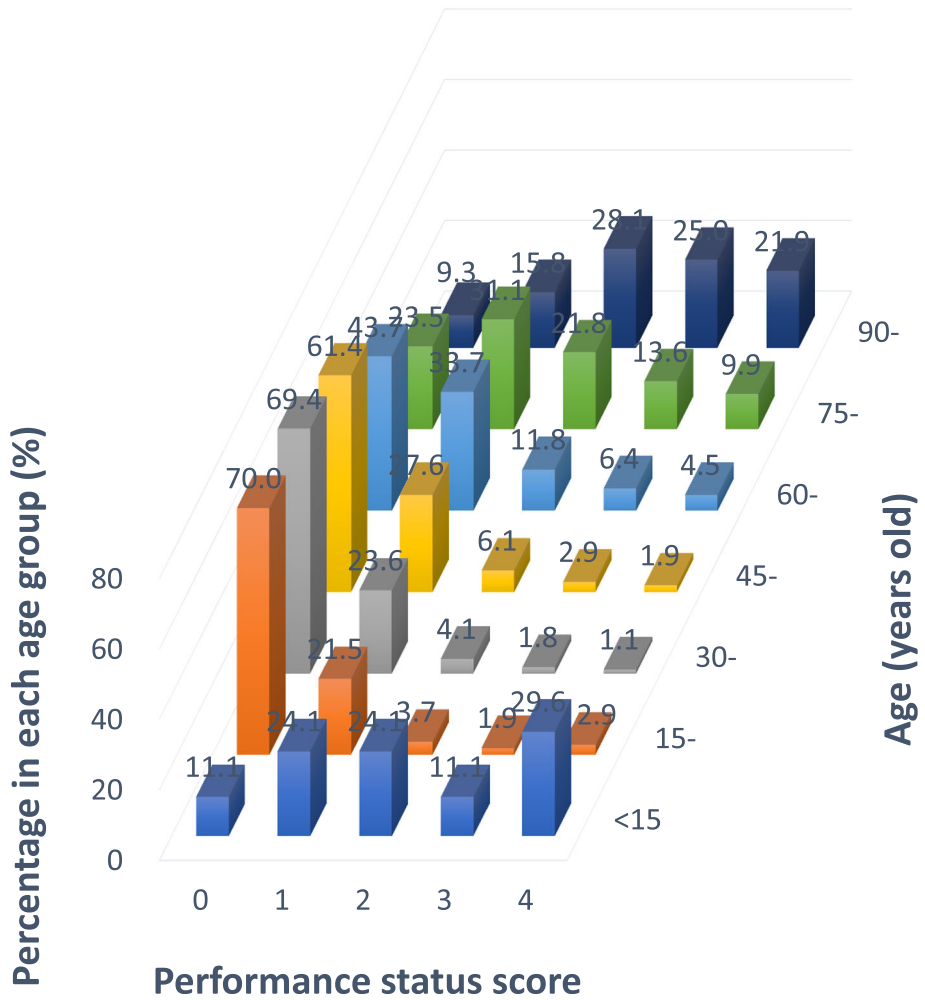

Fig. 4 Performance status and age. The numbers in the figure indicate the percentages for each age group. Data were obtained from the patient survey.

Table 4 Performance status of patients treated by main three kinds of treatment, sorted by different age

Dialysis method	Performance status score					Subtotal	Unspecified	No data available	Total
	Score 0	Score 1	Score 2	Score 3	Score 4				
a. Age <20 years old									
Facility hemodialysis	12	2	3	0	2	19	2	5	26
%	(63.2)	(10.5)	(15.8)	(0.0)	(10.5)	(100.0)			
Hemodiafiltration	7	2	0	1	0	10	0	2	12
%	(70.0)	(20.0)	(0.0)	(10.0)	(0.0)	(100.0)			
Peritoneal dialysis	11	24	12	7	18	72	10	35	117
%	(15.3)	(33.3)	(16.7)	(9.7)	(25.0)	(100.0)			
Total	30	28	15	8	20	101	12	42	155
%	(29.7)	(27.7)	(14.9)	(7.9)	(19.8)	(100.0)			
b. Age 20≤,<45 years old									
Facility hemodialysis	3314	1197	224	106	87	4928	242	1304	6474
%	(67.2)	(24.3)	(4.5)	(2.2)	(1.8)	(100.0)			
Hemodiafiltration	3214	1017	172	63	26	4492	102	1099	5693
%	(71.5)	(22.6)	(3.8)	(1.4)	(0.6)	(100.0)			
Peritoneal dialysis	274	89	7	6	6	382	34	238	654
%	(71.7)	(23.3)	(1.8)	(1.6)	(1.6)	(100.0)			
Total	6802	2303	403	175	119	9802	378	2641	12,821
%	(69.4)	(23.5)	(4.1)	(1.8)	(1.2)	(100.0)			
c. Age 45≤,<60 years old									
Facility hemodialysis	13,855	6543	1590	842	612	23,442	969	6010	30,421
%	(59.1)	(27.9)	(6.8)	(3.6)	(2.6)	(100.0)			
Hemodiafiltration	12,594	5504	1113	455	239	19,905	500	5014	25,419
%	(63.3)	(27.7)	(5.6)	(2.3)	(1.2)	(100.0)			
Peritoneal dialysis	1018	358	48	11	13	1448	79	821	2348
%	(70.3)	(24.7)	(3.3)	(0.8)	(0.9)	(100.0)			
Total	27,467	12,405	2751	1308	864	44,795	1548	11,845	58,188
%	(61.3)	(27.7)	(6.1)	(2.9)	(1.9)	(100.0)			
d. Age 60≤,<75 years old									
Facility hemodialysis	26,500	20,676	7809	4425	3566	62,976	2234	15,901	81,111
%	(42.1)	(32.8)	(12.4)	(7.0)	(5.7)	(100.0)			
Hemodiafiltration	18,841	14,599	4557	2305	1232	41,534	1023	11,136	53,693
%	(45.4)	(35.1)	(11.0)	(5.5)	(3.0)	(100.0)			
Peritoneal dialysis	1396	680	171	55	48	2350	210	1291	3851
%	(59.4)	(28.9)	(7.3)	(2.3)	(2.0)	(100.0)			
Total	46,737	35,955	12,537	6785	4846	106,860	3467	28,328	138,655
%	(43.7)	(33.6)	(11.7)	(6.3)	(4.5)	(100.0)			
e. Age 75≤ years old									
Facility hemodialysis	12,862	16,935	13,098	8973	7275	59,143	2183	15,121	76,447
%	(21.7)	(28.6)	(22.1)	(15.2)	(12.3)	(100.0)			
Hemodiafiltration	6692	9310	6252	3558	2123	27,935	730	8152	36,817
%	(24.0)	(33.3)	(22.4)	(12.7)	(7.6)	(100.0)			
Peritoneal dialysis	426	381	229	132	89	1257	145	697	2099
%	(33.9)	(30.3)	(18.2)	(10.5)	(7.1)	(100.0)			

Table 4 Performance status of patients treated by main three kinds of treatment, sorted by different age *(Continued)*

Dialysis method	Performance status score					Subtotal	Unspecified	No data available	Total
	Score 0	Score 1	Score 2	Score 3	Score 4				
Total	19,980	26,626	19,579	12,663	9487	88,335	3058	23,970	115,363
%	(22.6)	(30.1)	(22.2)	(14.3)	(10.7)	(100.0)			

The data were obtained from the patient survey

following 7 answer choices in response to a question regarding exercise habits.

A. Not at all or hardly
B. Less than once a week
C. Almost once a week
D. Two or three times a week
E. Four or five times a week
F. Every day or nearly every day
Z. Unknown

In the current survey, an answer to the question regarding exercise habits was collected from 213,930 patients (65.4%).

Results

Presence/absence of dementia

Age and dementia prevalence

The prevalence of dementia was calculated among all the dialysis patients and in each of the major age groups. The

Table 5 The prevalence of dementia sorted by age and performance status

Presence/absence of dementia	Performance status score					Subtotal	Unspecified	No data available	Total
	Score 0	Score 1	Score 2	Score 3	Score 4				
a. Age <65 years old									
Without dementia	46,015	21,848	4885	2292	1283	76,323	1233	1783	79,339
With dementia	289	278	226	235	348	1376	37	39	1452
Subtotal	46,304	22,126	5111	2527	1631	77,699	1270	1,822	80,791
Unspecified	592	481	161	94	175	1503	1462	2893	5858
No data available	1008	517	127	80	38	1,770	54	16,754	18,578
Total	47,904	23,124	5399	2701	1844	80,972	2786	21,469	105,227
Dementia prevalence (%)	0.6	1.3	4.4	9.3	21.3	1.8	2.9	2.1	1.8
b. Age 65≤,<75 years old									
Without dementia	32,132	25,876	8703	4218	2211	73,140	1120	1624	75,884
With dementia	519	953	1158	1100	1472	5202	116	185	5503
Subtotal	32,651	26,829	9861	5318	3683	78,342	1236	1809	81,387
Unspecified	460	530	336	196	262	1784	1351	2998	6133
No data available	767	648	260	130	86	1891	57	16,914	18,862
Total	33,878	28,007	10,457	5644	4031	82,017	2644	21,721	106,382
Dementia prevalence (%)	1.6	3.6	11.7	20.7	40.0	6.6	9.4	10.2	6.8
c. Age 75≤ years old									
Without dementia	18,242	22,867	13,660	7186	3305	65,260	1101	1571	67,932
With dementia	1030	2613	4918	4814	5551	18,926	371	635	19,932
Subtotal	19,272	25,480	18,578	12,000	8856	84,186	1472	2206	87,864
Unspecified	339	635	603	449	475	2501	1544	3242	7287
No data available	429	611	480	244	169	1933	50	18,593	20,576
Total	20,040	26,726	19,661	12,693	9,500	88,620	3,066	24,041	115,727
Dementia prevalence (%)	5.3	10.3	26.5	40.1	62.7	22.5	25.2	28.8	22.7

The data were obtained from the patient survey

results are shown in Table 2. The overall dementia prevalence among dialysis patients in the 2018 survey was 10.8% (1.8% in the age group of less than 65 years, 6.8% in the age group of 65–74 years, and 22.7% in the age group of 75 years or older). Thus, the dementia prevalence was markedly higher among subjects older than 65 years.

Sex and dementia prevalence

Figure 1 shows the dementia prevalence in each of the major age groups calculated according to sex. In each age group, the dementia prevalence was higher among females than among males (Supplementary Table 1).

Presence/absence of diabetes mellitus and dementia prevalence

Figure 2 shows the relationship between the presence/absence of diabetes mellitus and the dementia prevalence (Supplementary Table 2). In each age group, the dementia prevalence was higher among diabetic patients than among non-diabetic patients.

Treatment method and dementia prevalence

Table 3 shows the relationship between the three main treatment methods (facility hemodialysis, hemodiafiltration, and peritoneal dialysis) and the dementia prevalence. Hemodialysis patients had the highest prevalence of dementia, followed by hemodiafiltration patients and peritoneal dialysis patients.

Dialysis vintage and dementia prevalence

Figure 3 shows the relationship between the dialysis vintage and the dementia prevalence. During the first 10 years of dialysis, the dementia prevalence increased as the dialysis vintage increased (Supplementary Table 3). After 10 years, however, the dementia prevalence decreased as the dialysis vintage increased.

Performance status (PS)

Age and PS

Figure 4 graphically represents the distribution of age and PS (Supplementary Table 4). The percentages of patients with lower activity levels (higher PS scores) were relatively high among patients who were less than 15 years old or 60 years or older. Among patients who were 90 years or

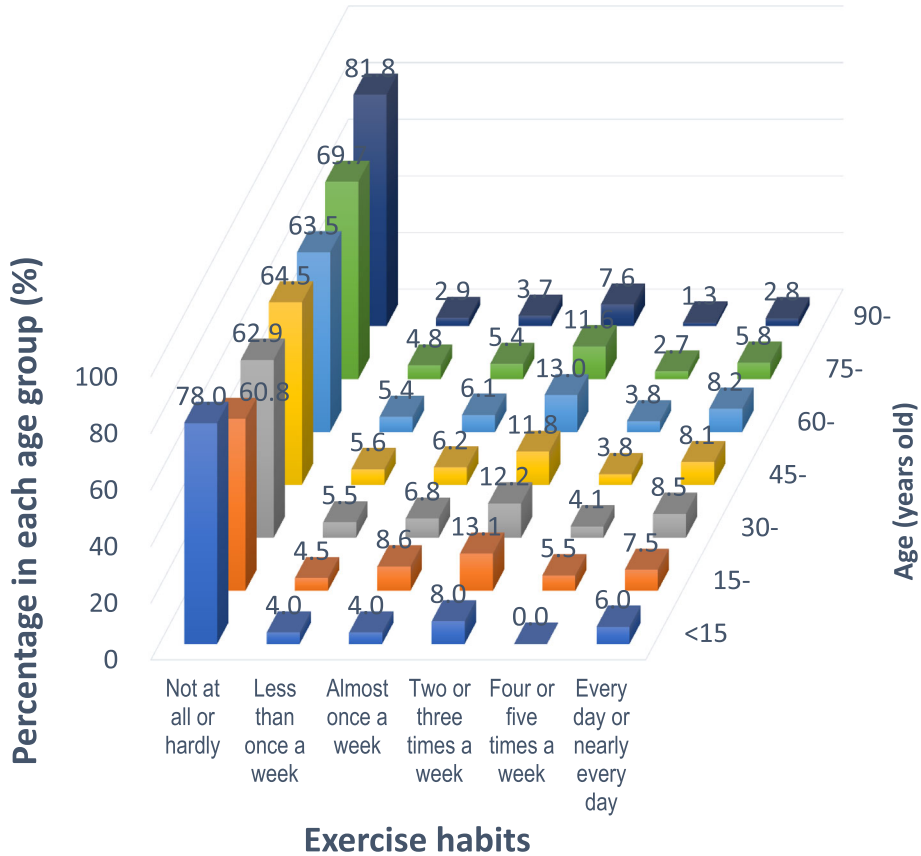

Fig. 5 Exercise habits and age. The numbers in the figure indicate the percentages for each age group. Data were obtained from the patient survey

older, the overwhelming majority of patients had low activity levels (high PS scores), and the percentage of patients with high activity levels (low PS scores) was small.

Treatment method and PS

Table 4 shows the relationship between the main three treatment methods (facility hemodialysis, hemodiafiltration, and peritoneal dialysis) and PS. The number of patients tabulated in some cells was too small, so this tabulation was performed as "under 20 years old" instead of "under 15 years old." Among patients aged 20 years or older, patients treated by peritoneal dialysis were the most active, followed by those treated with hemodiafiltration and facility hemodialysis. Among patients under the age of 20 years, patients treated by hemodiafiltration were the most active, followed by those treated with facility hemodialysis and peritoneal dialysis.

Dementia prevalence and PS

Table 5 shows the results summarizing the relationship between the prevalence of dementia and PS according to different age groups. Regardless of age, patients with a lower activity have a higher prevalence of dementia.

Exercise habits

Age and exercise habits

Figure 5 shows the results of the analysis of age versus exercise habits among the dialysis patients (Supplementary Table 5). In each age group, patients who were classified as "Not at all or hardly" in response to the question on exercise habits were predominant, accounting for 60–80% of all the patients.

Dialysis vintage and exercise habits

Next, the patients were divided into four age groups (0–44, 45–64, 65–74, and 75 years or older), and the relationship between the dialysis vintage and exercise habits was analyzed in each age group (Figs. 6, 7, 8 and 9; Supplementary Table 6). In the 45 years and older age groups, the percentages of patients who were classified as "Not at all or hardly" tended to be higher when the dialysis vintage was 35 years or longer. In the 0–44 age groups, the percentage of patients who were classified as "Not at all or

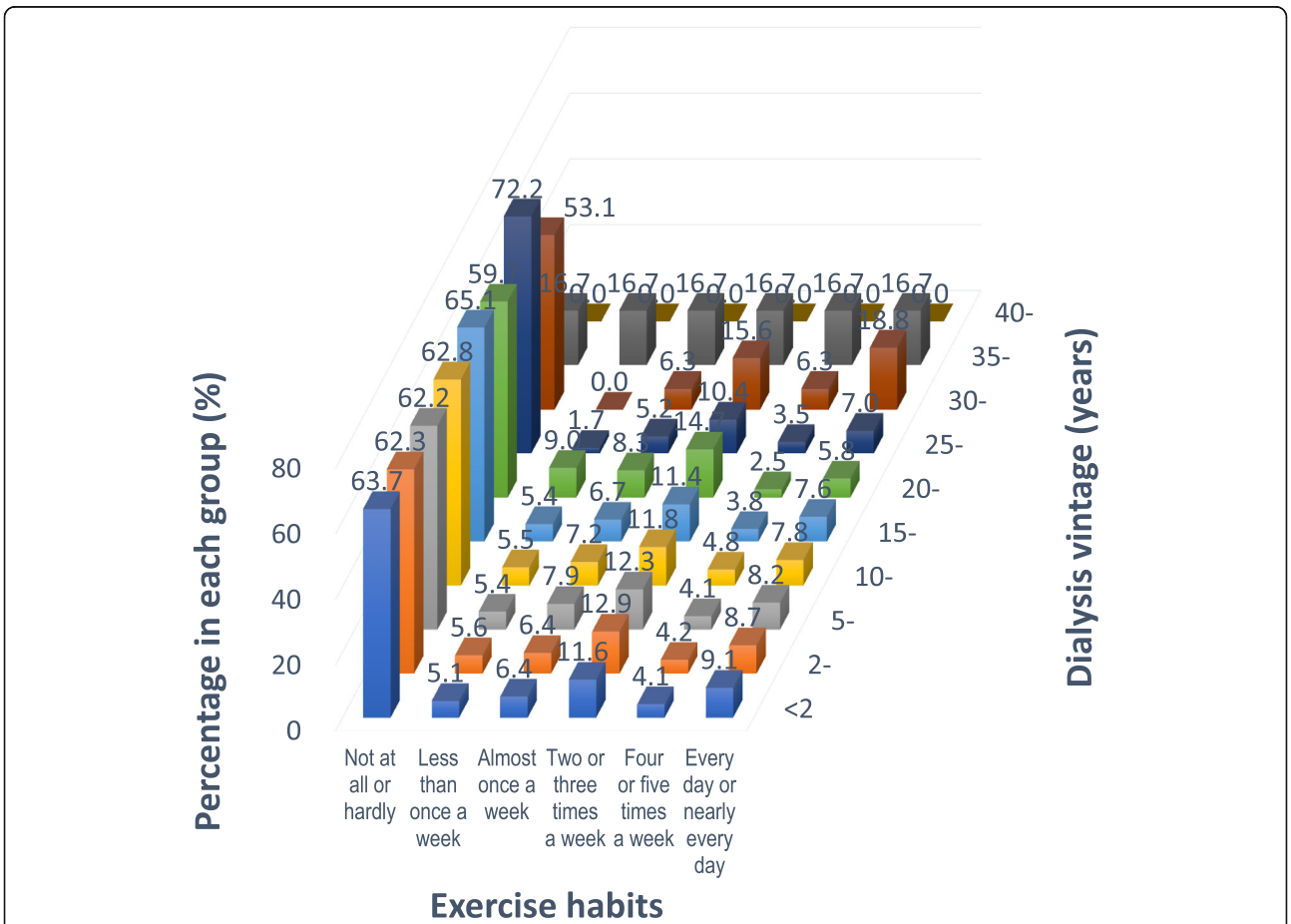

Fig. 6 Exercise habits and dialysis vintage: under 45 years old. The numbers in the figure indicate the percentages for each dialysis vintage group. Data were obtained from the patient survey

hardly" tended to increase in the group with a dialysis vintage of 25–29 years. However, the age 0–44 age groups included almost no patients with a dialysis vintage of 35 years or longer. No other evident relationship between the duration vintage and exercise habits was seen.

PS and exercise habits

Table 6 shows the results summarizing the relationship between exercise habits and PS for all the patients. Patients who exercised more often had a higher physical activity.

Dementia prevalence and exercise habits

Table 7 shows the results of tabulating the relationship between exercise habits and the prevalence of dementia according to major age group. Patients who exercised more frequently had a lower prevalence of dementia across all age groups.

Discussion

Presence/absence of dementia

Age and dementia prevalence

When the prevalence of dementia was analyzed in each of the major age groups, the dementia prevalence was found to be markedly increased in the 65 years or older age group (Table 2). As reference data, Fig. 10 shows the changes in dementia prevalence over time for each of the major age groups in the 2009, 2010, and 2018 surveys (Supplementary Table 7). The analyses in the 2009 and 2010 surveys were confined to "patients receiving hemodialysis at a facility 3 times/week" [8, 9]. For this reason, the analysis in 2018 included only "patients receiving hemodialysis at facilities 3 times/week." The dementia prevalence in 2018 in each age group was approximately equal to the corresponding prevalence recorded in 2009 and 2010. This indicates that the status of dementia prevalence among dialysis patients in Japan has not changed markedly over the past decade.

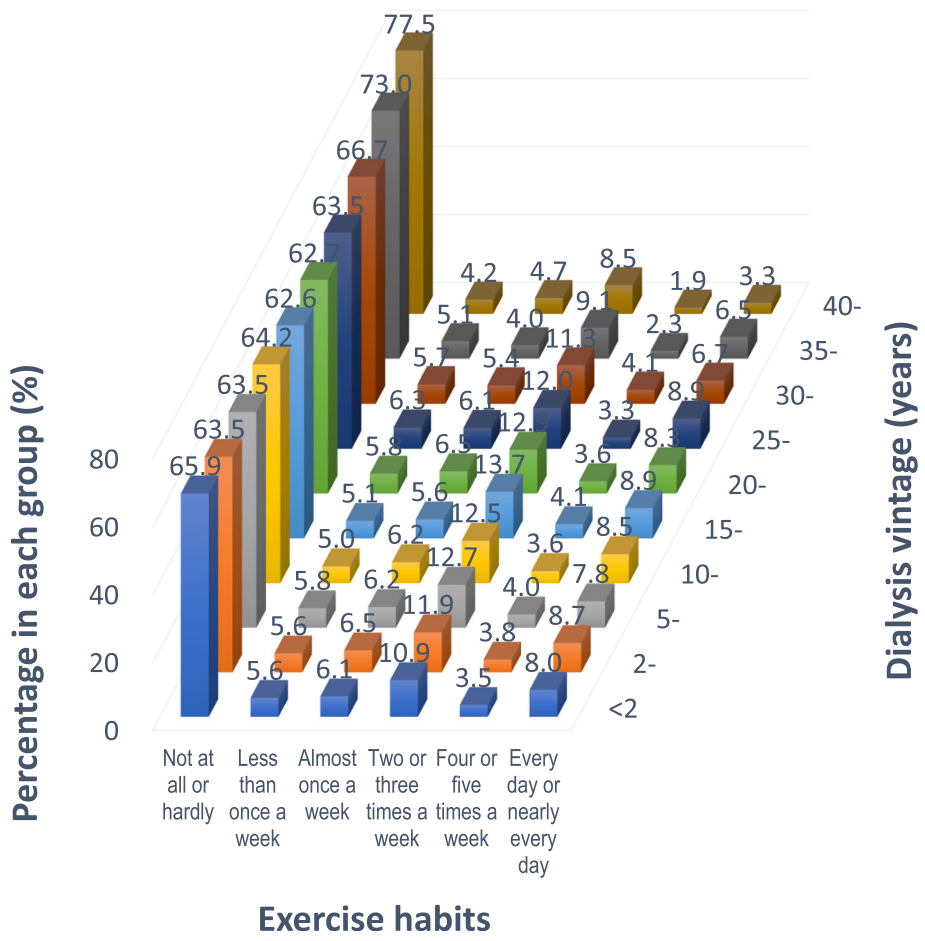

Fig. 7 Exercise habits and dialysis vintage: 45–64 years old. The numbers in the figure indicate the percentages for each dialysis vintage group. Data were obtained from the patient survey

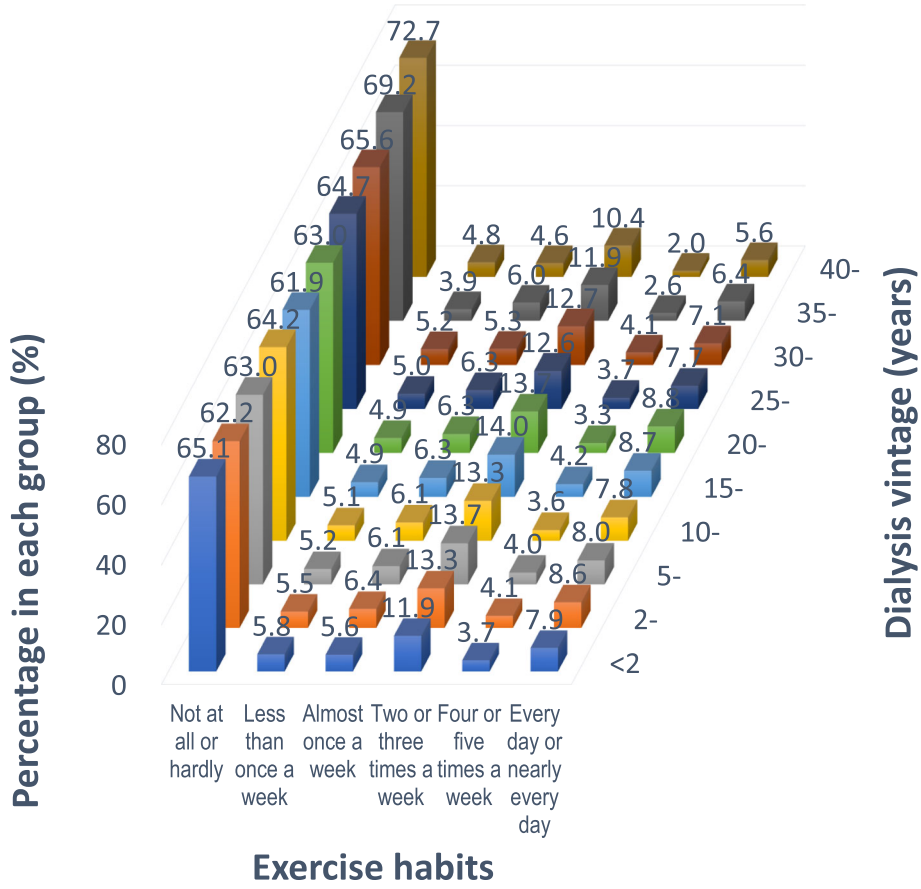

Fig. 8 Exercise habits and dialysis vintage: 65–74 years old. The numbers in the figure indicate the percentages for each dialysis vintage group. Data were obtained from the patient survey

Sex and dementia prevalence

When the dementia prevalence in each of the major age groups was analyzed according to sex, the prevalence in each age group was higher in the females than in the males (Fig. 1). A similar trend to that noted in the current survey was also observed in the surveys conducted in 2009 and 2010 within the framework of this survey program [8, 9]. Among elderly patients, the prevalence of dementia is generally higher in females than in males [14]. On the other hand, in Japan, the prevalence of dementia among young people under the age of 65 years has been reported to be lower in females than in males [15]. However, in this report, the prevalence of dementia in dialysis patients under the age of 65 years was higher in females than in males. To explore this matter, the prevalence of dementia according to the presence or absence of diabetes and the dialysis vintage was calculated for each sex (Tables 8 and 9). As shown here, the prevalence of dementia calculated for each age group was higher in females than in males, regardless of the presence of diabetes or the dialysis vintage. These results indicate that among Japanese dialysis patients, females are more susceptible to dementia than males. We could not clarify the reason for this difference in the present analysis.

Presence/absence of diabetes mellitus and dementia prevalence

An analysis of the relationship between the presence/absence of diabetes mellitus and the dementia prevalence revealed that the dementia prevalence was higher among diabetic patients than among non-diabetic patients in each age group (Fig. 2). This result was consistent with the previously reported finding that diabetes mellitus is a risk factor for dementia [16]. A trend similar to that observed in the current survey was also noted in the surveys conducted in 2009 and 2010 within the framework of this survey program [8, 9].

Treatment method and dementia prevalence

As shown in Table 3, facility hemodialysis patients had the highest prevalence of dementia, followed by

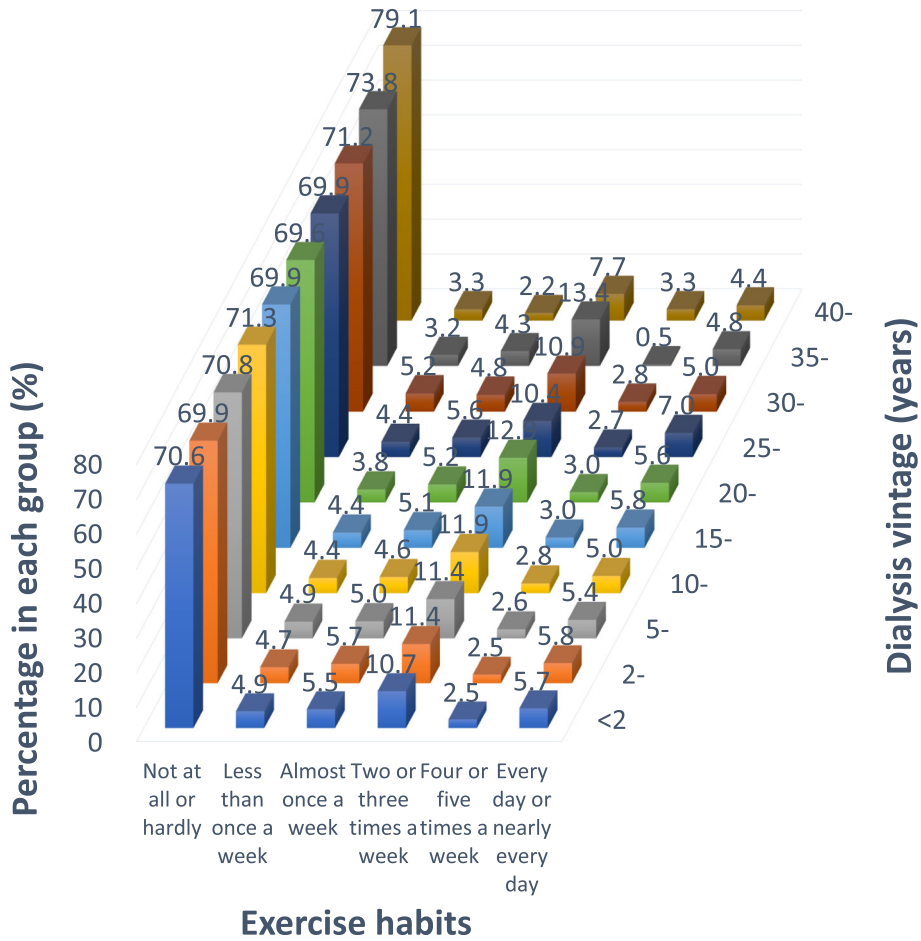

Fig. 9 Exercise habits and dialysis vintage: 75 years or older. The numbers in the figure indicate the percentages for each dialysis vintage group. Data were obtained from the patient survey

hemodiafiltration patients and peritoneal dialysis patients, regardless of age. Table 10 shows the basic background factors of the patients who were treated with each of the three main treatment methods. The mean age of the facility hemodialysis patients was the highest, followed by the mean ages of the hemodiafiltration and peritoneal dialysis patients. However, the prevalence of dementia, shown in Table 3, had already been stratified according to the different age groups. Therefore, it is difficult to attribute the high prevalence of dementia in facility hemodialysis patients to their advanced age. The mean dialysis vintage was the longest for hemodiafiltration, followed by those for facility hemodialysis and peritoneal dialysis. There was no significant difference in the percentage of male patients receiving each treatment. Thus, it seems unlikely that these findings could have affected the high prevalence of dementia among facility hemodialysis patients. The prevalence of diabetes was highest among facility hemodialysis patients, followed by patients receiving hemodiafiltration and peritoneal dialysis. This report shows that patients with diabetes have a high prevalence of dementia. This may have affected the high prevalence of dementia among facility hemodialysis patients and the low prevalence of dementia among peritoneal dialysis patients.

Dialysis vintage and dementia prevalence

In an analysis of the relationship between the duration of dialysis and the dementia prevalence, the dementia prevalence increased as the dialysis vintage increased in patients whose dialysis vintage was less than 10 years. Among patients whose dialysis vintage was more than 10 years, however, the dementia prevalence decreased as the dialysis vintage increased (Fig. 3). A trend similar to the one observed in the current survey was also noted in the surveys conducted in 2009 and 2010 within the framework of this survey program [8, 9]. To clarify this background, the relationships between dialysis vintage and basic background factors are summarized in Table 11. No significant difference in the mean age of patients belonging to each dialysis vintage was seen for patients with a dialysis vintage of less than 10 years, but the mean age tended to be lower in patients with a long dialysis vintage among

Table 6 Exercise habits and performance status (all dialysis patients)

Exercise habits	Performance status score					Subtotal	Unspecified	No data available	Total
	Score 0	Score 1	Score 2	Score 3	Score 4				
Not at all or hardly	48,347	40,194	22,863	15,643	13,161	140,208	781	576	141,565
%	(34.5)	(28.7)	(16.3)	(11.2)	(9.4)	(100.0)			
Less than once a week	4522	4282	1596	479	139	11,018	13	10	11,041
%	(41.0)	(38.9)	(14.5)	(4.3)	(1.3)	(100.0)			
Almost once a week	5315	4541	1769	648	172	12,445	35	20	12,500
%	(42.7)	(36.5)	(14.2)	(5.2)	(1.4)	(100.0)			
Two or three times a week	11,325	9262	3256	1457	497	25,797	43	197	26,037
%	(43.9)	(35.9)	(12.6)	(5.6)	(1.9)	(100.0)			
Four or five times a week	3975	2472	483	167	98	7195	7	33	7235
%	(55.2)	(34.4)	(6.7)	(2.3)	(1.4)	(100.0)			
Every day or nearly every day	9398	4699	969	275	86	15,427	21	104	15,552
%	(60.9)	(30.5)	(6.3)	(1.8)	(0.6)	(100.0)			
Subtotal	82,882	65,450	30,936	18,669	14,153	212,090	900	940	213,930
%	(39.1)	(30.9)	(14.6)	(8.8)	(6.7)	(100.0)			
Unspecified	16,455	10,356	3730	2012	1010	33,563	7507	718	41,788
No data available	2485	2051	851	357	212	5956	89	65,573	71,618
Total	101,822	77,857	35,517	21,038	15,375	251,609	8496	67,231	327,336
%	(40.5)	(30.9)	(14.1)	(8.4)	(6.1)	(100.0)			

The data were obtained from the patient survey

patients with a dialysis vintage of 10 years or more. In addition, a small proportion of patients with a dialysis vintage of 10 years or more had diabetes. This tendency was remarkable among patients with a dialysis vintage of 20 years or more. Thus, patients with diabetes had a relatively high prevalence of dementia in this tabulation. This may have been associated with the low prevalence of dementia among patients with a long dialysis vintage. It was previously reported that in non-diabetic patients with no history of cerebrovascular disease undergoing maintenance hemodialysis, the risk of the onset of dementia decreased as the dialysis vintage increased [17]. The results of the current survey may be consistent with this previous report.

Performance status (PS)

Age and PS

When the PS was analyzed according to age, the percentage of patients with lower activity levels (larger PS scores) increased in the 75 years or older age group. In the 65–74 years age group, on the other hand, the distribution of the PS scores was close to that in the 45–59 years age group. This result may indicate that the physical activity level in dialysis patients is relatively well preserved until the age of 75 years but begins to decrease rapidly after the age of 75 years. On the other hand, there were many patients with low activity scores in the under 15-year-old age group. This finding may indicate that renal failure impedes the development of the patients' physical functions.

Figures 11, 12, and 13 show the distribution of the PS scores in each of the major age groups evaluated at 3 points of time (1998, 2009, and 2018) [8, 12]. The data for 1998 and 2018 cover all the dialysis patients, while the data for 2009 covers only those patients who were receiving hemodialysis at a facility 3 times/week. During the period from 1998 to 2009, the percentage of patients with high activity levels increased slightly and that of patients with low activity levels decreased slightly in each age group (note that a small PS score means a high activity level). However, during the period from 2009 to 2018, the percentage of patients with high activity levels decreased and that of patients with low activity levels increased slightly in the 75 years or older age group. This may indicate that the physical activity level in the dialysis patients tended to improve from 1998 to 2009, but has improved minimally thereafter.

Treatment method and PS

As shown in Table 4, among patients aged 20 years and older, the PS of peritoneal dialysis patients was better than those of hemodiafiltration and facility hemodialysis patients. The number of patients tabulated in some cells was too small, so this tabulation

Table 7 Exercise habits and the prevalence of dementia, sorted by different age

Exercise habits	Presence/absence of dementia		Subtotal	Unspecified	No data available	Total	Dementia prevalence (%)
	Without dementia	With dementia					
a. Age <65 years old							
Not at all or hardly	40,525	933	41,458	754	939	43,151	2.3
Less than once a week	3571	51	3622	81	37	3740	1.4
Almost once a week	4007	92	4099	57	54	4210	2.2
Two or three times a week	7686	123	7809	137	233	8179	1.6
Four or five times a week	2450	22	2472	31	46	2549	0.9
Every day or nearly every day	5342	42	5384	84	107	5575	0.8
Subtotal	63,581	1263	64,844	1144	1416	67,404	1.9
Unspecified	12,753	139	12,892	1827	349	15,068	1.1
No data available	3005	50	3055	2887	16,813	22,755	1.6
Total	79,339	1452	80,791	5858	18,578	105,227	1.8
b. Age 65≦,<75 years old							
Not at all or hardly	38,775	3786	42,561	890	900	44,351	8.9
Less than once a week	3404	157	3561	102	37	3700	4.4
Almost once a week	3907	220	4127	63	52	4242	5.3
Two or three times a week	8348	408	8756	177	249	9182	4.7
Four or five times a week	2520	57	2577	45	60	2682	2.2
Every day or nearly every day	5326	133	5459	103	119	5681	2.4
Subtotal	62,280	4761	67,041	1380	1417	69,838	7.1
Unspecified	10,796	467	11,263	1765	351	13,379	4.1
No data available	2808	275	3083	2988	17,094	23,165	8.9
Total	75,884	5503	81,387	6133	18,862	106,382	6.8
c. Age 75≦ years old							
Not at all or hardly	37,285	14,275	51,560	1480	1023	54,063	27.7
Less than once a week	2952	518	3470	93	38	3601	14.9
Almost once a week	3330	590	3920	80	48	4048	15.1
Two or three times a week	6992	1257	8249	208	219	8676	15.2
Four or five times a week	1740	183	1923	41	40	2004	9.5
Every day or nearly every day	3703	401	4104	111	81	4296	9.8
Subtotal	56,002	17,224	73,226	2013	1449	76,688	23.5
Unspecified	9273	1762	11,035	2038	268	13,341	16.0
No data available	2657	946	3603	3236	18,859	25,698	26.3
Total	67,932	19,932	87,864	7287	20,576	115,727	22.7

The data were obtained from the patient survey

was performed as "under 20 years old" instead of "under 15 years old." This table may indicate that highly active patients are more likely to choose peritoneal dialysis. On the other hand, among patients under the age of 20 years, most of the patients chose peritoneal dialysis, and several peritoneal dialysis patients had low activity levels. These results suggest that pediatric renal failure patients tend to choose peritoneal dialysis and that their physical activity level is relatively low.

Dementia prevalence and PS

As shown in Table 5, regardless of age, patients with lower activity levels had a higher prevalence of dementia. Previous studies have shown that physical activity prevents the onset of dementia [18, 19]. The result of this

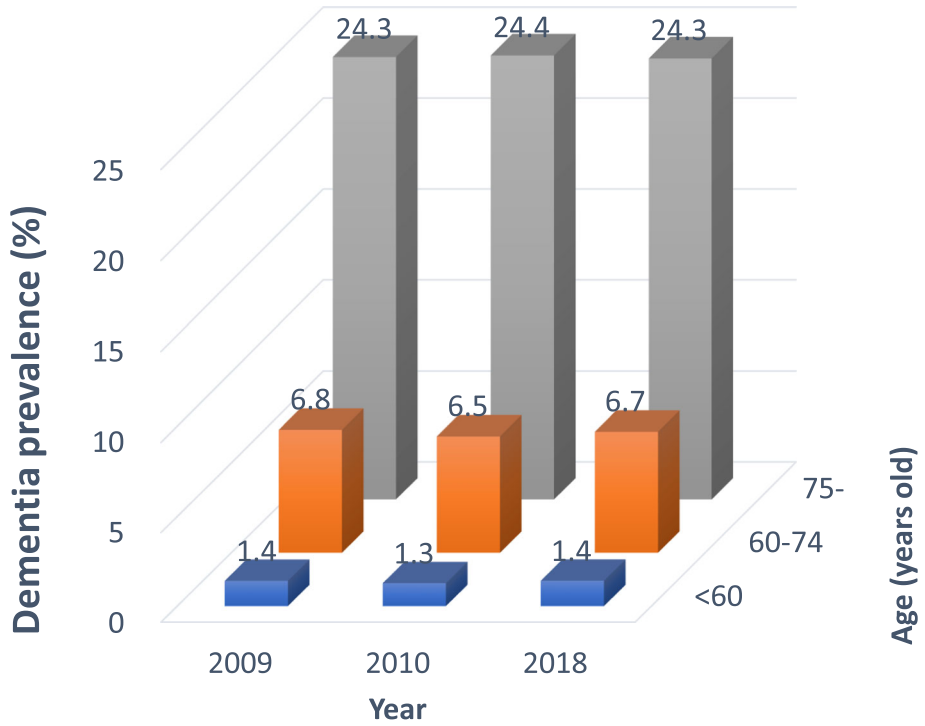

Fig. 10 Trend in dementia prevalence in hemodialysis patients who were treated three times a week. Data were obtained from the patient survey

report is consistent with the results of these previous studies.

Exercise habits

Age and exercise habits

When exercise habits were analyzed according to age, the answer "Not at all or hardly" was predominantly selected in each age group (Fig. 9). The next most frequently selected choice was "Two or three times a week" (8–13%) in each age group. This may indicate that the patients exercised at a pace consistent with a schedule in which hemodialysis was performed three times weekly. The percentages of patients who were classified as "Almost once a week" and "Every day or nearly every day" were each 4–8% in each age group.

Dialysis vintage and exercise habits

When the exercise habits were analyzed according to dialysis vintage (Figs. 7, 8, and 9), the percentage of patients who were classified as "Not at all or hardly" tended to be relatively high in the patients with a long dialysis vintage in each age group. This finding suggests that some patients receiving prolonged hemodialysis might have developed a motor disorder.

PS and exercise habits

As shown in Table 6, patients who exercised more often had higher physical activities. However, these results represent single observations made at one time point. Therefore, the causal relationship between exercise habits and physical activity cannot be discussed based on these results. However, this result indicates that exercise habits and physical activity are closely related even in dialysis patients.

Dementia prevalence and exercise habits

As shown in Table 7, patients who exercised more frequently had a lower prevalence of dementia across all age groups. Previous studies have shown that physical exercise prevents the onset of dementia [18, 19]. This result is consistent with the results of these previous studies. However, the present results represent observations made at a single point in time. Therefore, the causal relationship between exercise habits and dementia prevalence cannot be discussed based on these results.

Conclusion

In the 2018 survey, the presence/absence of dementia, PS, and exercise habits was investigated in individual

Table 8 The prevalence of dementia sorted by age and presence or absence of diabetes

Age (years old)	Males							Females						
	Without dementia	With dementia	Subtotal	Unspecified	No data available	Total	Dementia prevalence (%)	Without dementia	With dementia	Subtotal	Unspecified	No data available	Total	Dementia prevalence (%)
a) The patients without diabetes mellitus														
<65	23,937	256	24,193	701	1406	26,300	1.06	13,697	176	13,873	363	839	15,075	1.27
65≤,<75	20,194	892	21,086	681	1316	23,083	4.23	13,568	697	14,265	397	893	15,555	4.89
75≤	19,931	4181	24,112	992	1575	26,679	17.34	13,536	4653	18,189	715	1110	20,014	25.58
Subtotal	64,062	5,329	69,391	2,374	4297	76,062	7.68	40,801	5526	46,327	1475	2842	50,644	11.93
Unspecified	0	0	0	0	0	0		0	0	0	0	0	0	
No data available	0	0	0	0	0	0		0	0	0	0	0	0	
Total	64,062	5329	69,391	2374	4297	76,062	7.68	40,801	5526	46,327	1475	2842	50,644	11.93
Mean	66.85	79.99	67.86	69.50	68.41	67.94		68.19	81.53	69.78	71.83	69.88	69.85	
S.D.*	13.30	8.54	13.46	13.63	13.41	13.46		12.71	7.95	12.98	13.51	13.25	13.02	
b) The patients with diabetes mellitus														
<65	29,767	667	30,434	2216	6423	39,073	2.19	9123	267	9390	669	2005	12,064	2.84
65≤,<75	28,507	2376	30,883	2340	6608	39,831	7.69	10,947	1283	12,230	916	2500	15,646	10.49
75≤	21,222	5611	26,833	2125	5556	34,514	20.91	10,362	4316	14,678	1190	3025	18,893	29.40
Subtotal	79,496	8654	88,150	6681	18,587	113,418	9.82	30,432	5866	36,298	2775	7,530	46,603	16.16
Unspecified	0	0	0	0	0	0		0	0	0	0	0	0	
No data available	0	0	0	0	0	0		0	0	0	0	0	0	
Total	79,496	8654	88,150	6681	18,587	113,418	9.82	30,432	5866	36,298	2775	7,530	46,603	16.16
Mean	66.89	76.62	67.85	68.21	67.82	67.87		69.14	78.97	70.73	71.19	70.43	70.71	
S.D.*	11.32	8.62	11.45	11.54	11.41	11.45		11.56	8.30	11.68	11.35	11.80	11.68	

The data were obtained from the patient survey

Table 9 The prevalence of dementia sorted by different age and dialysis vintage

Age (years old)	Males							Females						
	Without dementia	With dementia	Subtotal	Unspecified	No data available	Total	Dementia prevalence (%)	Without dementia	With dementia	Subtotal	Unspecified	No data available	Total	Dementia prevalence (%)
a) Dialysis vintage <5 years														
<65	25,681	454	26,135	1956	6240	34,331	1.74	9280	183	9463	711	2304	12,478	1.93
65≤,<75	22,929	1634	24,563	1951	5926	32,440	6.65	9381	859	10,240	788	2388	13,416	8.39
75≤	24,125	5764	29,889	2524	7120	39,533	19.28	12,615	4929	17,544	1479	4146	23,169	28.10
Subtotal	72,735	7852	80,587	6431	19,286	106,304	9.74	31,276	5971	37,247	2978	8838	49,063	16.03
Unspecified	0	0	0	0	0	0		0	0	0	0	0	0	
No data available	0	0	0	0	0	0		0	0	0	0	0	0	
Total	72,735	7852	80,587	6431	19,286	106,304	9.74	31,276	5971	37,247	2978	8838	49,063	16.03
Mean	67.64	78.60	68.71	69.12	68.77	68.75		69.72	81.05	71.53	71.98	71.19	71.50	
S.D.*	12.85	8.69	12.92	13.05	12.98	12.94		13.10	7.86	13.08	13.36	13.43	13.16	
b) Dialysis vintage 5≤,<10 years														
<65	21,049	378	21,427	1561	4688	27,676	1.76	9100	203	9303	658	2121	12,082	2.18
65≤,<75	19,582	1402	20,984	1581	4780	27,345	6.68	9573	859	10,432	740	2313	13,485	8.23
75≤	14,938	3856	18,794	1551	4352	24,697	20.52	9006	3746	12,752	1018	2932	16,702	29.38
Subtotal	55,569	5636	61,205	4693	13,820	79,718	9.21	27,679	4808	32,487	2416	7366	42,269	14.80
Unspecified	0	0	0	0	0	0		0	0	0	0	0	0	
No data available	0	0	0	0	0	0		0	0	0	0	0	0	
Total	55,569	5636	61,205	4693	13,820	79,718	9.21	27,679	4808	32,487	2416	7366	42,269	14.80
Mean	66.65	77.75	67.67	68.31	67.95	67.76		68.37	80.26	70.13	70.70	70.07	70.15	
S.D.*	11.94	8.76	12.12	12.10	12.03	12.10		12.25	8.54	12.51	12.19	12.72	12.53	
c) Dialysis vintage 15 years ≤														

Table 9 The prevalence of dementia sorted by different age and dialysis vintage *(Continued)*

Age (years old)	Males							Females						
	Without dementia	With dementia	Subtotal	Unspecified	No data available	Total	Dementia prevalence (%)	Without dementia	With dementia	Subtotal	Unspecified	No data available	Total	Dementia prevalence (%)
<65	8754	144	8898	578	1987	11,463	1.62	5448	88	5536	359	1213	7108	1.59
65≤,<75	7779	362	8141	566	1833	10,540	4.45	6621	385	7006	487	1600	9093	5.50
75≤	3792	688	4480	349	1027	5856	15.36	3434	927	4361	318	961	5,640	21.26
Subtotal	20,325	1194	21,519	1493	4847	27,859	5.55	15,503	1400	16,903	1164	3774	21,841	8.28
Unspecified	0	0	0	0	0	0		0	0	0	0	0	0	
No data available	0	0	0	0	0	0		0	0	0	0	0	0	
Total	20,325	1194	21,519	1493	4847	27,859	5.55	15,503	1400	16,903	1164	3774	21,841	8.28
Mean	64.92	74.70	65.47	66.40	65.57	65.53		66.80	76.93	67.64	68.20	67.59	67.66	
S.D.*	10.68	8.98	10.83	10.52	10.90	10.83		10.08	8.11	10.32	10.37	10.43	10.34	

Table 10 The basic background factors of patients treated by main three kinds of dialysis methods

Treatment methods	Mean age (years old)	Mean dialysis vintage (years)	Percentage of male patients	Percentage of patients with diabetes
Facility hemodialysis	70.0	6.7	65.2	57.5
Hemodiafiltration	67.2	8.4	65.9	53.9
Peritoneal dialysis	63.8	2.9	65.9	52.2

Table 11 The basic background factors of patients sorted by different dialysis vintage

Background factors		Dialysis vintage (year)				
		<5	5≤,<10	10≤,<20	20≤	Total
Percentage of patients treated by each method	Facility hemodialysis	58.4	52.8	50.1	43.3	54.1
	Hemodiafiltration	36.7	45.1	48.5	51.8	42.3
	Peritoneal dialysis	4.8	1.9	0.6	0.2	2.9
	Others	0.1	0.3	0.8	4.8	0.7
Percentage of male patients		68.8	66.7	62.0	53.8	65.7
Percentage of patients with diabetes		62.9	62.3	47.4	14.5	56.1
Mean age (years old) of each dialysis vintage patients		69.9	69.2	67.9	66.6	69.1

This tabulation was performed on all dialysis patients

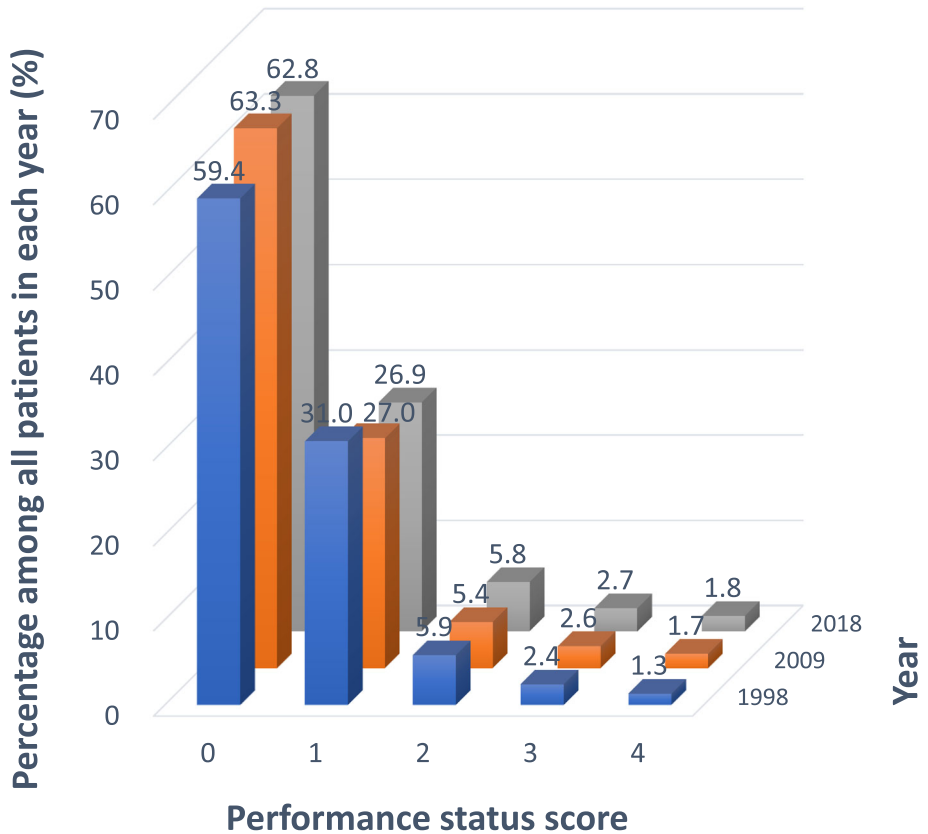

Fig. 11 Trend in performance status: under 60 years old. The numbers in the figure indicate the percentages for each year. Data in 1998 and 2018 are for all dialysis patients, while the data in 2009 is only for patients who were receiving hemodialysis at a facility 3 times/week. Data were obtained from the patient survey

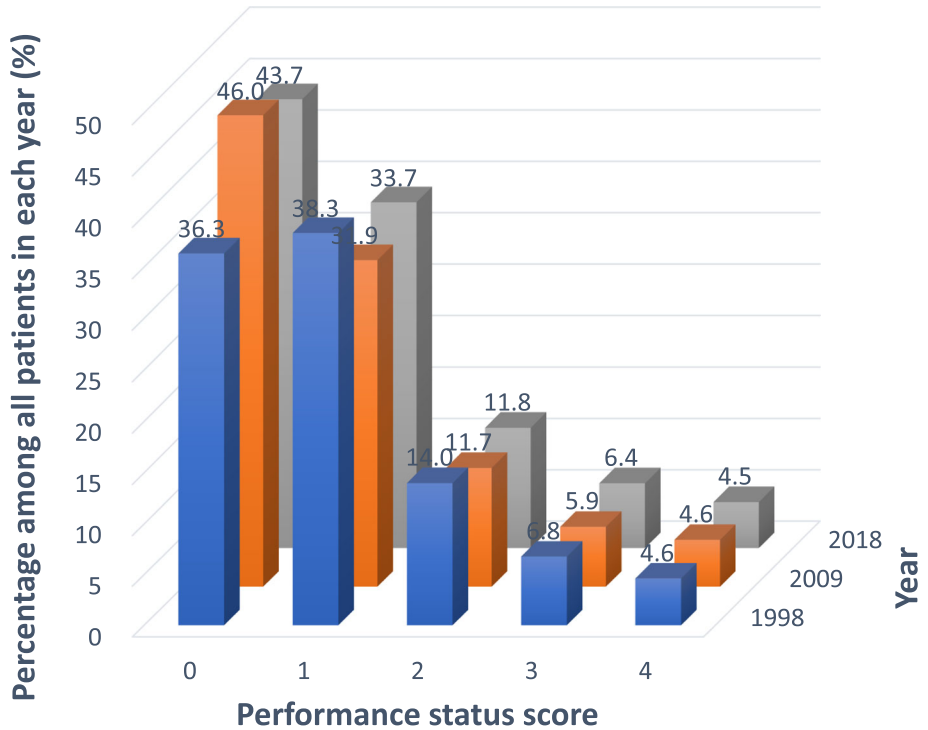

Fig. 12 Trend in performance status: 60–74 years old. The numbers in the figure indicate the percentages for each year. The data in 1998 and 2018 are for all dialysis patients, while the data in 2009 is only for those patients who were receiving hemodialysis at a facility 3 times/week. Data were obtained from the patient survey

Fig. 13 Trend in performance status: 75 years or older. The numbers in the figure indicate the percentages for each year. The data in 1998 and 2018 are for all dialysis patients, while the data in 2009 is only for those patients who were receiving hemodialysis at a facility 3 times/week. Data were obtained from the patient survey

dialysis patients. The dementia prevalence in the dialysis patients overall was 10.8% (1.8% in the less than 65 years age group, 6.8% in the 65–74 years age group, and 22.7% in the 75 years or older age group). An analysis of the patients' PS revealed that the percentage of patients with low activity levels (high PS scores) tended to be relatively high in the less than 15-year-old and 60 years or older age groups. An analysis of the exercise habits revealed that the percentage of patients selecting the choice of "Not at all or hardly" was the highest (60–80%) in each age group.

Abbreviations

HDS-R: Hasegawa dementia rating scale-revised; ICD10: 10th version of the International Classification of Diseases, Injuries, and Causes of Death; JRDR: JSDT Renal Data Registry; JSDT: Japanese Society for Dialysis Therapy; MMSE: Mini Mental State Examination; PS: Performance status; S.D.: Standard deviation; UMIN: University hospital Medical Information Network

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s41100-021-00357-5.

Additional file 1: Supplementary Table 1. Dementia prevalence sorted according to age and sex.

Additional file 2: Supplementary Table 2. Dementia prevalence sorted according to age and diabetic status.

Additional file 3: Supplementary Table 3. Dementia prevalence sorted according to age and dialysis vintage.

Additional file 4: Supplementary Table 4. Performance status and age.

Additional file 5: Supplementary Table 5. Exercise habits and age.

Additional file 6: Supplementary Table 6. Exercise habits, age and dialysis vintage.

Additional file 7: Supplementary Table 7. Trends in dementia prevalence among hemodialysis patients treated three times a week.

Additional file 8: Supplementary Table 8. Trends in performance status.Additional file 8 of Annual dialysis data report 2018, JSDT Renal Data Registry; dementia, performance status and exercise habits

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Consortia

on behalf of the Japanese Society for Dialysis Therapy Renal Data Registry Committee

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Authors' contributions

KN, IM, MT, and SN finalized the results of the survey and prepared this manuscript. SN, NH, and AW designed the survey sheets and made a special program operating within an MS Excel worksheet for the convenience of the self-assessments of dialysis quality made by each dialysis facility. T. Hase, T. Hama, JH, NJ, KM, SG, and MA 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. The authors read and approved the final manuscript.

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Availability of data and materials

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.
Anyone wanting to use the data and materials from the current manuscript with modifications or re-calculations, etc., must include the following sentence in 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."

Declarations

Ethics approval and consent to participate

The JRDR was approved by the ethics committee of the JSDT (approval no. 1) and was registered in the "University hospital Medical Information Network (UMIN) Clinical Trials Registry" under the clinical trial ID of UMIN000018641 on August 8, 2015: (Accessed June 2, 2020).
The aims of the JSDT Renal Data Registry (JRDR) were well explained to the participating dialysis patients at the dialysis facilities.
Documented approval forms from the patients were not required because all the data had already been collected, and there were no new interventions.
The original data was totally anonymized to avoid any risk of compromising the privacy of the dialysis facilities and the patients.
The data presented in the current manuscript does not contain any images, videos, or voice recording that could be used to identify an individual.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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References

1. Nakai S. The history of Japanese Society for Dialysis Therapy Registry. J Jpn Soc Dial Ther. 2010;43(2):119–52. (in Japanese). https://doi.org/10.4009/jsdt.43.119.
2. Masakane I, Nakai S. Recent trends of chronic dialysis in Japan from the viewpoint of the JSDT Renal Data Registry. J Jpn Soc Dial Ther. 2016;49(3):211–8. (in Japanese). https://doi.org/10.4009/jsdt.49.211.
3. Nitta K, Masakane I, Hanafusa N, Goto S, Abe M, Nakai S, et al. Annual dialysis data report 2018, JSDT Renal Data Registry. J Jap Soc Dial Ther. 2019;52(12):679–754. (in Japanese). https://doi.org/10.4009/jsdt.52.679.
4. National Cancer Institute, National Institutes of Health. Common toxicity criteria, version2.0 Publish Date April 30, 1999. http://ctep.cancer.gov/protocolDevelopment/electronic_applications/docs/ctcv20_4-30-992.pdf. (April 2020).
5. Nitta K, Goto S, Masakane I, Hanafusa N, Taniguchi M, Hasegawa T, et al. Annual dialysis data report for 2018, JSDT Renal Data Registry: survey methods, facility data, incidence, prevalence, and mortality. Ren Replace Ther. 2020;6(1):41. https://doi.org/10.1186/s41100-020-00286-9.
6. Nakai S, Masakane I, Akiba T, Shigematsu T, Yamagata K, Watanabe Y, et al. Overview of regular dialysis treatment in Japan as of 31 December 2006. Ther Apher Dial. 2008;12(6):428–56. https://doi.org/10.1111/j.1744-9987.2008.00634.x.
7. Nakai S, Masakane I, Shigematsu T, Hamano T, Yamagata K, Watanabe Y, et al. An overview of regular dialysis treatment in Japan (as of 31 December 2007). Ther Apher Dial. 2009;13(6):457–504. https://doi.org/10.1111/j.1744-9987.2009.00789.x.
8. Nakai S, Iseki K, Itami N, Ogata S, Kazama JJ, Kimata N, et al. Overview of regular dialysis treatment in Japan (as of 31 December 2009). Ther Apher Dial. 2012;16(1):11–53. https://doi.org/10.1111/j.1744-9987.2011.01050.x.
9. Nakai S, Iseki K, Itami N, Ogata S, Kazama JJ, Kimata N, et al. An overview of regular dialysis treatment in Japan (as of 31 December 2010). Ther Apher Dial. 2012;16(6):483–521. https://doi.org/10.1111/j.1744-9987.2012.01143.x.
10. World Health Organization. International Statistical Classification of Diseases and Related Health Problems. 10th Revision. Geneva: World Health Organization; 1993.
11. Japanese Society of Neurology. Dementia disease medical treatment guideline 2017. Tokyo: Igakushoin; 2017.
12. Japanese Society for Dialysis Therapy Renal Data Registry. An overview of dialysis treatment in Japan (as of Dec. 31, 1998). J Jap Soc Dial Ther. 2000;33(1):1-27.
13. Nakai S, Shinzato T, Nagura Y, Masakane I, Kitaoka T, Shinoda T, et al. An overview of regular dialysis treatment in Japan (as of December 2002). Ther Apher Dial. 2004;8(5):358–82.
14. World Health Organization and Alzheimer's disease international. Dementia: a public health priority. http://www.who.int/mental_health/publications/dementia_report_2012/en/. Accessed 7 Mar 2021.
15. Konagaya Y, Watanabe T, Konaga M. Frequency and clinical characteristics of the individuals with presenile dementia in Aichi prefecture. Clin Neurol. 2009;49(6):335–41.
16. Kopf D, Frölich L. Risk of incident Alzheimer's disease in diabetic patients: a systematic review of prospective trials. J Alzheimers Dis. 2009;16(4):677–85. https://doi.org/10.3233/JAD-2009-1011.
17. Nakai S, Wakai K, Kanda E, Kawaguchi K, Sakai K, Kitaguchi N. Is hemodialysis itself a risk factor for dementia? An analysis of nationwide registry data of patients on maintenance hemodialysis in Japan. Renal Replace Ther. 2018;4, 4(12, 1) https://doi.org/10.1186/s41100-018-0154-y.
18. Forbes D, Thiessen EJ, Blake CM, Forbes SC, Forbes S. Exercise programs for people with dementia. Cochrane Database Syst Rev. 2013;4(12):CD006489.
19. Littbrand H, Stenvall M, Rosendahl E. Applicability and effects of physical exercise on physical and cognitive functions and activities of daily living among people with dementia: a systematic review. Am J Phys Med Rehabil. 2011;90(6):495–518. https://doi.org/10.1097/PHM.0b013e318214de26.

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Renal Replacement Therapy

RESEARCH Open Access

2018 annual dialysis data report of the JSDT Renal Data Registry: patients with hepatitis

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Abstract

According to the annual survey of the Japanese Society for Dialysis Therapy Renal Data Registry (JRDR) conducted at the end of 2018, a total of 339,841 patients were receiving dialysis (hereinafter, dialysis patients) in Japan. This survey included an investigation of individual test results for hepatitis B surface antigen (HBsAg), hepatitis C virus (HCV) antibody (HCV-Ab), HCV-RNA, and serum alanine aminotransferase (ALT) (glutamic pyruvic transaminase [GPT]). The survey revealed that among dialysis patients in Japan, the prevalence of HBsAg positivity was 1.38% and the prevalence of HCV-Ab positivity was 4.7% at the end of 2018, both of which were markedly lower than the corresponding rates documented in 2007 (9.8% and 4.7%, respectively). The proportion of HCV-RNA-positive patients among all HCV-Ab-positive patients was 37.5%, which was also markedly lower than the percentage recorded in 2007 (64.0%). The prevalence of HBsAg positivity tended to increase as the dialysis vintage increased. The prevalence of HCV-Ab positivity was also not correlated with the dialysis vintage during the first 30 years of dialysis; however, it tended to increase as the dialysis vintage increased beyond the 30th year.

Trial registration: University hospital Medical Information Network (UMIN) Clinical Trials Registry, UMIN000018641. The JRDR was approved by the ethics committee of the JSDT (approval number 1-3) and was registered on August 8, 2015 (accessed June 2, 2020).

Keywords: Dialysis, Registry, Hepatitis, Prevalence

Introduction

Since 1968, the Japanese Society for Dialysis Therapy (JSDT) has conducted a survey of the status of chronic dialysis treatment in Japan at the end of every year. This survey, known as the JSDT Renal Data Registry (JRDR), covers nearly all dialysis facilities throughout the country [1, 2]. Although these facilities participate in the survey voluntarily, the response rate is nearly 100%; consequently, this survey accurately represents the current status of regular dialysis in Japan. The 2018 JRDR survey contained several topics, such as the kinetics of chronic dialysis patients and dialysis facilities as of the end of 2018, water treatment and hemodiafiltration, peritoneal dialysis, treatments for diabetes, mental and physical conditions, and the present status of viral hepatitis. The present review paper is an English translation of the results, which were reported in Japanese, regarding the

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seroprevalences of hepatitis virus markers among dialysis patients obtained from the JRDR survey conducted at the end of 2018 and published in the *Journal of the Japanese Society for Dialysis Therapy* [3].

Materials and methods

JRDR consists of two surveys: a facility survey and a patient survey. The facility survey investigated details of the facility, such as the number of patients treated and the number of beds, while the patient survey investigated the patient backgrounds, such as the age and treatment method of individual patients treated at the facility. Spreadsheets created using spreadsheet software for personal computers were used for the surveys. Each patient was allocated one line of response space on the patient survey spreadsheet. Individual patient information was added to the spreadsheet by facility staff, rather than being answered directly by the individual patient.

The details of the survey of dialysis patients conducted in 2018 are available in a report describing the basic data of 2018 survey [4]. The survey included questions designed to investigate hepatitis-related items. The hepatitis B surface antigen (HBsAg), hepatitis C virus (HCV) antibody (HCV-Ab), and HCV-RNA statuses were investigated using the options shown in Table 1. These items were surveyed for all the patients included in this study. Information on the basic survey items was collected in the patient surveys from 327,336 patients. Among the patients whose information was available, 269,898 patients (82.5%) provided information on their HBsAg status, 269,667 patients (82.1%) provided information on their HCV-Ab status, and 91,334 patients (27.9%) provided information on their HCV-RNA status. Valid information regarding a question on the serum alanine aminotransferase (ALT) level was collected from 281,331 patients (85.9%).

The prevalence of positivity for each of the indicators was calculated using the equation shown below.

$$\text{Prevalence of positivity}(\%) = \text{Number of patients with a positive test result} \div \left[\text{number of patients with a positive test result} + \text{number of patients with a negative test result}\right] \times 100$$

Table 1 Survey items and options used for hepatitis survey

HBs antigen	HCV antibody	HCV-RNA
A. HBs antigen-negative	A. HCV antibody-negative	A. HCV-RNA-negative
B. HBs antigen-positive	B. HCV antibody-positive	B. HCV-RNA-positive
Z. HBs antigen-unknown	Z. HCV antibody-unknown	Z. HCV-RNA-unknown

The prevalences of HBsAg positivity and HCV-Ab positivity were calculated for all the patients whose information for each item was valid.

In the trend analyses of these prevalences, exponential function regression was performed by plotting the prevalence of positivity among all dialysis patients recorded during each survey year along the *y*-axis and the year along the *x*-axis. The regression equation was determined using the least square method. JMP ver.15.2.0 (SAS Institute Inc.) was used as the analysis software.

Results

Trend in the prevalence of HBsAg positivity

Figure 1 graphically represents the changes over time in the prevalence of HBsAg positivity among all dialysis patients during the period from 1999 to 2018 [5–9] (Supplementary Table 1). The prevalence of HBsAg positivity remained almost unchanged at about 2% from 1999 to 2007. During the interim period of 11 years between 2007 and the current survey conducted in 2018, the prevalence of HBsAg positivity decreased markedly to 1.38%.

Figure 2 shows the results of an exponential function regression analysis, with the prevalence of positivity recorded at 5 time-points during the 1999-2007 period plotted along the *y*-axis and the year plotted along the *x*-axis. The prevalence of positivity in 2018 was 1.38%, which was considerably lower than the rate predicted by the regression formula.

Dialysis vintage and the prevalence of HBsAg positivity

Figure 3 shows the relationship between the dialysis vintage and the prevalence of HBsAg positivity in the current survey (Supplementary Table 2). The prevalence of HBsAg positivity was lowest (1.18%) in the group of patients with a dialysis vintage of less than 2 years. The prevalence of positivity increased steadily as the dialysis vintage increased.

Age and the prevalence of HBsAg positivity

Table 2 shows the relationship between the patients' age and the prevalence of HBsAg positivity in the current survey. The prevalence of HBsAg positivity was highest between the ages of 60 and 74.

Treatment method and the prevalence of HBsAg positivity

Table 3 shows the relationship between the patients' treatment methods and the prevalence of HBsAg positivity in the current survey. The prevalence of HBsAg positivity was highest among hemofiltration patients (10.00%), followed by blood adsorption dialysis patients (2.91%). The third highest prevalence of HBsAg positivity was among hemodialysis patients (1.48%). The prevalence of HBsAg positivity among peritoneal dialysis patients

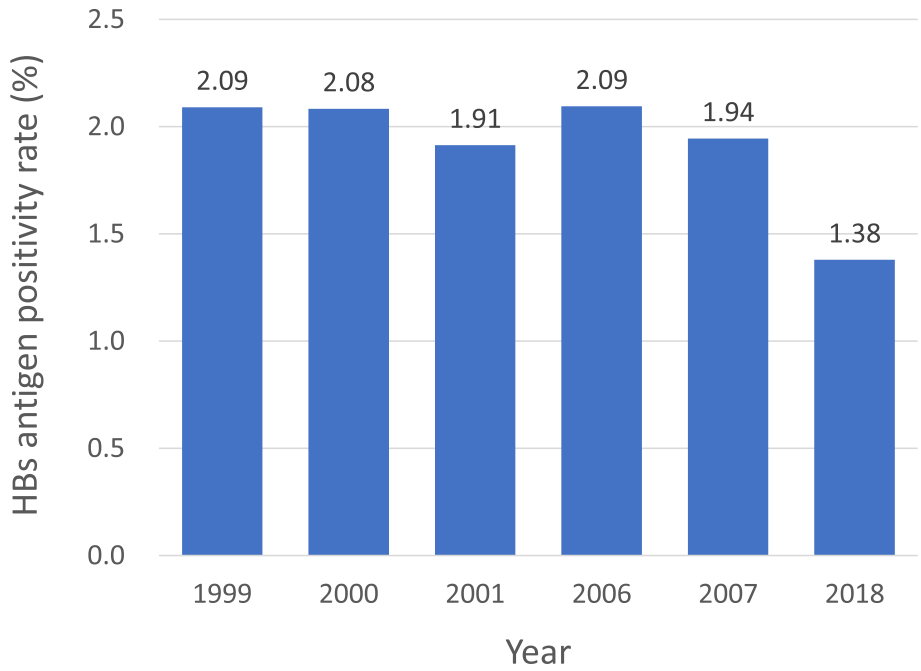

Fig. 1 Trend in the prevalence of HBs antigen positivity from 1999 to 2018 [5–9]. The data were obtained from the patient survey. HBsAg, hepatitis B surface antigen

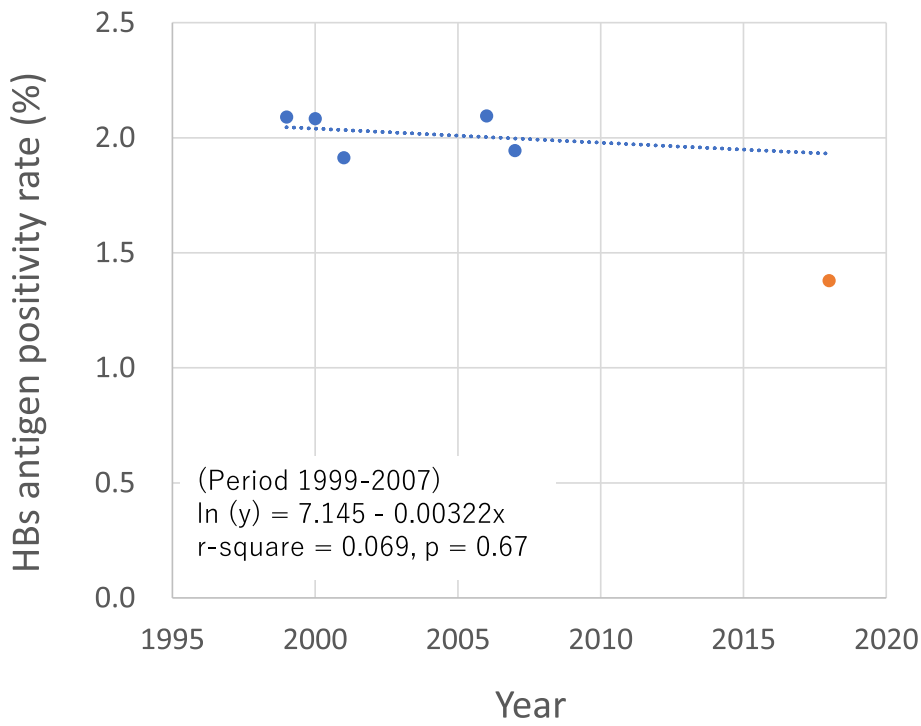

Fig. 2 Trend in the prevalence of HBs antigen positivity (results of a regression analysis) [5–9]. The data were obtained from the patient survey. HBsAg, hepatitis B surface antigen

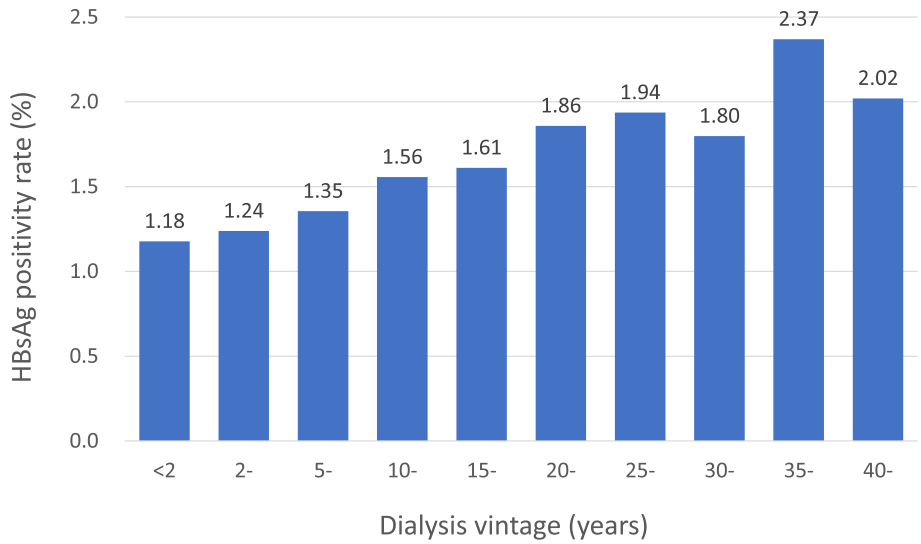

Fig. 3 Prevalence of HBs antigen positivity according to dialysis vintage as of the end of 2018. The data were obtained from the patient survey. HBsAg, hepatitis B surface antigen

(1.43%) was slightly lower than that among hemodialysis patients. The prevalence of HBsAg positivity among hemodiafiltration patients (1.20%) was lower than that among hemodialysis patients. The prevalence of HBsAg positivity among home hemodialysis patients (0.91%) was the lowest, compared with those among patients undergoing the five other types of dialysis treatments.

Trend in the prevalence of HCV-Ab positivity

Under this survey program, HCV-Ab seroprevalence was first investigated in 1999. Thereafter, it was investigated every year from 1999 to 2003; HCV-Ab seroprevalence was not examined in 2004 and 2005, but it was once again included in the survey in 2006 and 2007 [1]. After 2007, the investigation was discontinued for 11 years, until it was resumed in the current survey. Figure 4 shows the changes in the prevalence of HCV-Ab positivity during the 8 years for which data is available (1999 through 2003, 2006, 2007, and 2018) [5–11] (Supplementary Table 3).

The prevalence of HCV-Ab positivity tended to decrease gradually from 1999 to 2007. In 2018, it was 4.7%, which was markedly lower than the rate recorded in

Table 2 The prevalence of HBs antigen-positive patients sorted by their age, at the end of 2018

Age (years old)	HBs antigen-negative	HBs antigen-positive	Subtotal	Unspecified	No data available	Total	HBs antigen positivity prevalence (%)
< 15	47	0	47	11	30	88	0.00
15 ≤, < 30	656	1	657	27	161	845	0.15
30 ≤, < 45	9976	61	10,037	347	1761	12,145	0.61
45 ≤, < 60	47,936	639	48,575	1768	8353	58,696	1.32
60 ≤, < 75	113,627	1975	115,602	3984	20,249	139,835	1.71
75 ≤, < 90	87,944	1003	88,947	3188	16,093	108,228	1.13
90 ≤	5990	43	6033	251	1215	7499	0.71
Subtotal	266,176	3722	269,898	9576	47,862	327,336	1.38
Unspecified	0	0	0	0	0	0	
No data available	0	0	0	0	0	0	
Total	266,176	3722	269,898	9576	47,862	327,336	1.38
Mean	69	68	69	69	69	69	
S.D.[a]	12	11	12	13	13	13	

The data were obtained from the patient survey
[a]Standard deviation
HBs hepatitis B surface

Table 3 The prevalence of HBs antigen-positive patients sorted by their treatment method, at the end of 2018

Treatment method	HBs: hepatitis B surface	HBs antigen-positive	Subtotal	Unspecified	No data available	Total	HBs antigen positivity prevalence (%)
Hemodialysis	158,700	2382	161,082	5,127	28,270	194,479	1.48
Hemodiafiltration	99,864	1213	101,077	4,023	16,534	121,634	1.20
Hemofiltration	9	1	10	0	2	12	10.00
Blood adsorption dialysis	1202	36	1238	37	159	1434	2.91
Home hemodialysis	544	5	549	15	144	708	0.91
Peritoneal dialysis	5857	85	5942	374	2753	9069	1.43
Subtotal	266,176	3722	269,898	9576	47,862	327,336	1.38
Unspecified/no data available	0	0	0	0	0	0	
Total	266,176	3722	269,898	9576	47,862	327,336	1.38

The data were obtained from the patient survey
HBs hepatitis B surface

2007 (9.8%). Figure 5 illustrates the results of an exponential function regression analysis, with the prevalence of HCV-Ab positivity recorded at 7 time-points during the 1999–2007 period plotted along the *y*-axis and the year plotted along the *x*-axis. The prevalence of HCV-Ab positivity (4.7%) in 2018 was approximately equal to the prevalence predicted by the regression formula.

Dialysis vintage and the prevalence of HCV-Ab positivity

Figure 6 graphically represents the relationship between the dialysis vintage and the prevalence of HCV-Ab positivity (Supplementary Table 4). Until a dialysis vintage of 25 years, the prevalence of HCV-Ab positivity was almost constant at 4.0–4.7%. However, at dialysis vintages of more than 25 years, the prevalence of HCV-Ab positivity increased linearly as the dialysis vintage increased.

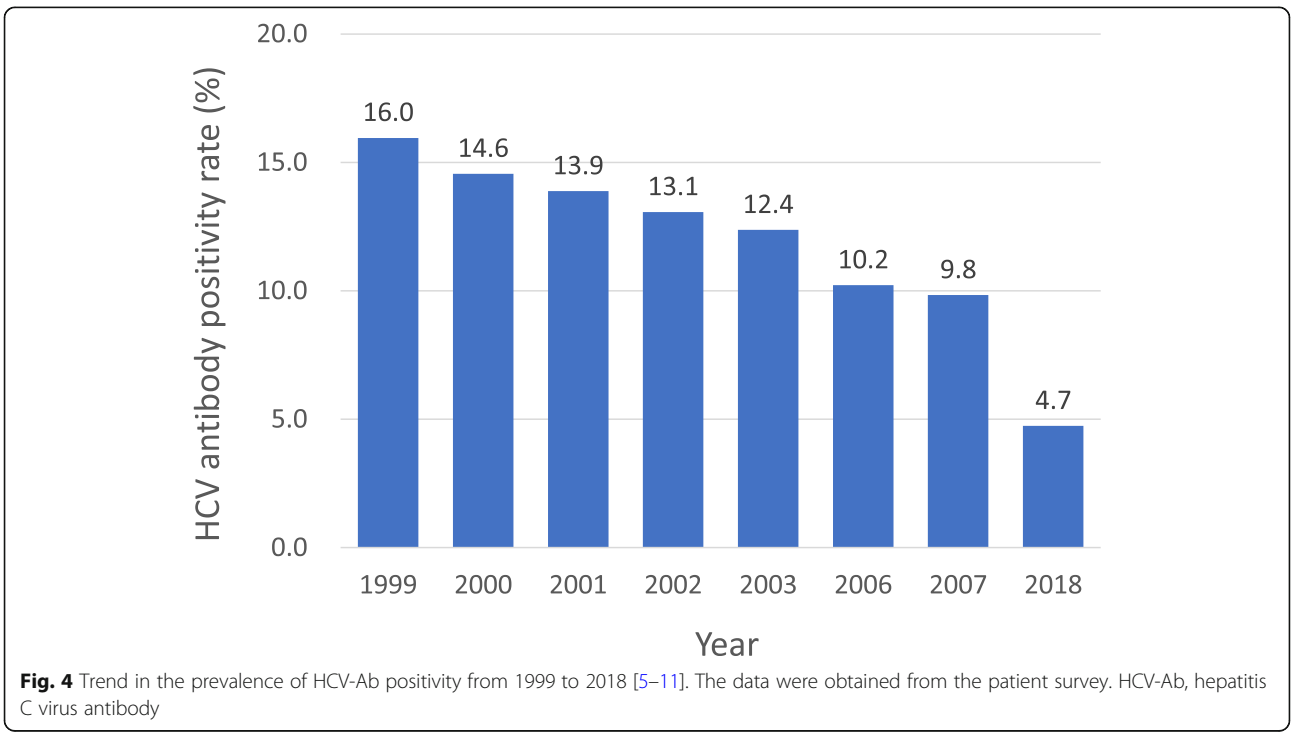

Fig. 4 Trend in the prevalence of HCV-Ab positivity from 1999 to 2018 [5–11]. The data were obtained from the patient survey. HCV-Ab, hepatitis C virus antibody

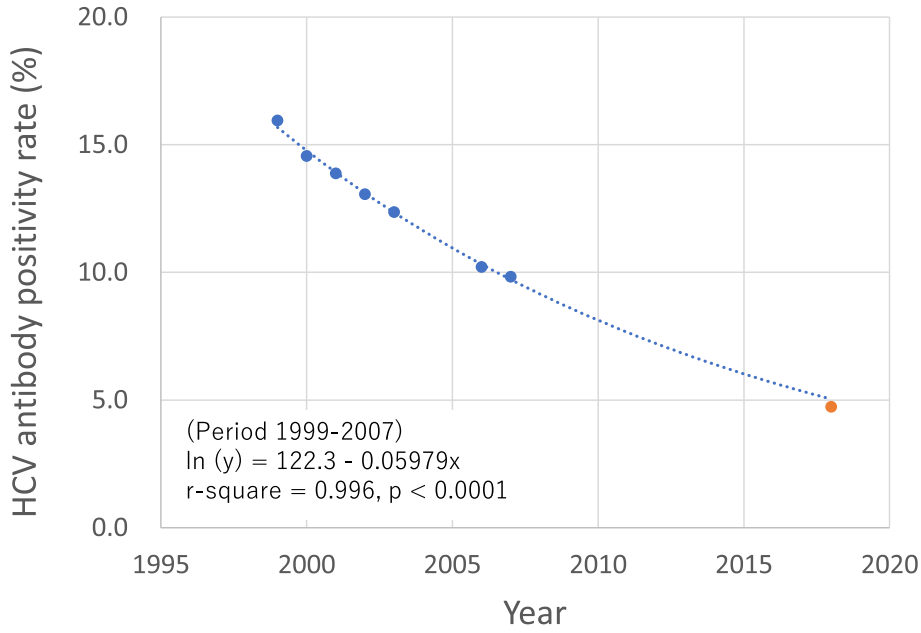

Fig. 5 Trend in the prevalence of HCV-Ab positivity (results of a regression analysis) [5–11]. HCV-Ab, hepatitis C virus antibody

Age and the prevalence of HCV-Ab positivity

Table 4 shows the relationship between the patients' age and the prevalence of HCV-Ab positivity in the current survey. Similar to the prevalence of HBsAg positivity, in patients between the ages of 60 and 74, the prevalence of HCV-Ab positivity was highest.

Treatment method and the prevalence of HCV-Ab positivity

Table 5 shows the relationship between the patients' treatment methods and the prevalence of HCV-Ab positivity in the current survey. The prevalence of HCV-Ab positivity was highest among blood adsorption dialysis

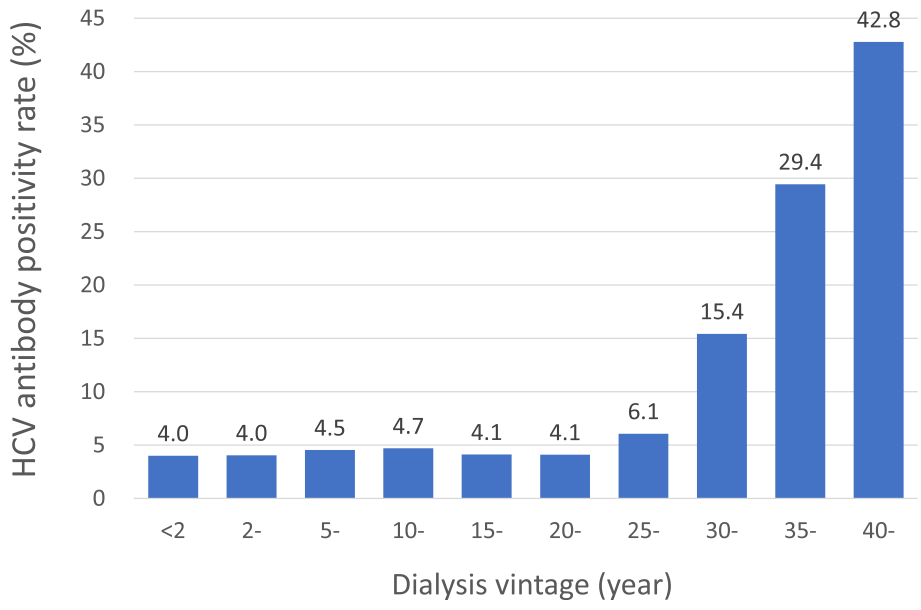

Fig. 6 Prevalence of HCV-Ab positivity according to dialysis vintage as of the end of 2018. The data were obtained from the patient survey. HCV-Ab, hepatitis C virus antibody

Table 4 The prevalence of HCV antibody-positive patients sorted by their age, at the end of 2018

Age (years old)	HCV antibody-negative	HCV antibody-positive	Subtotal	Unspecified	No data available	Total	HCV antibody positivity rate (%)
< 15	47	0	47	11	30	88	0.00
15 ≤, < 30	655	5	660	24	161	845	0.76
30 ≤, < 45	9856	139	9995	358	1792	12,145	1.39
45 ≤, < 60	46,430	1954	48,384	1777	8535	58,696	4.04
60 ≤, < 75	108,983	6145	115,128	4079	20,628	139,835	5.34
75 ≤, < 90	84,163	4275	88,438	3305	16,485	108,228	4.83
90 ≤	5799	216	6015	244	1240	7499	3.59
Subtotal	255,933	12,734	268,667	9798	48,871	327,336	4.74
Unspecified	0	0	0	0	0	0	
No data available	0	0	0	0	0	0	
Total	255,933	12,734	268,667	9798	48,871	327,336	4.74
Mean	69	70	69	69	69	69	
S.D.[a]	13	11	12	13	13	13	

The data were obtained from the patient survey
[a]Standard deviation
HCV hepatitis C virus

patients (18.04%). The second highest prevalence of HCV-Ab positivity was among hemodiafiltration patients (4.92%). The prevalence of HCV-Ab positivity among hemodialysis patients (4.62%) was slightly lower than that among hemodiafiltration patients. The prevalence of HCV-Ab positivity among patients undergoing peritoneal dialysis (2.45%) was much lower than that among patients undergoing hemodialysis. The prevalence of HCV-Ab positivity among home hemodialysis patients (1.84%) was even lower than that among peritoneal dialysis patients. The prevalence of HCV-Ab positivity among hemofiltration patients was 0.0%. Since the

Table 5 The prevalence of HCV antibody-positive patients sorted by their treatment method, at the end of 2018

Treatment method	HCV antibody-negative	HCV antibody-positive	Subtotal	Unspecified	No data available	Total	HCV antibody positivity rate (%)
Hemodialysis	152,905	7413	160,318	5205	28,956	194,479	4.62
Hemodiafiltration	95,677	4946	100,623	4147	16,864	121,634	4.92
Hemofiltration	8	0	8	2	2	12	0.00
Blood adsorption dialysis	995	219	1214	40	180	1434	18.04
Home hemodialysis	533	10	543	20	145	708	1.84
Peritoneal dialysis	5815	146	5961	384	2724	9069	2.45
Subtotal	255,933	12,734	268,667	9798	48,871	327,336	4.74
Unspecified/no data available	0	0	0	0	0	0	
Total	255,933	12,734	268,667	9798	48,871	327,336	4.74

The data were obtained from the patient survey
HCV hepatitis C virus

number of hemofiltration patients was very small (only 12), the prevalence of HCV-Ab positivity observed in this survey should be interpreted with caution.

HCV-Ab and HCV-RNA

The HCV-RNA test is a test that measures the presence/absence of hepatitis C virus antigen. Figure 7 shows the results of the distribution of HCV-Ab and HCV-RNA among the 90,023 patients who underwent both measurements in the current survey (Supplementary Table 5). The results revealed that 92.6% of the patients tested negative for both HCV-Ab and HCV-RNA, while 2.7% tested positive for both.

In the 8-year period from 1999 to 2018, both HCV-Ab and HCV-RNA were measured. Figure 8 shows the trend in the prevalence of HCV-RNA positivity among HCV-Ab-positive patients in each of those 8 years [5–11] (Supplementary Table 3). The rate rose steadily each year until 2003 and then began to decrease from 2006.

ALT (GPT)

Figure 9 shows the data regarding the serum ALT level in HBsAg-positive and HBsAg-negative patients (Supplementary Table 6), while Fig. 10 shows the data regarding the serum ALT level in HCV-Ab-positive and HCV-Ab-negative patients (Supplementary Table 7). Figure 11 shows the data regarding the serum ALT level in HCV-RNA-positive and HCV-RNA-negative patients in the HCV-Ab-positive group (Supplementary Table 8).

The serum ALT level was less than 30 IU/L in most of the above groups of patients.

Discussion

Trend in the prevalence of HBsAg positivity

Within the framework of this survey program of our society, HBsAg determination was first performed in 1971. In that investigation, HBsAg was called "Australia antigen (Au antigen)." This survey represented the first investigation of the epidemiological background of individual patients within the framework of this survey program [12]. According to the report on that survey, the total number of patients undergoing maintenance hemodialysis in Japan was 1994 as of the end of 1971. Of these patients, 1826 were undergoing hemodialysis using either the Kiil-type or Kolf-type dialyzer. The patients, both males and females, were predominantly from the age group of 26–30 years. Information on Au antigen (HBsAg) collected from 1055 of these patients revealed 103 positive cases and 952 negative cases, corresponding to a prevalence of HBsAg positivity of 9.76% [12] (prevalence of Au antigen positivity = number of Au antigen-positive patients ÷ [number of Au antigen-positive patients + number of Au antigen-negative patients]). After the investigation in 1971, the next investigation of HBsAg was conducted 28 years later, in 1999 [5]. The prevalence of HBsAg positivity in 1999 was 2.09%, which was much lower than the rate of 9.76% recorded in 1971.

From 1999 to 2007, the prevalence of HBsAg positivity remained almost unchanged at about 2% (Fig. 1). In the

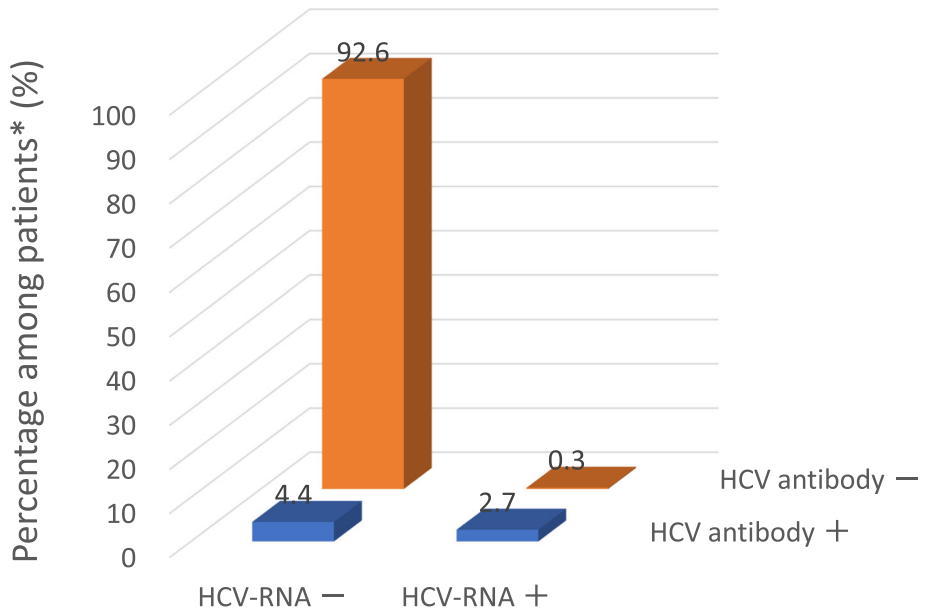

Fig. 7 Prevalence according to HCV-Ab and HCV-RNA statuses as of the end of 2018. The data were obtained from the patient survey. The percentage shows the value among all the patients for whom information on HCV-RNA and HCV-Ab statuses were available. HCV-Ab hepatitis C virus antibody; HCV-RNA hepatitis C virus ribonucleic acid

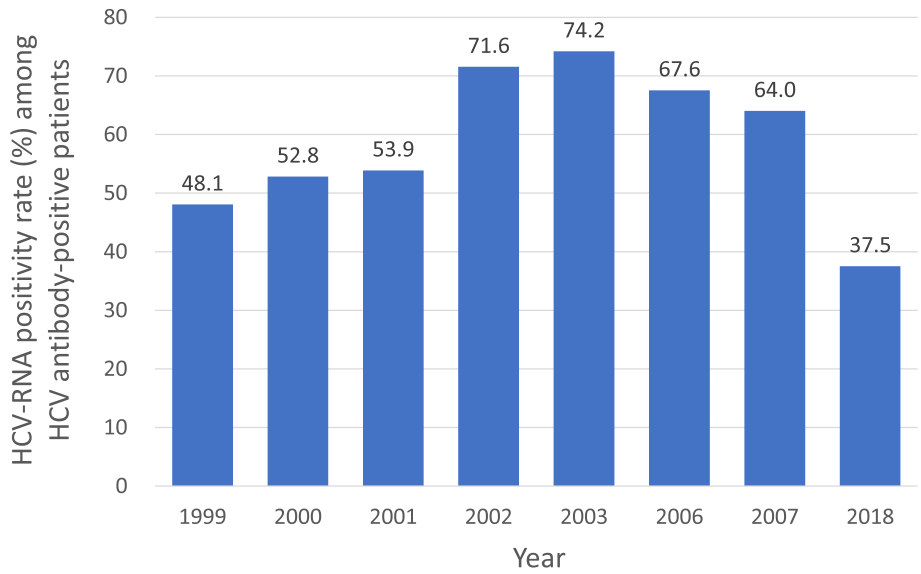

Fig. 8 Trend in the prevalence of HCV-RNA positivity among HCV-Ab-positive patients between 1999 and 2018 [5–11]. HCV-Ab, hepatitis C virus antibody

current survey conducted in 2018, which was 11 years after the last investigation, the prevalence of HBsAg positivity was 1.38%; this prevalence was markedly lower than the last recorded data in 2007. Exponential function regression was performed by plotting the prevalence of HBsAg positivity among all the dialysis patients at 5 time-points during the 1999–2007 period along the *y*-axis and the year along the *x*-axis, and the prevalence of HBsAg positivity (1.38%) in 2018 was considerably lower than the rate predicted by the regression formula (Fig. 2). This result indicates that the prevalence of HBsAg positivity among dialysis patients in Japan improved in a non-continuous manner during the 11-year period from 2007 to 2018. The reason for this change remains unexplained. Regarding the general population in Japan, as of the year 2000, the prevalence of HBsAg positivity was reportedly highest (1.37%) among subjects born between 1946 and 1950 and was lower in other age groups [13]. The cohort born between 1946 and 1950 was aged 50 to 54 years old in 2000. The age of this cohort as of 2018 was 68 to 72 years, which overlaps with the 70–74 age group (which had the highest proportion of positivity among the dialysis patients in the 2018 survey). The prevalence of HBsAg positivity among dialysis patients seems to be higher than the rate in the general population, even as of 2018, although we cannot arrive at a

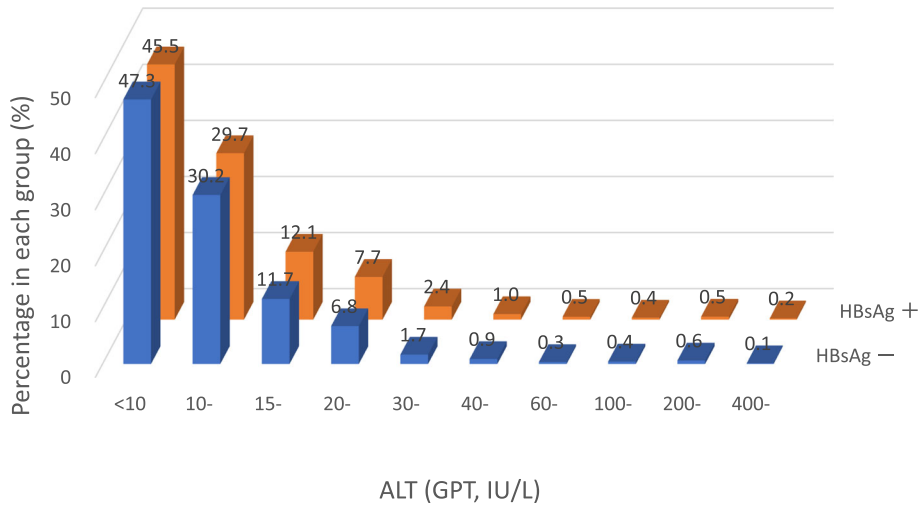

Fig. 9 Patient distribution of different ALT (GPT) values according to HBs antigen status as of the end of 2018. The data were obtained from the patient survey. HBsAg, hepatitis B surface antigen

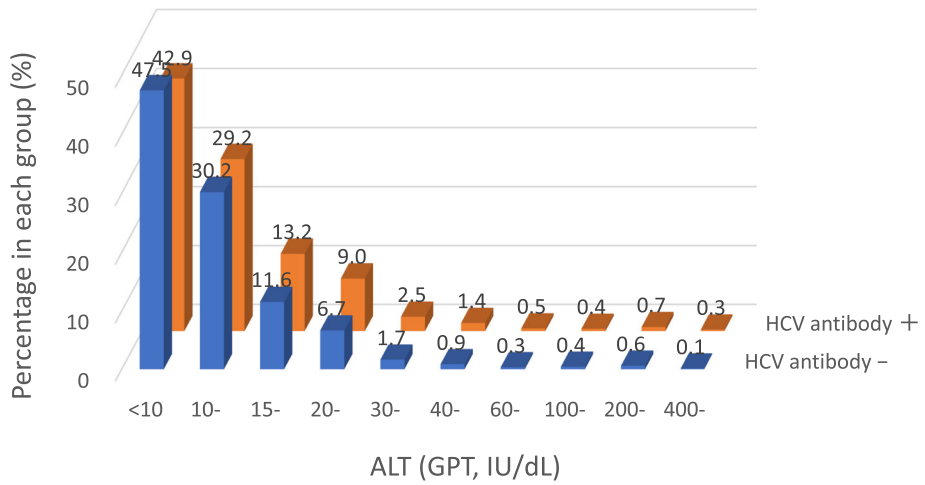

Fig. 10 Patient distribution of different ALT (GPT) values according to HCV-Ab status as of the end of 2018. The data were obtained from the patient survey. HBsAg, hepatitis B surface antigen

definitive conclusion about this tendency because of variances in the age distributions and years of investigation.

Dialysis vintage and the prevalence of HBsAg positivity

An analysis of the relationship between the dialysis vintage and the prevalence of HBsAg positivity revealed that the prevalence of HBsAg positivity was lowest in the group with a dialysis vintage of less than 2 years, with the rate increasing steadily with increases in the dialysis vintage thereafter (Fig. 3). Figure 12 graphically represents the relationship between the dialysis vintage and the prevalence of HBsAg positivity in the 2007 survey, enabling a comparison of the 2007 survey data with the data from the current survey [9] (Supplementary Table 9). Overall, the prevalence of positivity was higher in 2007 than in 2018. However, the results of the 2007 survey revealed that the prevalence of positivity increased gradually as the dialysis vintage increased, similar to the tendency observed in the 2018 survey.

The group of patients covered in the 2007 survey had started receiving maintenance dialysis in or before 2007. The group of patients with a dialysis vintage of 10 years or longer covered in the 2018 survey was initiated on maintenance dialysis beginning in or before 2008. These two groups of patients may thus be considered as constituting approximately the same cohort. A comparison of the prevalences of HBsAg positivity in the 2007 and 2018 surveys,

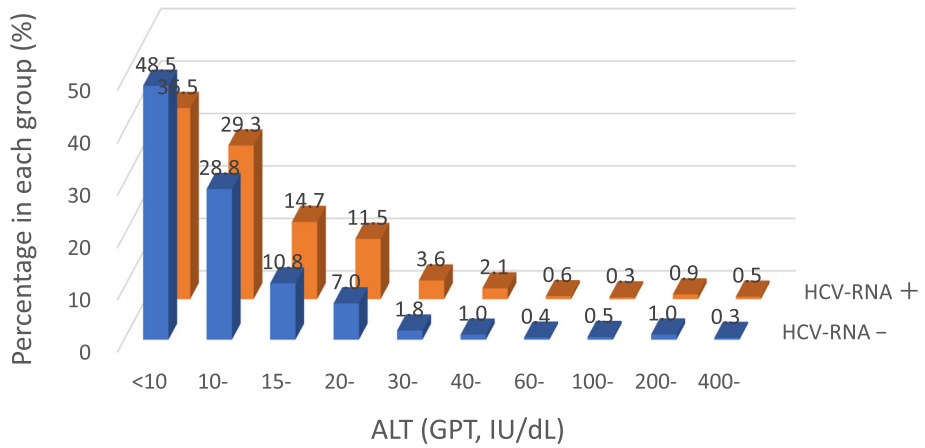

Fig. 11 Patient distribution of different ALT (GPT) values according to HCV-RNA status among HCV-Ab-positive patients as of the end of 2018. The data were obtained from the patient survey. HCV-Ab, hepatitis C virus antibody; HCV-RNA, hepatitis C virus ribonucleic acid

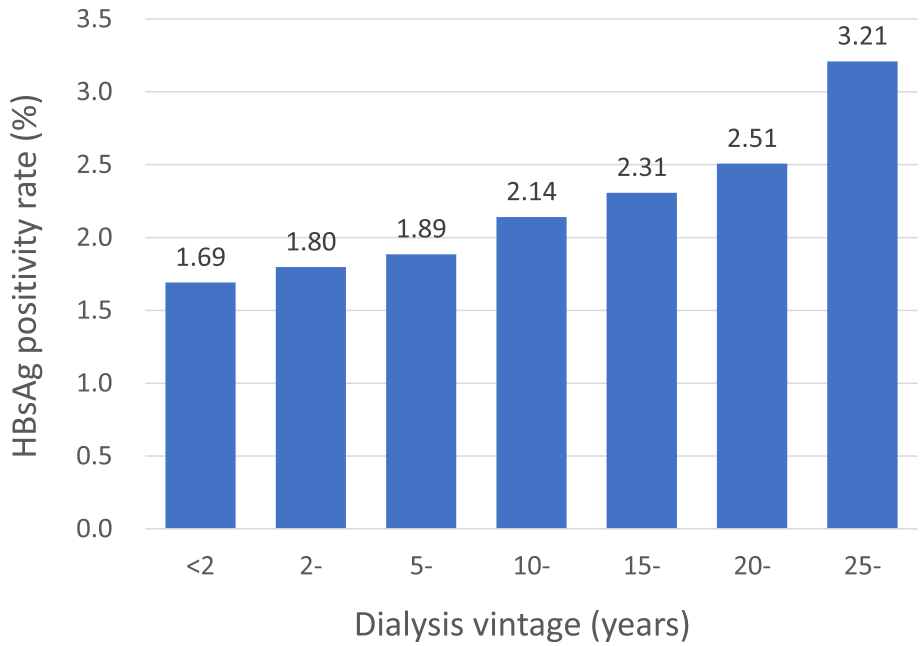

Fig. 12 Prevalence of HBs antigen-positive patients according to dialysis vintage as of the end of 2007. The data were obtained from the patient survey. HBsAg, hepatitis B surface antigen

paying close attention to the aforementioned patient cohort, revealed that the prevalence of positivity in the 2018 survey was lower than that in the 2007 survey. This trend was more marked among patients with a longer dialysis vintage. In other words, the prevalence of positivity in the group of patients with a dialysis vintage of 10–25 years in the 2018 survey accounted for 85% of the prevalence of positivity in the group of patients with a dialysis vintage of 0–15 years in the 2007 survey. These two groups of patients constitute approximately the same patient cohort. The prevalence of positivity in the group of patients with a dialysis vintage of 40 years or more in the 2018 survey accounted for about 63% of the prevalence of positivity in the group of patients with a dialysis vintage of 30 years or more in the 2007 survey. These two groups also constituted approximately the same patient cohort. These results may be interpreted as suggesting a tendency towards seroconversion (from HBsAg-positive to HBsAg-negative) or dropout because of death during the 10-year interval between the two surveys.

In the survey conducted in 2018, the group of patients with a dialysis vintage of less than 10 years (who were initiated on maintenance dialysis in or after 2009) showed a tendency towards a gradual increase in the prevalence of HBsAg positivity as the dialysis vintage increased (Fig. 3). This suggests that, even at present, a certain number of patients newly develop hepatitis B infection after the initiation of hemodialysis.

Age and the prevalence of HBsAg positivity

In patients between the ages of 65 and 74 years, the prevalence of HBsAg positivity was highest. This result may be related to the tendency of the patients between the ages of 65 and 74 years to have a longest dialysis vintage (Supplementary Table 10).

Treatment method and the prevalence of HBsAg positivity

The prevalence of HBsAg positivity was highest among hemofiltration patients. However, the number of hemofiltration patients was very small (only 12), so this value should be interpreted with caution. The prevalence of HBsAg positivity among blood adsorption dialysis patients was second highest. This result may be related to these patients having very long dialysis vintages (Supplementary Table 11). Of note, the prevalence of HBsAg positivity among hemodiafiltration patients was lower than that among hemodialysis patients, even though the dialysis vintage of the hemodiafiltration patients tended to be longer than that of the hemodialysis patients. The dialysis vintage of peritoneal dialysis patients is considerably shorter than that of hemodialysis patients. However, the prevalence of HBsAg positivity among peritoneal dialysis patients was nearly equal to that among hemodialysis patients, even though peritoneal dialysis patients do not require extracorporeal circulation.

Trend in the prevalence of HCV-Ab positivity

When an exponential function regression analysis was conducted, with the prevalence of HCV-Ab positivity recorded at 7 time-points during the 1999–2007 period plotted along the *y*-axis and the year plotted along the *x*-axis, the prevalence of HCV-Ab positivity tended to decrease steadily over time, and the reported prevalence of HCV-Ab positivity in 2018 (4.7%) was approximately equal to the rate predicted by the regression curve (Fig. 5). This finding may be interpreted as suggesting that the prevalence of HCV-Ab positivity among all dialysis patients has continued to decrease at an approximately constant pace during the past 2 decades. However, we cannot rule out the possibility that this interpretation is erroneous for the reason discussed in the next section.

Dialysis vintage and the prevalence of HCV-Ab positivity

When the prevalence of HCV-Ab positivity was analyzed according to dialysis vintage, the prevalence of positivity remained almost unchanged at 4.0–4.7% when the dialysis vintage was less than 25 years, but the prevalence of positivity increased linearly as the dialysis vintage increased after 25 years (Fig. 6). The year 1993 was 25 years before 2018. The result mentioned above suggests that the prevalence of HCV-Ab positivity did not increase with time among the patients who began receiving maintenance dialysis around or after 1993. As reference data, Fig. 13 shows the relationship between the dialysis vintage and the prevalence of HCV-Ab positivity in the previous survey performed in 2007 [9] (Supplementary Table 12). In the survey conducted in 2007, the prevalence of positivity remained almost unchanged at 7.6–7.9% among patients with a dialysis vintage of less than 15 years, but it increased linearly as the dialysis vintage increased beyond 15 years. The year 1992 was 15 years before 2007. This result also suggests that the prevalence of HCV-Ab positivity did not increase among the patients who began receiving maintenance dialysis around or after 1992. Hepatitis C virus was discovered in 1989. After the discovery of this virus, the incidence of hepatitis C associated with blood transfusion decreased sharply [14, 15]. The treatment of renal anemia using an erythropoietin preparation in dialysis patients began to be covered by the national health insurance program in Japan in 1990 and transfusion therapy for anemia in dialysis patients decreased sharply thereafter. Consequently, the decrease in the prevalence of HCV-Ab positivity after the year 1992 or 1993 could be interpreted as reflecting these improvements in the treatment of anemia in dialysis patients.

As described in the section on HBsAg, the group of patients with a dialysis vintage of 10–24 years covered by the 2018 survey can be considered being approximately equivalent to the group of patients with a dialysis vintage of 0–14 years covered by the 2007 survey. The prevalence of HCV-Ab positivity in this group was 4.1–4.7% in the 2018 survey, which was about 2/3 of the rate of 7.6–7.8% estimated in the corresponding group in the 2007 survey. In general, patients are unlikely to test negative for HCV-Ab once they have tested positive. Here, we may assume that the low prevalence of HCV-Ab positivity in the current survey can be attributed to a reduction in HCV-Ab-positive patients because of death. If this assumption is valid, the prevalence of positivity

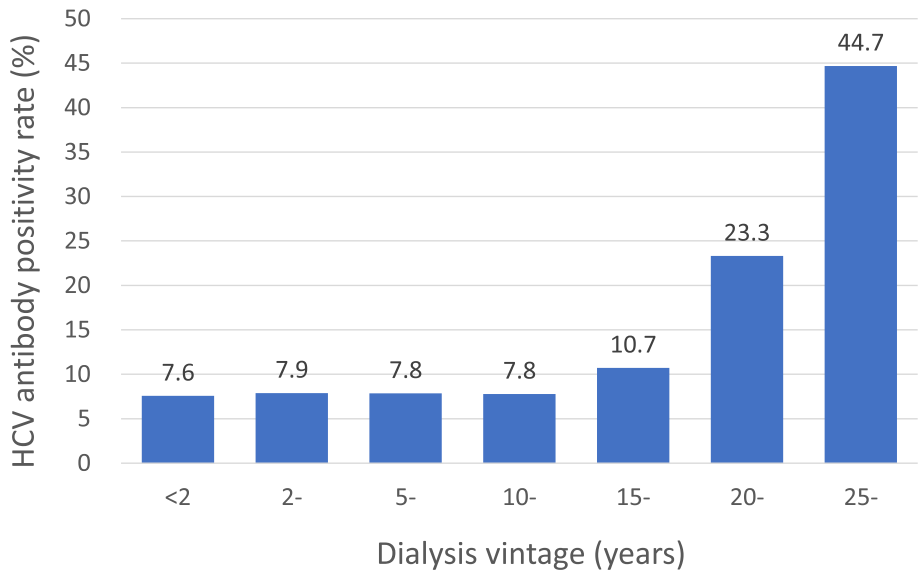

Fig. 13 Prevalence of HCV-Ab positivity among patients according to dialysis vintage as of the end of 2007. The data were obtained from the patient survey. HCV-Ab, hepatitis C virus antibody

could be considered as showing a tendency towards a gradual reduction with increasing dialysis vintage. However, the survey results did not indicate such a trend. Furthermore, the prevalence of positivity in the group of patients with a dialysis vintage of less than 10 years was also 4.0–4.5%, which was approximately equal to the rate in the patient group with a dialysis vintage of 10–24 years. We may therefore judge that the dropout of HCV-Ab-positive patients because of death was not responsible for the lower prevalence of HCV-Ab positivity in the current survey in the group of patients that was initiated on dialysis in or after 1992–1993, compared with the prevalence of positivity documented in the same group in the previous survey conducted in 2007. The reason for the lower prevalence of HCV-Ab positivity in the current survey, compared with that in the 2007 survey, remains uncertain. One potential explanation is that the methods used for HCV-Ab testing have changed during the last decade. HCV antibody testing methods can be classified into three generations (first, second, and third) depending on the region of the viral antigen used for antibody detection. Later generations of testing methods detect a wider range of antigens. The latest 3rd generation inspection methods were developed in the late 1990s, and these 3rd generation inspection methods became widespread in the 2000s. In general, the difference in detection sensitivity between the 2nd generation test method and the 3rd generation test method for HCV antibody is thought to be minimal [16]. However, the difference between the prevalence of HCV-Ab positivity in the 2007 survey and that in the 2018 survey may partly reflect the difference in detection sensitivity between 2nd generation and 3rd generation HCV antibody test methods.

As mentioned in the preceding section, the prevalence of HCV-Ab positivity among all dialysis patients included in the 2018 survey was approximately equal to the rate predicted from the changes over time for the prevalence of HCV-Ab positivity during the 1999–2007 period. If we assume that the prevalence of HCV-Ab positivity at present is, for some reason or other, equivalent to about 2/3 of the prevalence of HCV-Ab positivity recorded with the testing method available in 2007, the prevalence of positivity in 2018 as predicted based on the changes over time during the 1999–2007 period should be about 2/3 of the predicted value, i.e., equal to about 3%. In practice, however, the prevalence of positivity recorded in 2018 was 4.7%. This could be interpreted as suggesting that the magnitude of the reduction in the prevalence of HCV-Ab positivity among dialysis patients overall in the 2018 survey was not as large as the reduction predicted by the changes in the prevalence of HCV-Ab positivity during the 1999–2007 period.

Age and the prevalence of HCV-Ab positivity

Similar to the prevalence of HBsAg positivity, in patients between the ages of 65 and 74 years, the prevalence of HCV-Ab positivity was highest. This result may be related to the tendency of the patients between the ages of 65 and 74 years to have a longest dialysis vintage (Supplementary Table 10).

Treatment method and the prevalence of HCV-Ab positivity

The prevalence of HCV-Ab positivity was extremely high among patients undergoing blood adsorption dialysis. This observation is probably related to the very long dialysis vintages of these patients, since the prevalence of HCV-Ab positivity was significantly higher among patients with a dialysis vintage of over 25 years (Fig. 6, Supplementary Table 4). Of note, unlike the prevalence of HBsAg positivity, the prevalence of HCV-Ab positivity in peritoneal dialysis patients was much lower than the prevalence of HCV-Ab positivity among hemodialysis patients. The dialysis vintage of peritoneal dialysis patients is considerably shorter than that of hemodialysis patients. And as mentioned before, the prevalence of HCV-Ab positivity increased much more than that of HBsAg positivity along with the dialysis vintage. These situations may have affected the difference in the prevalences of HCV-Ab and HBsAg positivity among the patients.

HCV-Ab and HCV-RNA

An analysis of the distribution of HCV-Ab and HCV-RNA among dialysis patients revealed that 92.6% of the patients tested negative for both HCV-Ab and HCV-RNA, while 2.7% tested positive for both (Fig. 7). As reference data, Fig. 14 shows the distribution of HCV-Ab and HCV-RNA in the survey conducted in 2007 (analyzing 63,098 patients; Supplementary Table 13). In 2007, 85.6% of the patients tested negative for both HCV-Ab and HCV-RNA, while 9.0% tested positive for both. Thus, the negativity rate for both antibody and RNA was 7.0 percentage points higher in 2018 than in 2007, while the prevalence of positivity for both was 6.3 points lower in 2018 than in 2007. Thus, one can say that the prevalence of positivity for both antibody and RNA had decreased in 2018 to 1/3 or lower, compared with the rate recorded in 2007. For a long time, no treatment was available for dialysis patients with hepatitis C. In 2015, however, treatment with direct-acting antivirals (DAAs) began to be covered by the national health insurance program in Japan. At present, the treatment of hepatitis C using DAAs in dialysis patients is also covered by the national health insurance program. The clinical use of DAAs for the treatment of hepatitis C may have contributed to the sharp drop in the percentage of patients who tested positive for both HCV-Ab and

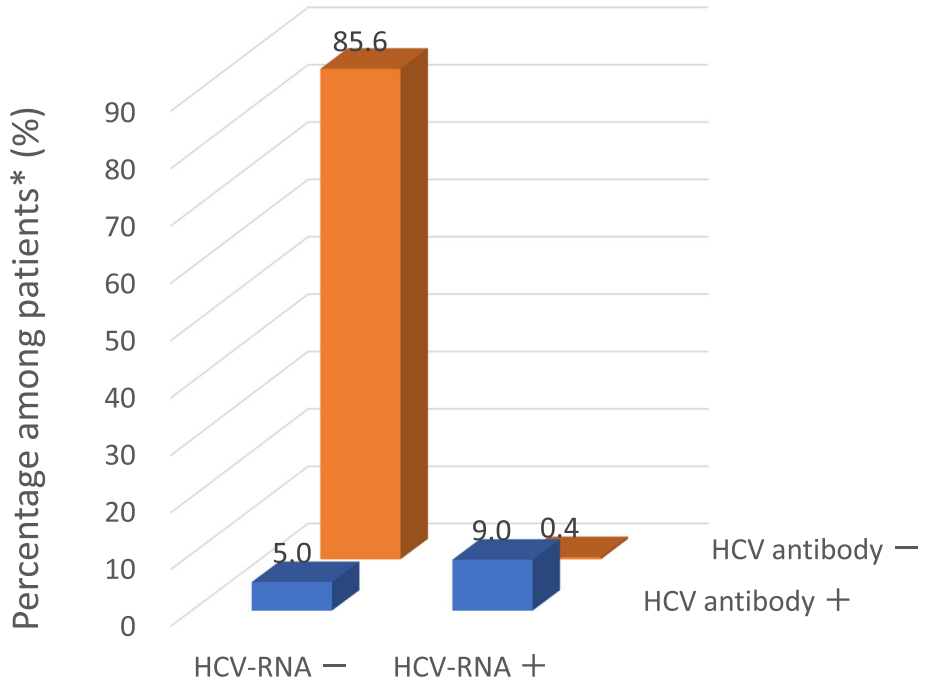

Fig. 14 Prevalence according to HCV-Ab and HCV-RNA statuses as of the end of 2007. The data were obtained from the patient survey. The percentage shows the value among all the patients for whom information on HCV-RNA and HCV-Ab statuses were available. HCV-Ab, hepatitis C virus antibody; HCV-RNA, hepatitis C virus ribonucleic acid

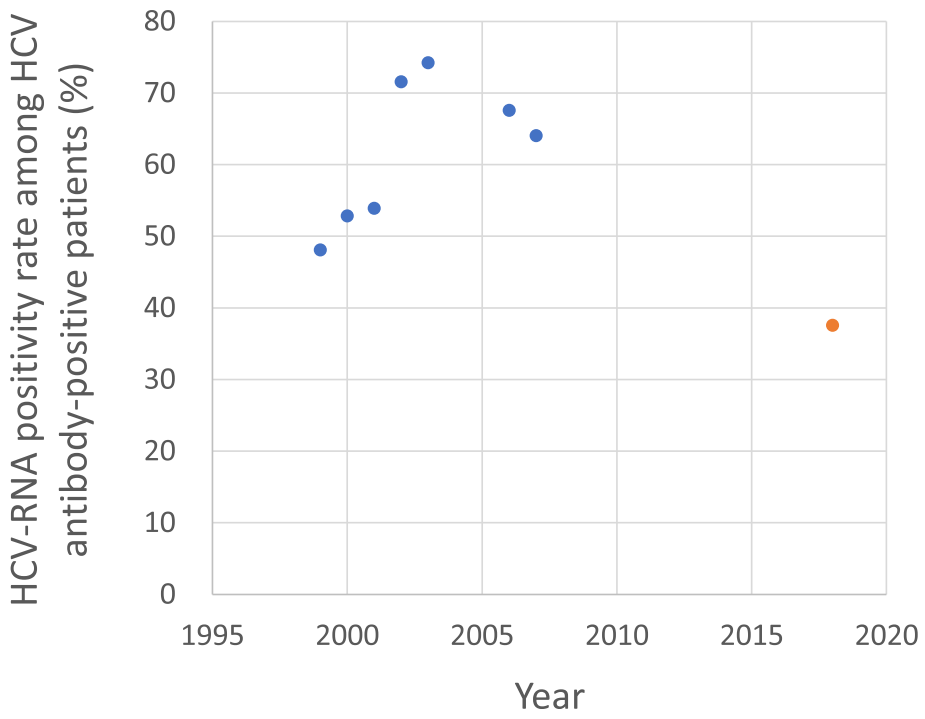

Fig. 15 Trend in the prevalences of HCV-RNA positivity among HCV-Ab-positive patients (using a proportional scale showing the history year). The data were obtained from the patient survey. HCV-Ab, hepatitis C virus antibody; HCV-RNA, hepatitis C virus ribonucleic acid

HCV-RNA during the 11-year period from 2007 to 2018. To test the validity of this hypothesis, we conducted the following analysis.

In the current survey, HCV-RNA data was available for 50.2% of the HCV-Ab-positive patients, while similar data was available for only 32.7% of the HCV-Ab-negative patients. These results suggest that HCV-RNA measurements are less likely to be conducted for HCV-Ab-negative patients. Thus, the difference in the percentage of patients who have undergone HCV-RNA testing among HCV-Ab-negative patients might have caused a bias in the prevalence of HCV-RNA positivity. In other words, if the percentage of patients undergoing HCV-RNA determination among the HCV-Ab-negative patients increased, the number of HCV-RNA-negative patients would also increase, causing a bias (reduction) in the prevalence of HCV-RNA positivity among all the patients. To avoid such a bias, we calculated the prevalence of HCV-RNA positivity among the HCV-Ab-positive patients alone in each survey year and analyzed the changes over time during the 8-year period in which the HCV-Ab and HCV-RNA statuses were determined (Fig. 8) [5–11]. The rate increased each year until 2003 but then began to decrease from 2006 onwards. Figure 15 shows a scatter diagram, with the prevalence of HCV-RNA positivity plotted along the *y*-axis and the year plotted along the *x*-axis. Because a tendency towards a reduction in the prevalence of HCV-RNA positivity began to be noted in 2006, it was difficult to judge based on this illustration alone whether the prevalence of positivity in 2018 was lower than the rate anticipated from the trend noted before 2007, i.e., whether the start of the clinical application of DAAs in 2015 caused a decrease in the number of HCV-RNA-positive patients.

ALT (GPT)

An analysis of the serum ALT level in HBsAg-positive and HBsAg-negative patients revealed that the mean serum ALT level was slightly lower in the HBsAg-negative patients (14.57 IU/L) than in the HBsAg-positive patients (15.49 IU/L); however, large differences in the distribution of patients with low and high serum ALT levels were not seen between the two groups (Fig. 9). In a similar analysis of the serum ALT level conducted among HCV-Ab-positive and HCV-Ab-negative patients, the mean serum ALT level was slightly lower in the HCV-Ab-negative patients (14.51 IU/L) than in the HCV-Ab-positive patients (16.36 IU/L), although large differences in the distribution of patients with high and low serum ALT levels were not seen between the two groups (Fig. 10). These results indicate that neither the HBsAg status nor the HCV-Ab status exerted a significant impact on the serum ALT level in dialysis patients.

When the serum ALT levels in HCV-RNA-positive and HCV-RNA-negative patients were analyzed only among HCV-Ab-positive patients, the mean level was higher in the HCV-RNA-positive patients (19.09 IU/L) than in the HCV-RNA-negative patients (16.60 IU/L), and an analysis of the patient distribution revealed a lower percentage of patients with a serum ALT level of less than 10 IU/L and a higher percentage of patients with a serum ALT level in the range of 15–59 IU/L in the HCV-RNA-positive group, compared with the HCV-RNA-negative group (Fig. 11). These findings indicate that seropositivity for HCV-RNA among the HCV-Ab-positive patients tended to be associated with hepatic impairment.

Conclusion

Among the dialysis patients in Japan, the prevalence of HBsAg positivity was 1.38% and the prevalence of HCV-Ab positivity was 4.7% as of the end of 2018. Each of these rates was markedly lower than the corresponding rate (9.8% and 4.7%, respectively) reported in the 2007 survey. The percentage of HCV-RNA-positive patients among all the HCV-Ab-positive patients was 37.5%, which was also much lower than the rate of 64.0% estimated in 2007. The prevalence of HBsAg positivity tended to be higher in patients with a longer dialysis vintage. The prevalence of HCV-Ab positivity was not correlated with the dialysis vintage when the dialysis vintage was less than 30 years, but it tended to increase as the dialysis vintage increased after 30 years.

Abbreviations

ALT: Alanine aminotransferase; Au antigen: Australia antigen; DAAs: Direct-acting antivirals; GPT: Glutamic pyruvic transaminase; HBsAg: Hepatitis B surface antigen; HCV: Hepatitis C virus; JRDR: The JSDT Renal Data Registry; JSDT: Japanese Society for Dialysis Therapy; RNA: Ribonucleic acid; UMIN: University hospital Medical Information Network

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s41100-021-00338-8.

Additional file 1: Supplementary Table 1. Trend in the prevalence of HBs-antigen-positive patients from 1999 to 2018.

Additional file 2: Supplementary Table 2. Prevalence of HBs-antigen-positive patients according to dialysis vintage as of the end of 2018.

Additional file 3: Supplementary Table 3. Trends in the prevalences of HCV-Ab positivity and HCV-RNA positivity from 1999 to 2018.

Additional file 4: Supplementary Table 4. Prevalence of HCV-Ab positivity according to dialysis vintage as of the end of 2018.

Additional file 5: Supplementary Table 5. Prevalence according to HCV-Ab and HCV-RNA statuses as of the end of 2018

Additional file 6: Supplementary Table 6. Patient-distribution of different ALT (GPT) values according to HBs-antigen status as of the end of 2018.

Additional file 7: Supplementary Table 7. Patient-distribution of different ALT (GPT) values according to HCV-Ab status as of the end of 2018.

Additional file 8: Supplementary Table 8. Patient-distribution of different ALT (GPT) values according to HCV-RNA status among HCV-Ab-positive patients as of the end of 2018.

Additional file 9: Supplementary Table 9. Prevalence of HBs-antigen-positive patients according to dialysis vintage as of the end of 2007.

Additional file 10: Supplementary Table 10. Dialysis vintage of all dialysis patients according to age as of the end of 2018.

Additional file 11: Supplementary Table 11. Dialysis vintage of all dialysis patients according to treatment method as of the end of 2018.

Additional file 12: Supplementary Table 12. Prevalence of HCV-Ab positivity according to dialysis vintage as of the end of 2007.

Additional file 13: Supplementary Table 13. Prevalence according to HCV-Ab and HCV-RNA statuses as of the end of 2007.

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Authors' contributions
KN, IM, MT, and SN finalized the results of the survey and prepared the manuscript. SN, NH, and AW designed the survey sheets and created a special program that ran within MS Excel for the convenience of the self-assessments of dialysis quality made by each dialysis facility. T Hase, T Hama, JH, NJ, KM, SG, and MA 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.

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Availability of data and materials
For anyone wishing to use the data and materials from the current manuscript without modifications, all the data and materials are freely available provided that the source of the data (JSDT) is stated.
For anyone wishing to use the data and materials from the current manuscript with modifications, including any re-calculations, etc., the data and materials may be used if the following sentence is included with their publication. "The data reported here were 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."

Declarations

Ethics approval and consent to participate
The JSDT registry was approved by the ethics committee of the JSDT (approval no. 1).
The aims of the JSDT Renal Data Registry (JRDR) were adequately explained to the participating dialysis patients at the dialysis facilities.
Written consent from the patients was not required because all the data had already been collected and no new interventions were performed.
The original data was totally anonymized to avoid any risk of compromising the privacy of the dialysis facilities and the patients.
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
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Competing interests
The authors declare that they have no competing interests.

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References
1. Nakai S. The history of Japanese Society for Dialysis Therapy Registry. J Jpn Soc Dial Ther. 2010;43(2):119–52. (in Japanese). https://doi.org/10.4009/jsdt.43.119.
2. Masakane I, Nakai S. Recent trends of chronic dialysis in Japan from the viewpoint of the JSDT Renal Data Registry. J Jpn Soc Dial Ther. 2016;49(3):211–8. (in Japanese). https://doi.org/10.4009/jsdt.49.211.
3. Nitta K, Masakane I, Hanafusa N, Goto S, Abe M, Nakai S, et al. Annual dialysis data report 2018, JSDT Renal Data Registry. J Jap Soc Dial Ther. 2019;52(12):679–754. (in Japanese). https://doi.org/10.4009/jsdt.52.679.
4. Nitta K, Goto S, Masakane I, Hanafusa N, Taniguchi M, Hasegawa T, et al. Annual dialysis data report for 2018, JSDT Renal Data Registry: survey methods, facility data, incidence, prevalence, and mortality. Ren Replace Ther. 2020;6(1):41. https://doi.org/10.1186/s41100-020-00286-9.
5. Nakai S, Shinzato T, Sanaka T, Kikuchi K, Kitaoka T, Shinoda T, et al. An overview of dialysis treatment in Japan (as of Dec. 31, 1999). J Jpn Soc Dial Ther. 2001;34(7):1121–47.
6. Nakai S, Shinzato T, Sanaka T, Kikuchi K, Kitaoka T, Shinoda T, et al. The current state of chronic dialysis treatment in Japan (as of December 31, 2000). J Jpn Soc Dial Ther. 2002;35(7):1155–84. https://doi.org/10.4009/jsdt.35.1155.
7. Nakai S, Shinzato T, Nagura Y, Masakane I, Kitaoka T, Shinoda T, et al. An overview of regular dialysis treatment in Japan (as of December 2001). Ther Apher Dial. 2004;8(1):3–32. https://doi.org/10.1111/j.1526-0968.2004.00109.x.
8. Nakai S, Masakane I, Akiba T, Shigematsu T, Yamagata K, Watanabe Y, et al. Overview of regular dialysis treatment in Japan as of 31 December 2006. Ther Apher Dial. 2008;12(6):428–56. https://doi.org/10.1111/j.1744-9987.2008.00634.x.
9. Nakai S, Masakane I, Shigematsu T, Hamano T, Yamagata K, Watanabe Y, et al. An overview of regular dialysis treatment in Japan (as of 31 December 2007). Ther Apher Dial. 2009;13(6):457–504. https://doi.org/10.1111/j.1744-9987.2009.00789.x.
10. Nakai S, Shinzato T, Nagura Y, Masakane I, Kitaoka T, Shinoda T, et al. An overview of regular dialysis treatment in Japan (as of December 2002). Ther Apher Dial. 2004;8(5):358–82.

11. Nakai S, Shinzato T, Nagura Y, Masakane I, Kitaoka T, Shinoda T, et al. An overview of regular dialysis treatment in Japan as of December 2003. Ther Apher Dial. 2005;9(6):431–58.
12. Odata M. Nationwide questionnaire report on the current status of dialysis in Japan. J Jap Soc Dial Ther. 1972;5(2):184–8 (in Japanese).
13. Akita T, Tanaka J, Satake M, Lin Y, Wada T, Kato K, et al. Meta-regression analysis of sex- and birth year-specific prevalence of HBsAg and anti-HCV among undiagnosed Japanese: Data from the first-time blood donors, periodical health checkup, and the comprehensive health checkup with lifestyle education (Ningen Dock). J Epidemiol. 2019;30(9):420–5. https://doi.org/10.2188/jea.JE20190055.
14. Choo QL, Kuo G, Weiner AJ, Overby LR, Bradley DW, Houghton M. Isolation of a cDNA clone derived from a blood-borne non-A, non-B viral hepatitis genome. Science. 1989;244(4902):359–62. https://doi.org/10.1126/science.2523562.
15. Kuo G, Choo QL, Alter HJ, Gitnick GL, Redeker AG, Purcell RH, et al. An assay for circulating antibodies to a major etiologic virus of human non-A, non-B hepatitis. Science. 1989;244(4902):362–4. https://doi.org/10.1126/science.2496467.
16. Fujino T, Enjoji M, Yatsuhashi H. Development of assays for measuring HBV- and HCV-related markers. J Anal Bio-Sci. 2013;36(5):343–51.

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