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

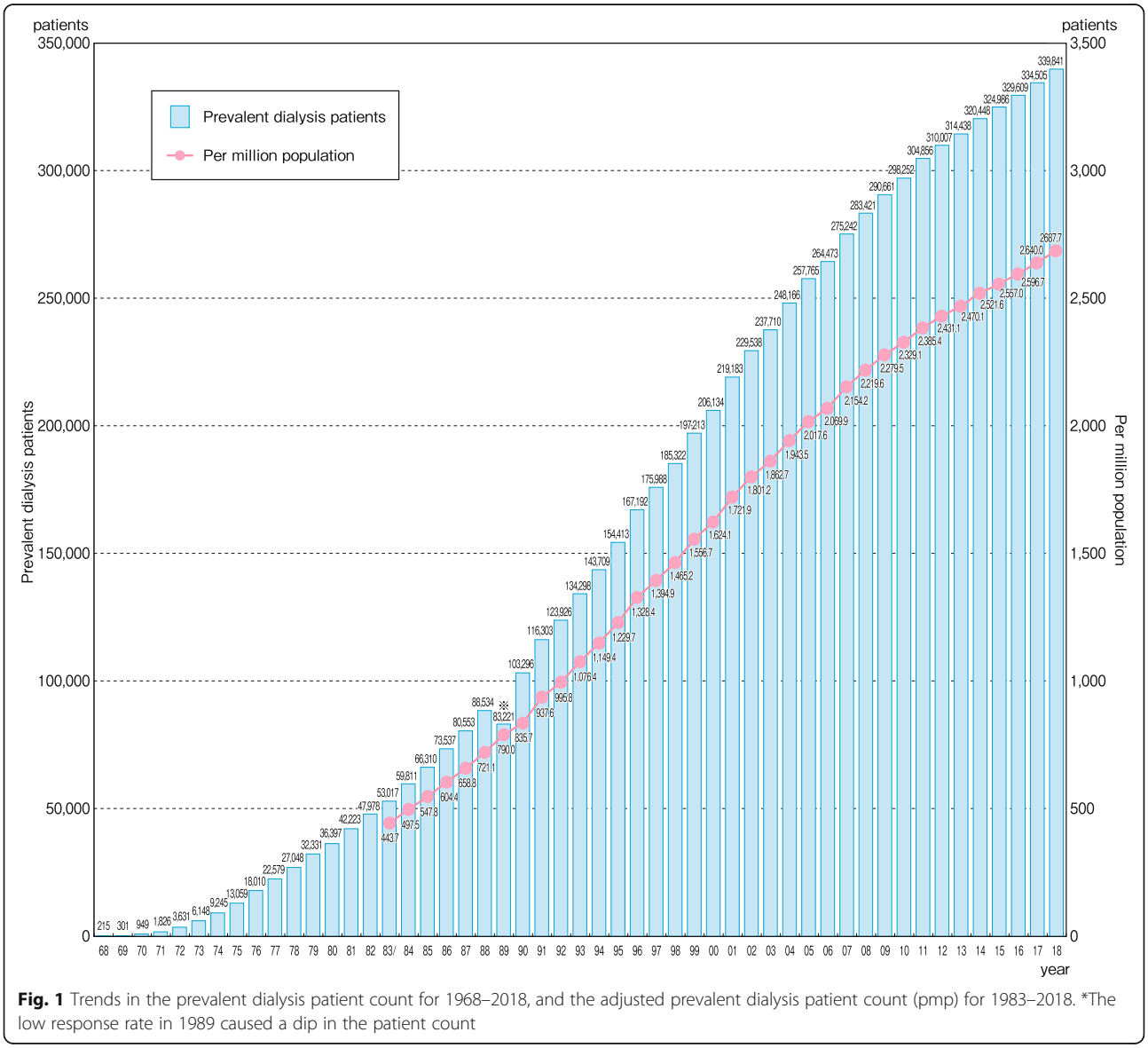

Fig. 1 Trends in the prevalent dialysis patient count for 1968–2018, and the adjusted prevalent dialysis patient count (pmp) for 1983–2018. *The low response rate in 1989 caused a dip in the patient count

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].

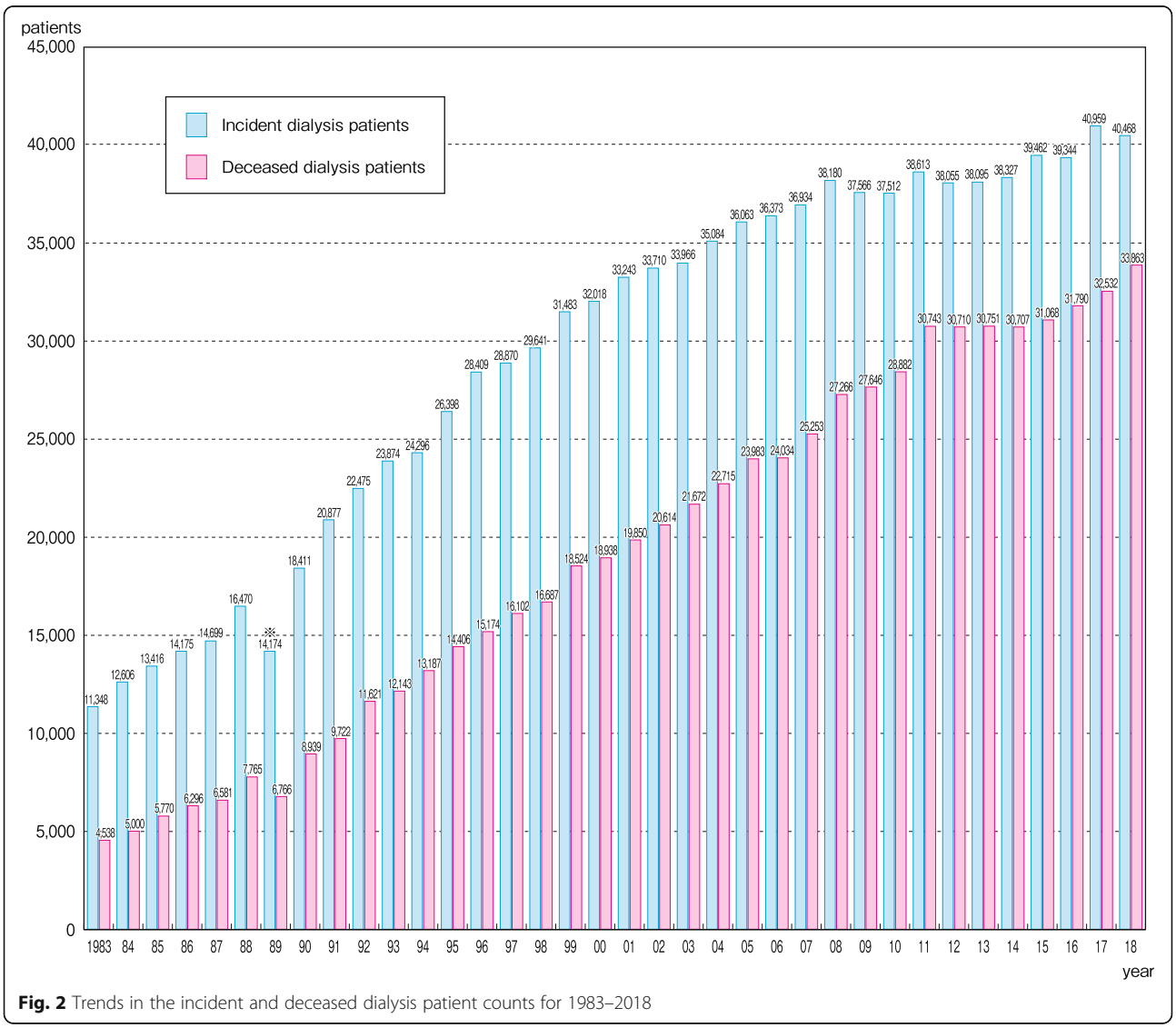

Fig. 2 Trends in the incident and deceased dialysis patient counts for 1983–2018

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]

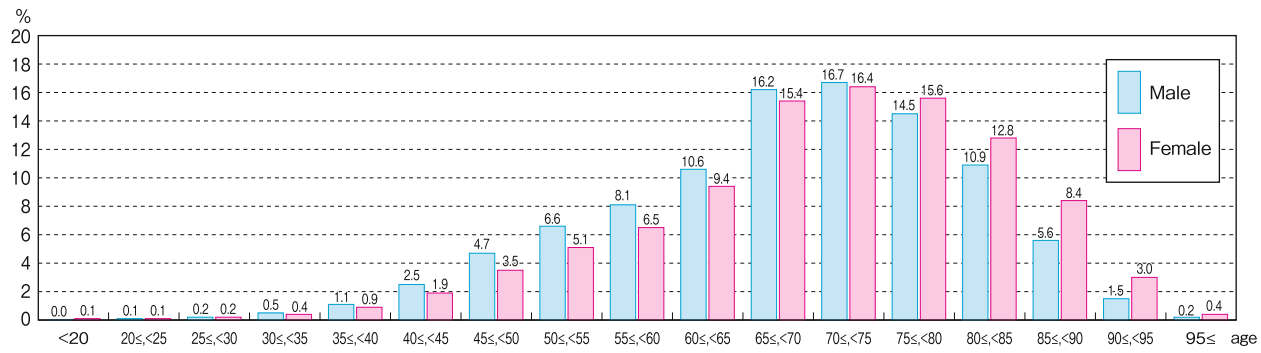

Fig. 3 Prevalent dialysis patient distribution by age and sex for 2018

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

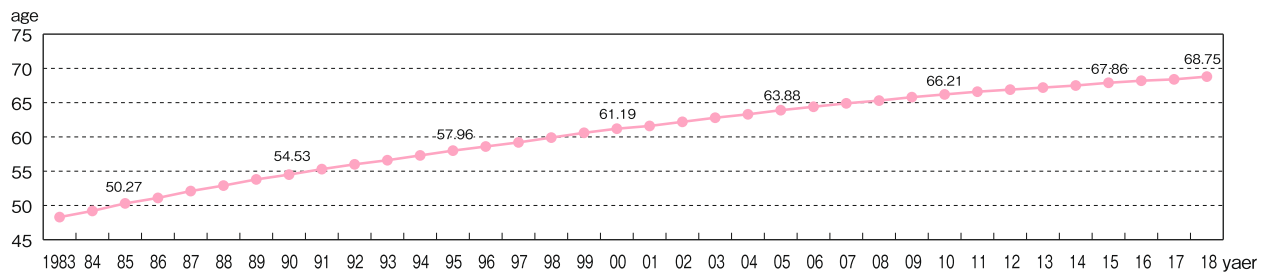

Fig. 4 Trend in the average age of the prevalent dialysis patients for 1983–2018

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

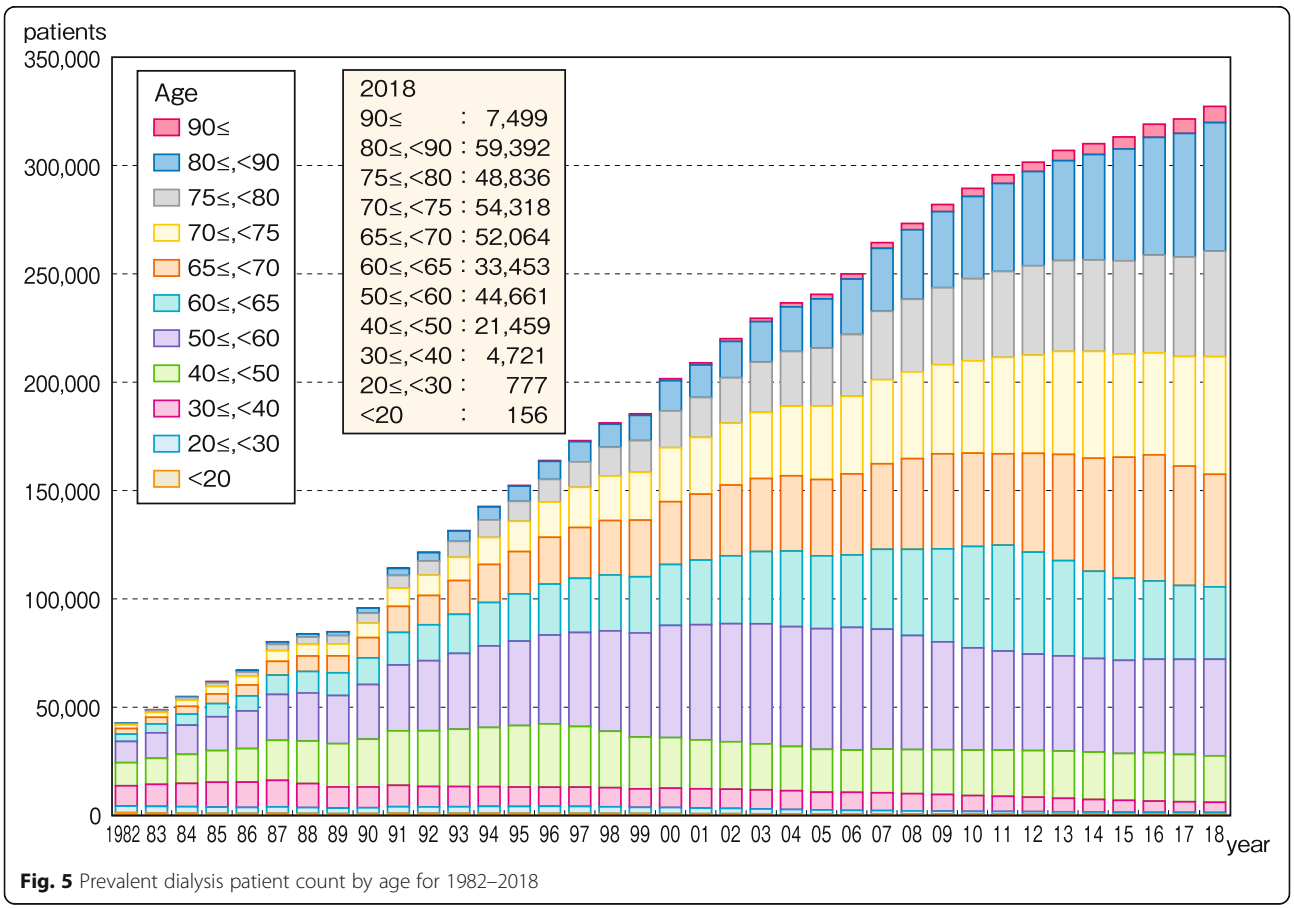

Fig. 5 Prevalent dialysis patient count by age for 1982–2018

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

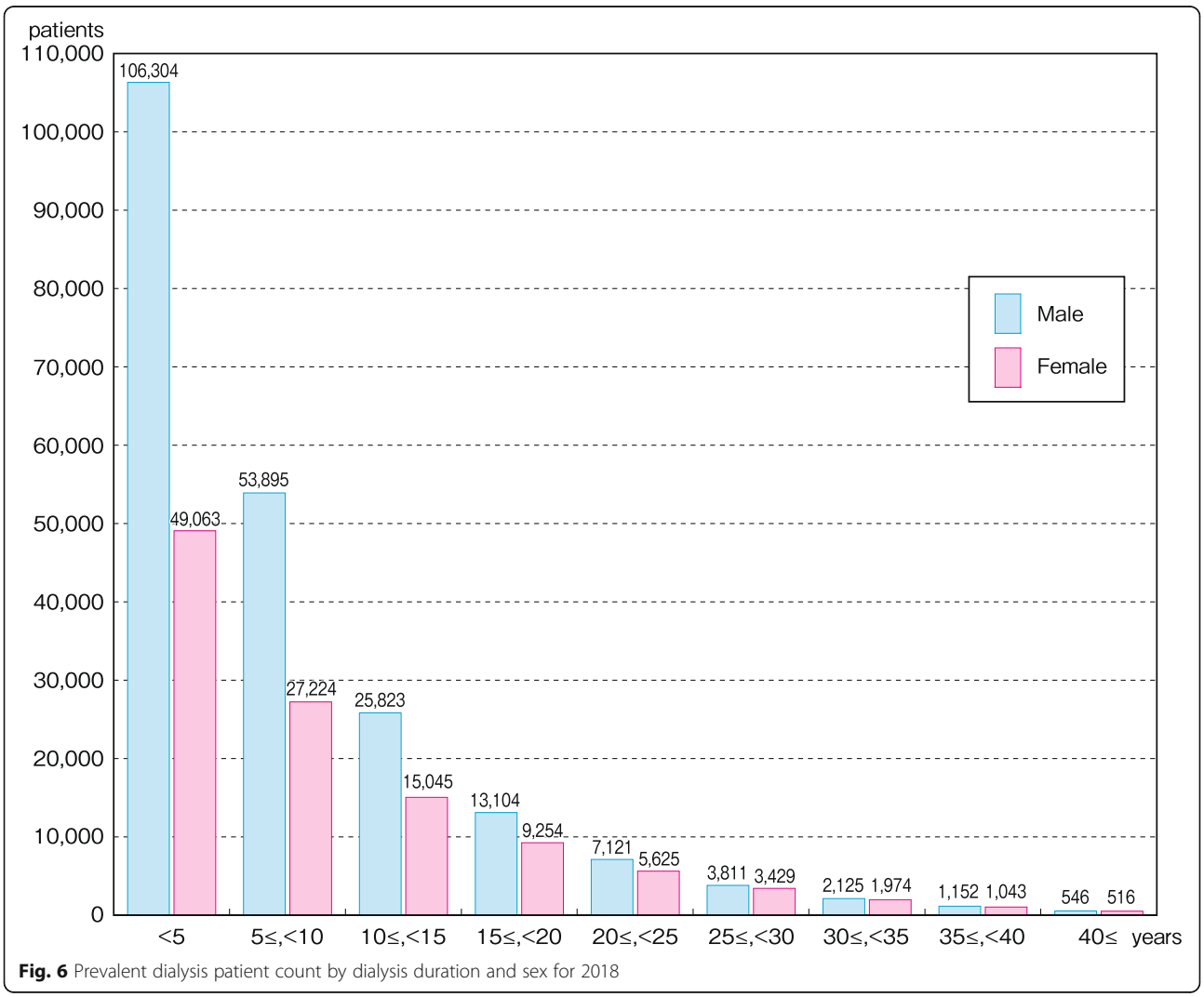

Fig. 6 Prevalent dialysis patient count by dialysis duration and sex for 2018

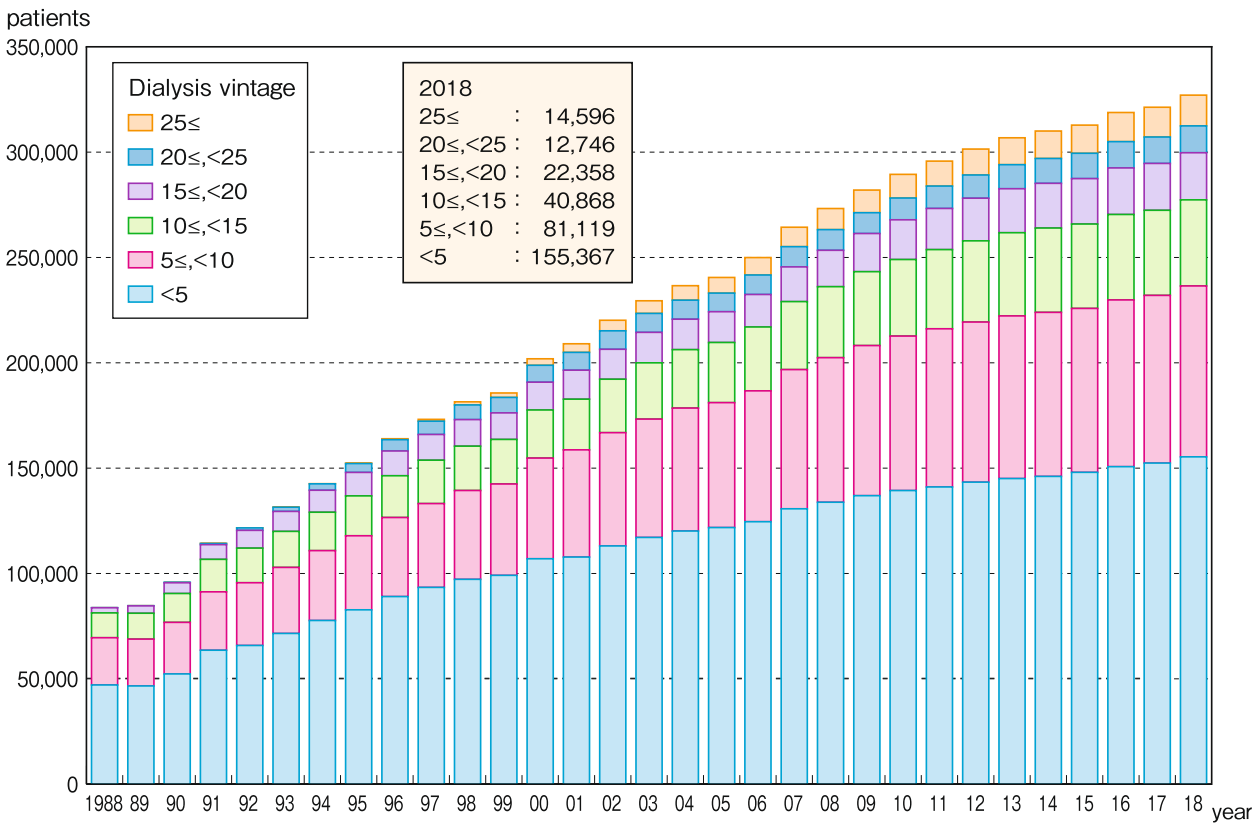

Fig. 7 Prevalent dialysis patient count by dialysis duration for 1988–2018

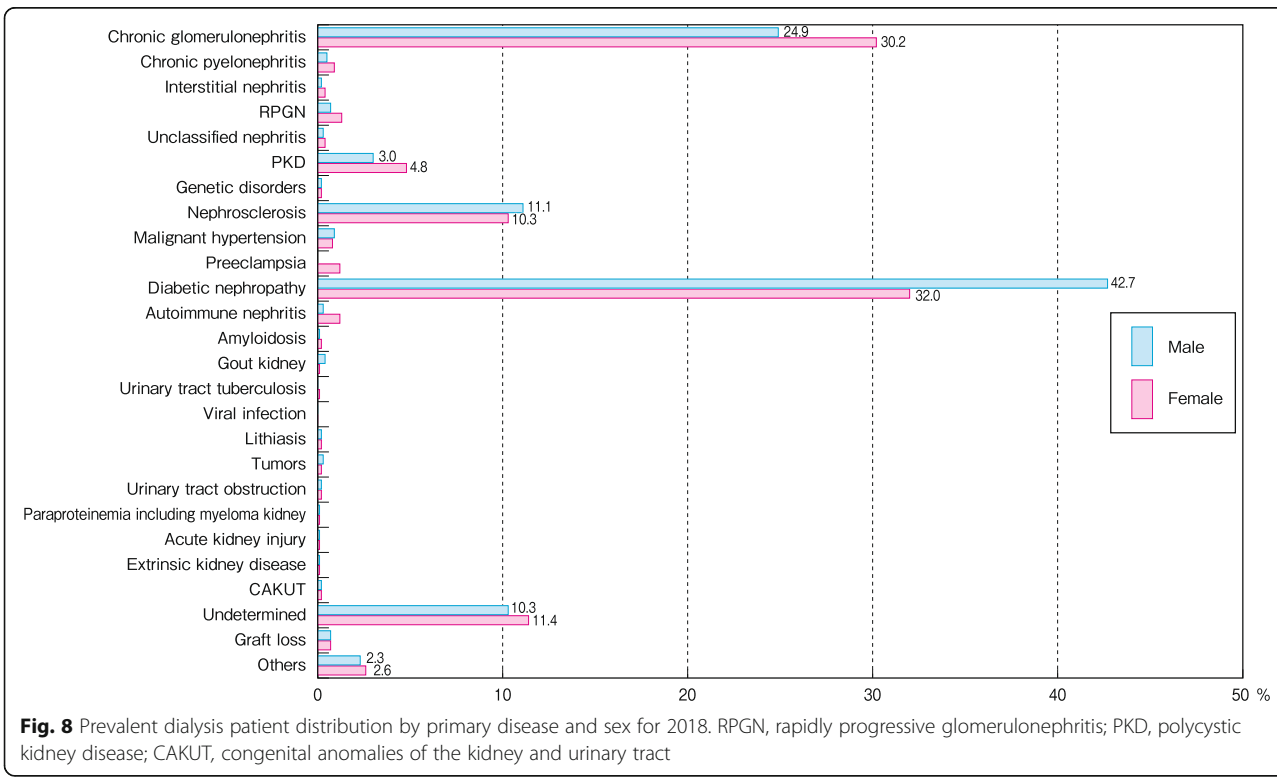

Fig. 8 Prevalent dialysis patient distribution by primary disease and sex for 2018. RPGN, rapidly progressive glomerulonephritis; PKD, polycystic kidney disease; CAKUT, congenital anomalies of the kidney and urinary tract

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

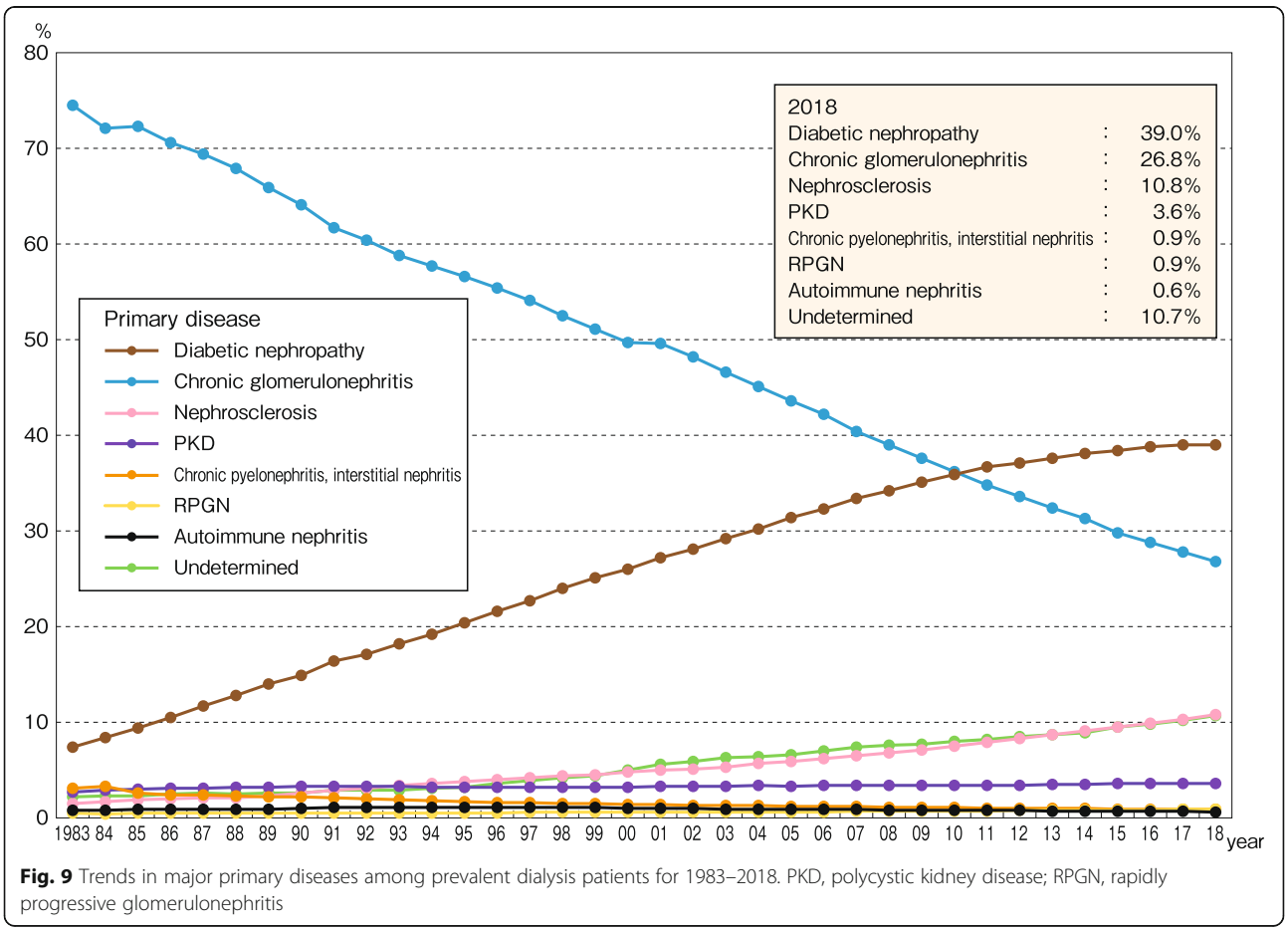

Fig. 9 Trends in major primary diseases among prevalent dialysis patients for 1983–2018. PKD, polycystic kidney disease; RPGN, rapidly progressive glomerulonephritis

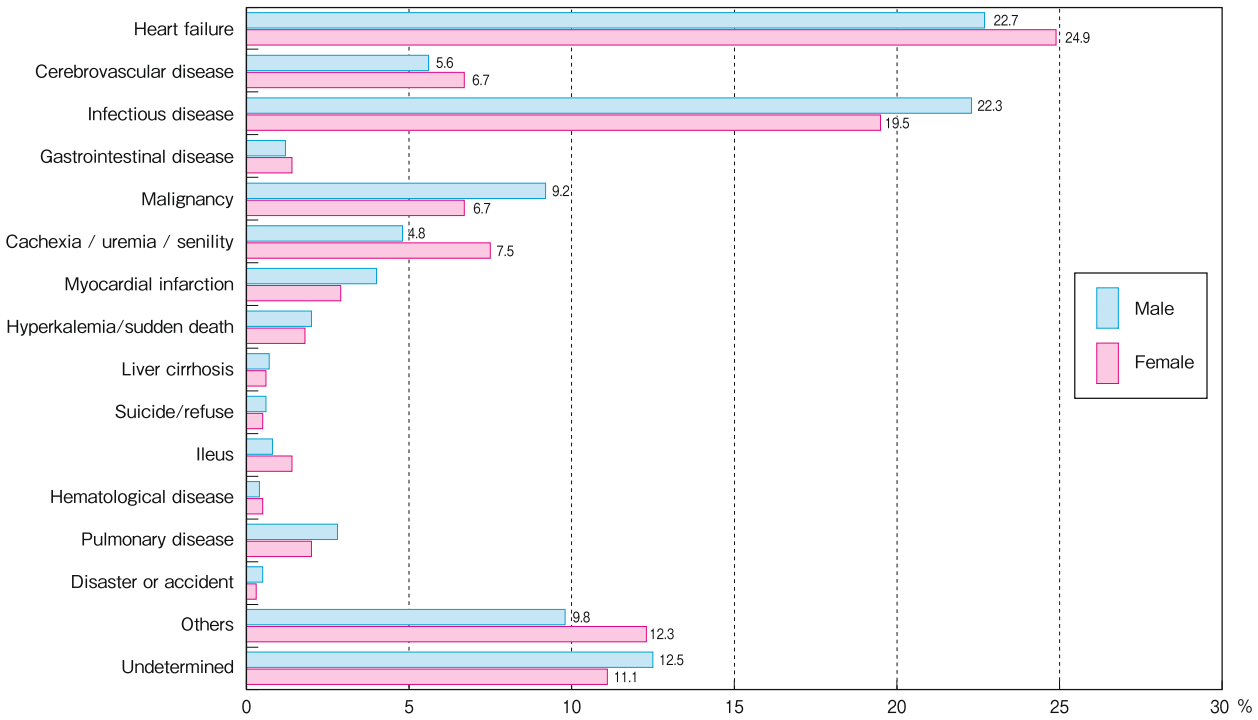

Fig. 10 Deceased dialysis patient distribution by cause of death and sex for 2018

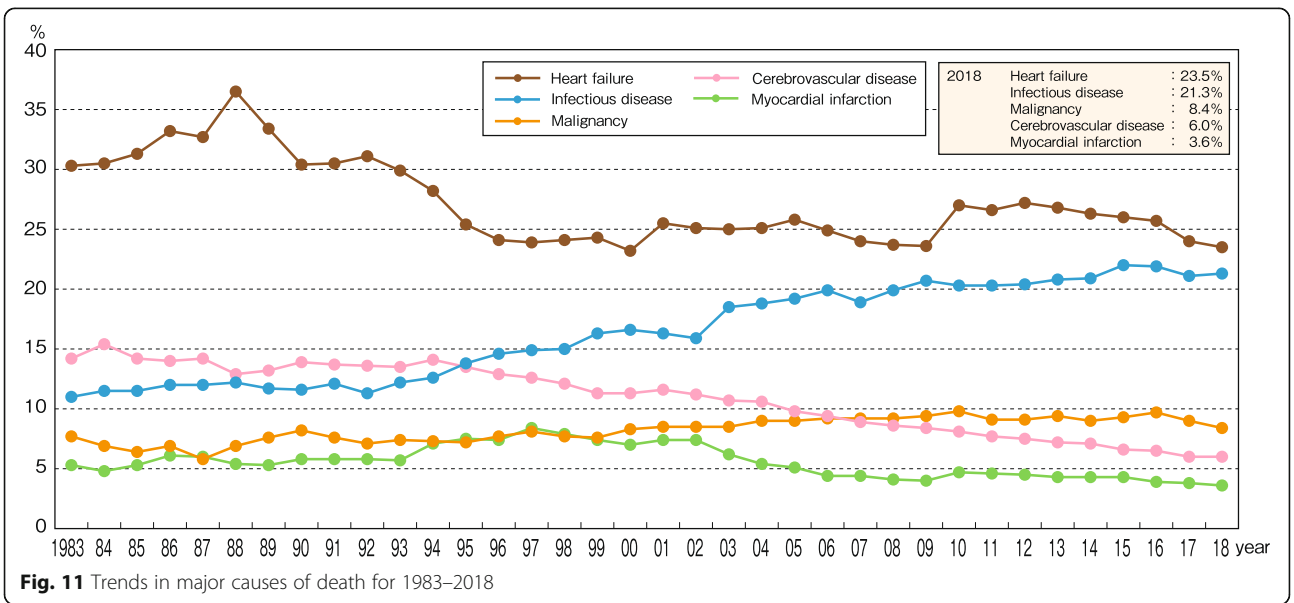

Fig. 11 Trends in major causes of death for 1983–2018

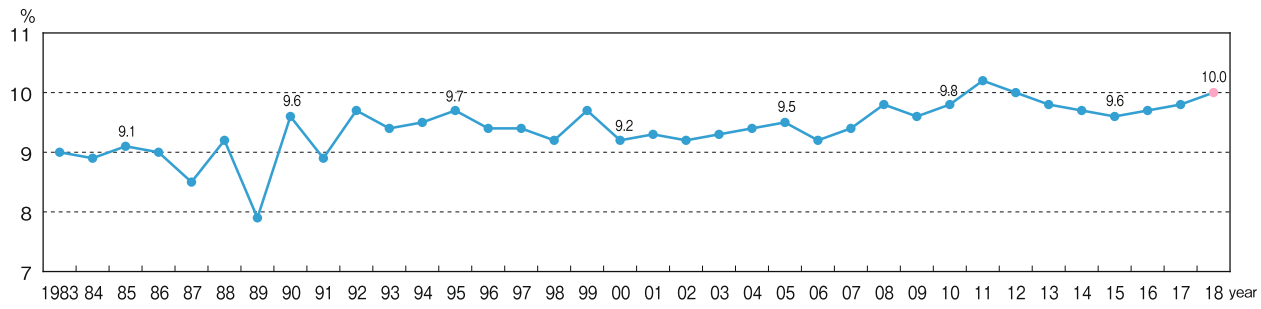

Fig. 12 Trend in annual crude death rate for 1983–2018

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).

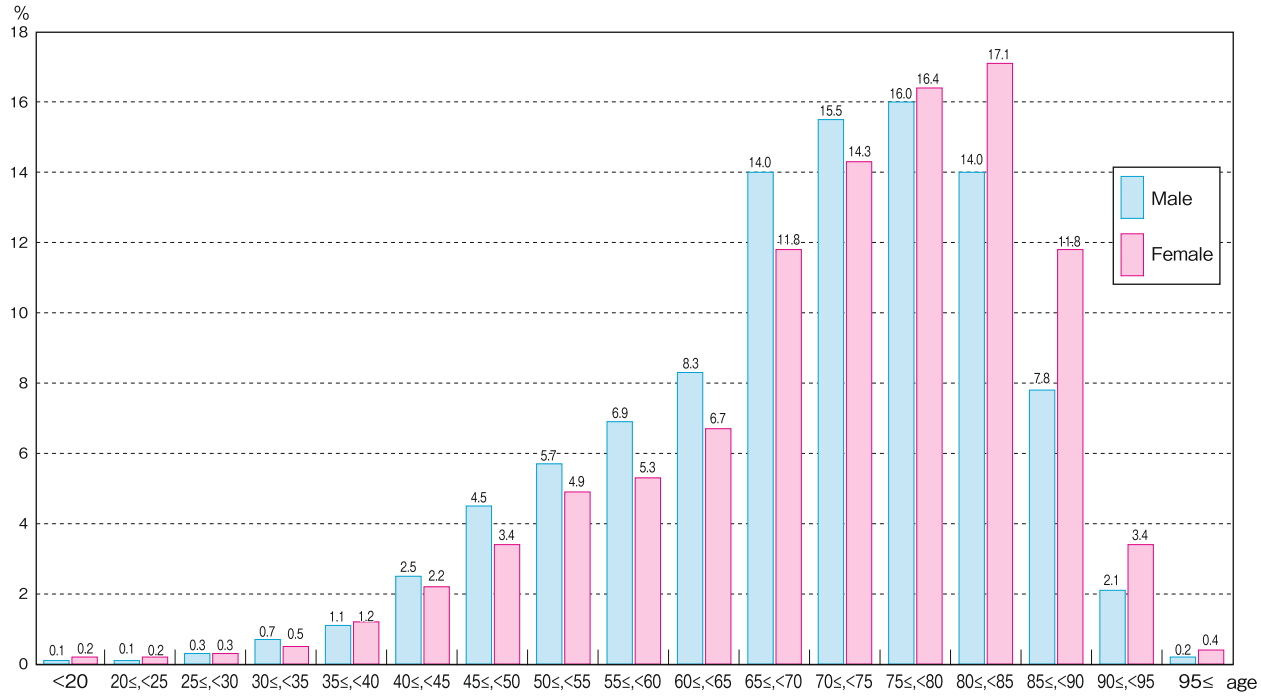

Fig. 13 Incident dialysis patient distribution by age and sex for 2018

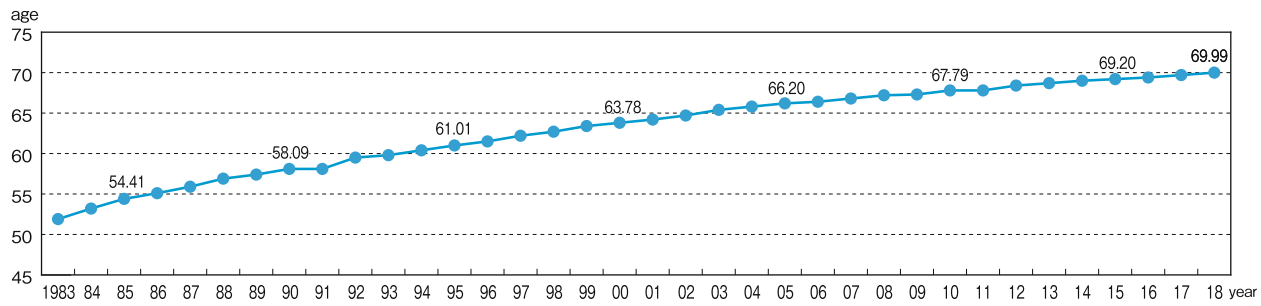

Fig. 14 Trend in average age of incident dialysis patients for 1983–2018

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%,

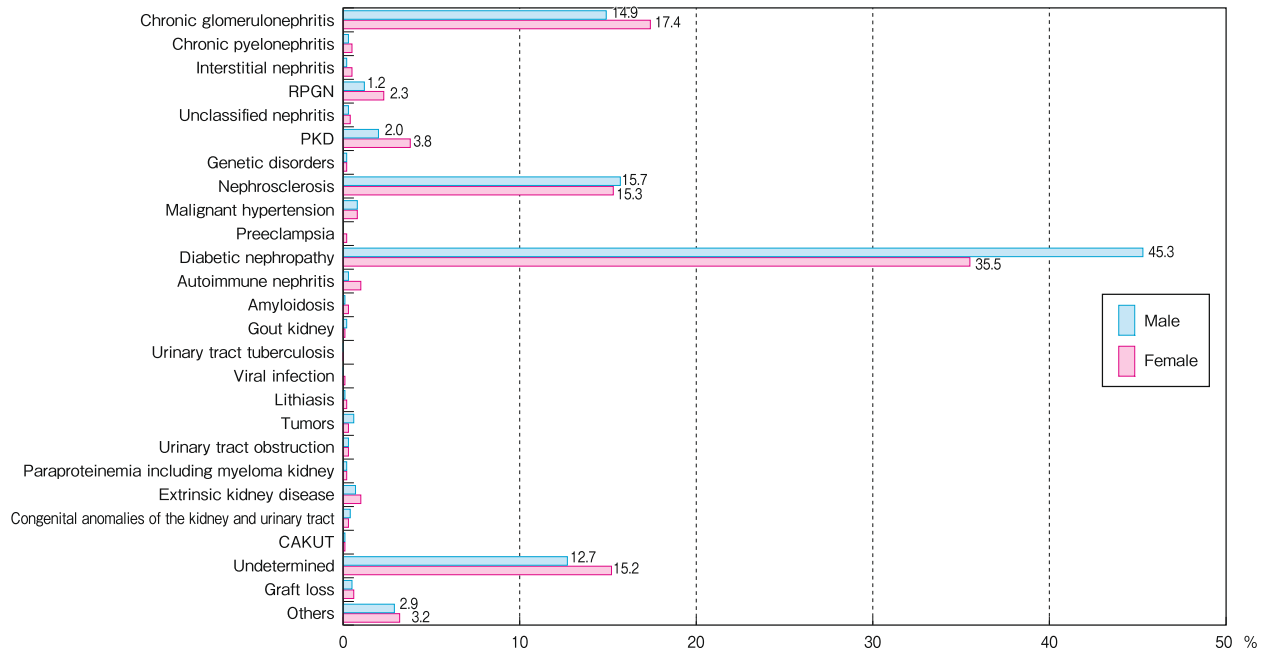

Fig. 15 Incident dialysis patient distribution by primary disease and sex for 2018. RPGN, rapidly progressive glomerulonephritis; PKD, polycystic kidney disease; CAKUT, congenital anomalies of the kidney and urinary tract

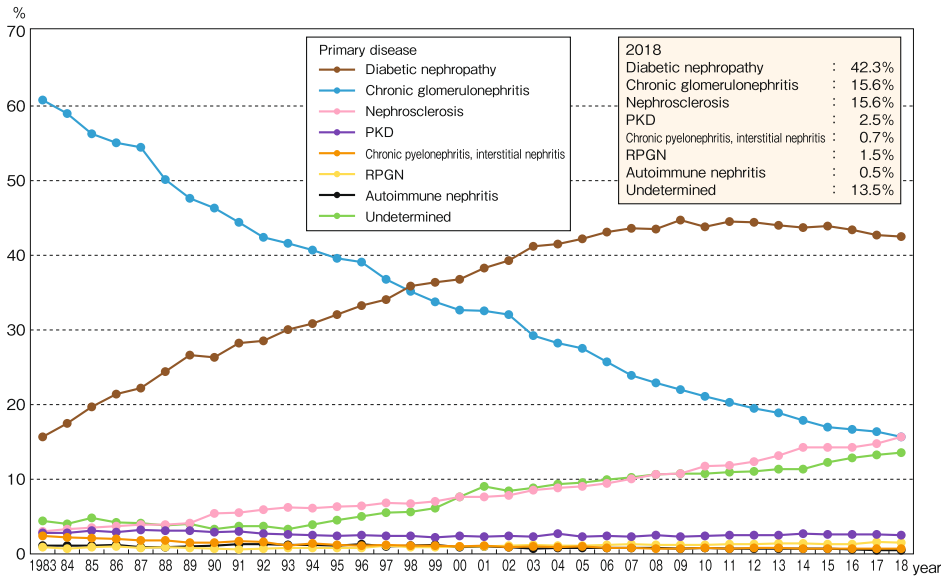

Fig. 16 Trends in major primary diseases of incident dialysis patients for 1983–2018. PKD, polycystic kidney disease; RPGN, rapidly progressive glomerulonephritis

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

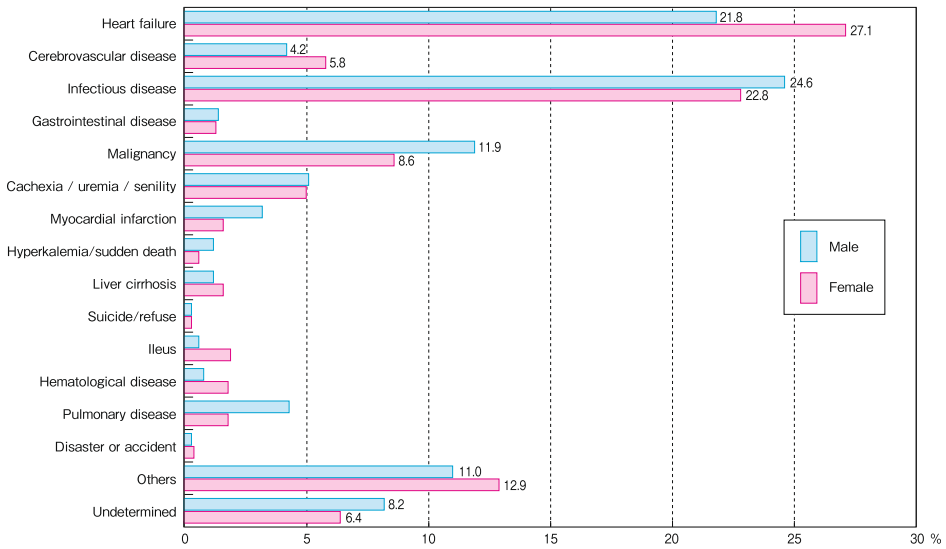

Fig. 17 Incident dialysis patient distribution by cause of death and sex for 2018

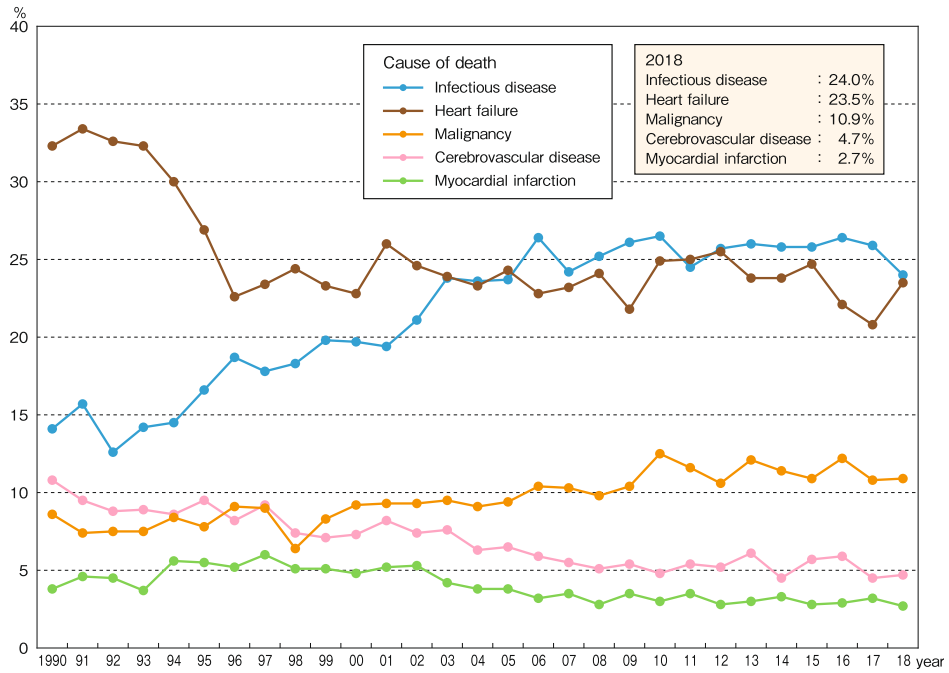

Fig. 18 Trends in major causes of death during the incident year for 1990–2018

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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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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