Annual dialysis data report for 2018, JSST
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 (Continued on next page)
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 JSST 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 | 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 | Hemodialysis (HD) | 177,718 (57.6) | 24,704 (79.4) | 202,422 (59.6) |
| Inpatients | Hemodialfiltration (HDF) | 119,959 (38.9) | 5,834 (18.8) | 125,793 (37.0) |
| Total | 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 477 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

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].

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**Fig. 2** Trends in the incident and deceased dialysis patient counts for 1983–2018
| Prefecture | Number of survey facilities | Number of facilities | Hemodialysis | Hemodialfiltration | Hemofiltration | Blood adsorption | Home hemodialysis | Peritoneal dialysis | PD only | PD + HD 1/week | PD + HD 2/week | PD + HD 3/week | PD + HD other frequencies | Total | Per million of general population** |
|------------|-----------------------------|----------------------|--------------|-------------------|---------------|------------------|-----------------|---------------------|---------|----------------|----------------|----------------|-----------------------------|-------|-----------------|
| Hokkaido   | 261                         | 257                  | 8940         | 6524              | 0             | 85               | 9               | 16,060              | 397     | 90             | 3              | 1              | 11                         | 16,060| 3038.2          |
| Aomori     | 41                          | 40                   | 1348         | 2177              | 0             | 5                | 3               | 2615                | 69      | 12             | 1              | 0              | 0                          | 3615  | 2862.2         |
| Iwate      | 44                          | 44                   | 2610         | 432               | 0             | 10               | 0               | 3147                | 84      | 11             | 0              | 0              | 2                          | 3147  | 2535.9         |
| Miyagi     | 65                          | 65                   | 3833         | 1967              | 0             | 13               | 4               | 5929                | 96      | 12             | 1              | 1              | 2                          | 5929  | 2560.0         |
| Akita      | 42                          | 42                   | 1402         | 724               | 0             | 2                | 2               | 2186                | 53      | 3              | 0              | 0              | 0                          | 2186  | 22283          |
| Yamagata   | 36                          | 35                   | 1666         | 948               | 0             | 5                | 12              | 2686                | 44      | 8              | 1              | 2              | 0                          | 2686  | 24642          |
| Fukushima  | 70                          | 68                   | 2568         | 2417              | 0             | 16               | 0               | 5119                | 71      | 33             | 10             | 4              | 0                          | 5119  | 27462          |
| Ibaraki    | 86                          | 86                   | 5777         | 2392              | 0             | 48               | 17              | 8317                | 68      | 14             | 1              | 0              | 0                          | 8317  | 28909          |
| Tochigi    | 78                          | 78                   | 4250         | 2058              | 0             | 22               | 7               | 6480                | 121     | 18             | 1              | 2              | 1                          | 6480  | 33299          |
| Gunma      | 63                          | 62                   | 4028         | 1942              | 0             | 0                | 13              | 6058                | 56      | 18             | 1              | 0              | 0                          | 6058  | 3103.5         |
| Saitama    | 196                         | 191                  | 10044        | 8037              | 0             | 60               | 74              | 18541               | 239     | 76             | 9              | 1              | 1                          | 18541 | 25295          |
| Chiba      | 156                         | 154                  | 9365         | 5817              | 0             | 35               | 13              | 15,525              | 228     | 61             | 5              | 1              | 0                          | 15,525| 24820          |
| Tokyo      | 442                         | 435                  | 17838        | 13,422            | 3             | 140              | 95              | 32682               | 896     | 264            | 16             | 1              | 7                          | 32682 | 23645          |
| Kanagawa   | 264                         | 264                  | 14113        | 6818              | 2             | 63               | 31              | 21,664              | 539     | 98             | 2              | 0              | 3                          | 21,664| 23607          |
| Niigata    | 54                          | 54                   | 3794         | 1221              | 1             | 20               | 2               | 5229                | 161     | 26             | 2              | 1              | 1                          | 5229  | 23281          |
| Toyama     | 42                          | 42                   | 1875         | 589               | 0             | 14               | 3               | 2589                | 98      | 13             | 0              | 2              | 0                          | 2589  | 24657          |
| Ishikawa   | 41                          | 41                   | 1815         | 813               | 0             | 20               | 5               | 2718                | 59      | 6              | 0              | 0              | 0                          | 2718  | 23780          |
| Fukui      | 25                          | 25                   | 1026         | 710               | 0             | 3                | 3               | 1845                | 76      | 22             | 5              | 0              | 0                          | 1845  | 23837          |
| Yamanashi  | 33                          | 33                   | 1272         | 1020              | 0             | 6                | 2               | 2335                | 21      | 14             | 0              | 0              | 0                          | 2335  | 28580          |
| Nagano     | 73                          | 72                   | 3063         | 2097              | 2             | 12               | 18              | 5297                | 83      | 18             | 3              | 1              | 0                          | 5297  | 25676          |
| Gifu       | 72                          | 72                   | 3470         | 1486              | 0             | 22               | 28              | 5096                | 70      | 19             | 1              | 0              | 0                          | 5096  | 25518          |
| Shizuoka   | 126                         | 126                  | 5707         | 5252              | 1             | 44               | 21              | 11,158              | 104     | 22             | 6              | 0              | 1                          | 11,158| 30495          |
| Aichi      | 193                         | 193                  | 12,223       | 5728              | 1             | 80               | 46              | 18,783              | 611     | 91             | 2              | 0              | 1                          | 18,783| 2492.1         |
| Me         | 55                          | 52                   | 2849         | 1015              | 0             | 22               | 8               | 3972                | 65      | 12             | 1              | 0              | 0                          | 3972  | 2217.8         |
| Shiga      | 40                          | 39                   | 1682         | 1370              | 0             | 33               | 35              | 3235                | 97      | 18             | 0              | 0              | 0                          | 3235  | 2291.1         |
| Kyoto      | 81                          | 79                   | 3822         | 2507              | 0             | 80               | 11              | 6641                | 138     | 74             | 8              | 0              | 1                          | 6641  | 2563.1         |
| Osaka      | 326                         | 320                  | 12,465       | 10,851            | 2             | 168              | 47              | 24070               | 428     | 97             | 5              | 5              | 2                          | 24070 | 27312          |
| Hyogo      | 201                         | 199                  | 7787         | 6213              | 0             | 122              | 72              | 14,390              | 167     | 26             | 3              | 0              | 0                          | 14,390| 26240          |
| Nara       | 50                          | 48                   | 1762         | 1502              | 0             | 30               | 8               | 3429                | 96      | 30             | 0              | 0              | 1                          | 3429  | 25609          |
| Wakayama   | 48                          | 47                   | 2299         | 612               | 0             | 11               | 27              | 3015                | 98      | 8              | 0              | 0              | 0                          | 3015  | 32246          |
| Prefecture | Number of surveyed facilities | Number of responded facilities | Hemodialysis | Hemodialfiltration | Hemofiltration | Blood adsorption filtration | Home hemodialysis | Peritoneal dialysis | Total | Per million of general population** |
|------------|-------------------------------|-------------------------------|-------------|-------------------|---------------|---------------------------|----------------|-------------------|-------|------------------------|
| 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 | 38193                  |
| Kagawa     | 48                           | 48                            | 1277        | 1262              | 0             | 12                        | 8              | 141               | 49    | 0                      | 0     | 1                      | 2750 | 28586                  |
| 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 | 35467                  |
| Fukuoka    | 198                          | 194                            | 10,389      | 3954              | 1             | 37                        | 19             | 691               | 43    | 0                      | 1     | 2                      | 15137 | 29640                  |
| Saga       | 36                           | 36                            | 1809        | 739               | 0             | 7                         | 1              | 8                 | 7     | 0                      | 0     | 0                      | 2571 | 31392                  |
| Nagasaki   | 63                           | 62                            | 2708        | 1191              | 0             | 11                        | 19             | 117               | 37    | 2                      | 0     | 1                      | 4060 | 30276                  |
| Kumamoto   | 90                           | 89                            | 4901        | 1511              | 0             | 30                        | 4              | 130               | 26    | 0                      | 0     | 2                      | 6604 | 37587                  |
| Oita       | 70                           | 68                            | 2958        | 941               | 0             | 9                         | 4              | 108               | 32    | 4                      | 1     | 0                      | 4057 | 35463                  |
| Miyazaki   | 65                           | 65                            | 2977        | 901               | 0             | 4                         | 0              | 56                | 4     | 0                      | 0     | 6                      | 3948 | 36522                  |
| Kagoshima  | 95                           | 95                            | 4016        | 1305              | 1             | 22                        | 2              | 153               | 30    | 0                      | 0     | 6                      | 5535 | 34294                  |
| Okinawa    | 72                           | 70                            | 2374        | 1946              | 0             | 20                        | 2              | 74                | 27    | 1                      | 2     | 1                      | 4447 | 30711                  |
| Total      | 4,458                        | 4,402                         | 202,422     | 125,798           | 14 (0.0)      | 1,447 (0.4)               | 720 (0.2)      | 7,582             | 1,621 | 142 (0.0)              | 30 (0.0) | 70 (0.0)              | 339,841 | 26877                  |

*The above data were obtained from the facility survey.

**The numbers of dialysis patients were adjusted as per million population (pmp) by the annual government report reference [7].
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...
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
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. 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. 10 Deceased dialysis patient distribution by cause of death and sex for 2018

Fig. 11 Trends in major causes of death 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:

\[
\text{Crude death rate} = \left\{ \frac{\text{no. of deaths}}{\text{no. of patients, previous year}} + \frac{\text{no. of patients, target year}}{2} \right\} \times 100 \%
\]

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).
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%,...
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
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 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 1982-2018.
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.
videos, or voice recording that could be used to identify an individual. The data presented in the current manuscript does not contain any images, the privacy of the dialysis facilities and the patients. The original data was totally anonymized to avoid any risk of compromising interventions.

Documented approval forms from the patients were not required because participating dialysis patients at the dialysis facilities. The aims of the JSDT Renal Data Registry (JRDR) were well explained to the (approval no. 1).

The JSDT registry was approved by the ethics committee of the JSDT. Ethics approval and consent to participate

The interpretation and reporting of these data are the responsibility of the here have been provided by the Japanese Society for Dialysis Therapy (JSDT).

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-calculation 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.”

Acknowledgements

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

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, and 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, and MT, and SG finalized the results of the survey and prepared this manuscript.

Funding

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

Availability of data and materials

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 JSMT 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.

Received: 29 June 2020 Accepted: 3 August 2020

Published online: 04 September 2020

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