Specialist care and improved long-term survival of dialysis patients

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Abstract

Background. The quality of dialysis care provided by specialists is expected to be superior to that by nonspecialists. However, little is known about the actual effect of specialist care on long-term prognosis in dialysis patients. We sought to determine whether specialist care can actually be associated with better survival rates in a nationwide Japanese dialysis cohort.

Methods. The Japanese Society for Dialysis Therapy (JSDT) has annually reported clinical and demographic variables of dialysis patients for each prefecture in Japan since 1983. We analysed the data for the 47 prefectures from 1983 to 2006 to evaluate the relationship between the proportion of specialists and the cumulative survival rates for 5-year periods.

Results. Trend analyses revealed that a higher quintile of specialists was associated with a better cumulative survival rate at 5-, 10-, 15- and 20-year periods. Univariate analyses for the 47 prefectures showed a higher proportion of specialists to be correlated with a better cumulative survival at 10-, 15- and 20-year periods. Multivariate analyses revealed that the proportion of specialists persisted as an independent contributor for better survival at 10-, 15- and 20-year periods even after adjustment for age, sex, diabetes mellitus and socioeconomic status, while the survival rate at 5 years was at a nonsignificant level.

Conclusions. While our study should be confirmed using data for individuals, this was not possible due to privacy issues. Therefore, based on our current findings, we conclude that for patients on maintenance dialysis, specialist care can be associated with better survival rates, particularly with longer follow-up.

Keywords: care; dialysis; ecological study; mortality; specialist

Introduction

The annual mortality rate for dialysis patients is approximately 10% to 20% per year [3,16,17], which is more than twice that for the general population. To reduce the morbidity and mortality of end-stage renal disease, renal transplantation is considered to be the best therapeutic strategy at present. Unfortunately, however, donor sources are not sufficient to meet the demand worldwide [20]. Particularly in Japan, which has the highest prevalence of dialysis patients but where there is little chance to be a recipient [7,16], dialysis specialists are expected to play a key role in improving the quality of dialysis care.

To date, several studies have emphasized the role of specialist care [8,11,22]. Avorn et al. demonstrated that management by a nephrologist before initiation of dialysis reduced the 1-year mortality of dialysis patients [1]. Others have also reported that earlier and more frequent referral to nephrologists during the predialysis phase contributed to improvement of the 1-year survival rate [27,30].

However, little is known about the actual effect of specialist care on long-term survival for patients on maintenance dialysis. In addition, while the renoprotective effects of predialysis nephrologist care have been investigated [5,9,10,12,13], the appropriate role of specialist care after initiation of dialysis has rarely been discussed. Dialysis specialists should be able to improve patient prognosis by integrated therapies to alleviate anaemia and to improve nutritional status, mineral metabolism and dialysis prescription [7,18].

In order to determine whether specialist care can improve long-term survival rates of dialysis patients, we analysed a 23-year macro-level Japanese dialysis cohort. The present study was designed to examine the ecological association between specialist care and survival rates for patients on chronic dialysis.
Specialist care and improved survival in dialysis

Materials and methods

Clinical and demographic characteristics of dialysis patients, on either haemo- or peritoneal dialysis, were obtained from the reports of the Japanese Society for Dialysis Therapy (JSDT) [16]. JSDT started annual surveys of chronic dialysis patients throughout Japan in 1968, but at that time, survey items were so limited that detailed analyses had not been performed. After 1983, JSDT prospectively began to collect patient information more precisely and now covers more than 98% of the patients every year, which makes it possible to calculate reliable cumulative survival rates. Data on individuals are not currently available because of limitation of data access due to privacy issues. For this study, we extracted aggregated level data of each prefecture from 1983 to 2006 and conducted a nationwide ecological study.

In Japan, there are two major specialist qualifications in subspecialty nephrology: one is the board-certified nephrologist of the Japanese Society of Nephrology, and the other is the dialysis specialist certified by the JSDT. There are 2983 board-certified nephrologists who deal mainly with renal disease until the initiation of dialysis. There are 4167 JSDT-certified dialysis specialists who deal mainly with dialysis patients. In this article, the ‘specialist’ referred to is the latter dialysis specialist. Physicians other than dialysis specialists are treated as ‘nonspecialist’ in this article. To become a dialysis specialist, physicians must receive training for at least 5 years for a combined credential in internal medicine (or urology) plus nephrology at authorized renal units, attend designated meetings, write articles concerning dialysis, report clinical summaries of 20 cases and finally pass written and oral examinations. Accordingly, it usually takes about 10 years to become a dialysis specialist. To maintain the quality and qualification of specialists, they are required to obtain credits from continuous medical education (CME) courses every 5 years. Unfortunately, not all patients are treated by qualified specialists, and thus the quality of chronic dialysis care differs from place to place.

The estimation of quality of care is difficult, and no methodology has been established to date. Some previous studies dealing with the quality and influence of specialist care regarded the presence of a higher proportion of specialists as indicating a facility with a higher quality of care [14,15,24]. In the present study, we hypothesized that higher quality dialysis care would be possible in regions with higher proportions of specialists among the total population of physicians. We calculated the ratio of dialysis specialists to all physicians in each prefecture as a surrogate to evaluate the quality of specialist care.

At the same time, we calculated the ratio of nephrology specialists and cardiology specialists to the total population of physicians as reference values for dialysis specialists. We could not obtain data for primary-care physicians (PCP) or family practitioners (FP) because they are not currently established as specialists in Japan, where any patient can directly consult a specialist without first visiting a general practitioner (GP).

The number of all physicians in each prefecture is reported biannually by the Japanese Ministry of Health, Labour and Welfare. The average income per capita in each prefecture, provided annually by the Japanese Ministry of Internal Affairs and Communications, was used as the proxy for socioeconomic status.

Statistical analyses

The normality of the data was first assessed using the Shapiro–Wilks test. Individual level data were extracted and averaged out to calculate cumulative survival rates of each prefecture. The association between the cumulative survival rate and the proportion of dialysis specialists was analysed using the Jonkheere trend test for 5-year periods. When performing trend tests, the 47 prefectures were allocated into quintiles according to the proportion of dialysis specialists.

For the following simple ecological regression studies, correlation coefficients were calculated using Pearson’s method. We employed the area of the predicted 95% probability ellipse as the positioning goodness value in the comparison between specialists. We developed a multivariable regression model to identify independent factors for prefectural differences in survival rates. For the multivariable (stepwise forward and backward) regression studies, age, sex, socioeconomic status, proportion of diabetic nephropathy and proportion of specialists were added to the model. These parameters were included when $P$ values were less than 0.10 and were deleted when $P$ values exceeded 0.10 upon adjustment. In all models, the absence of colinearity was verified, and interactions between variables were tested. All statistical analyses were performed using JMP software (Version 8.0; SAS institute Inc., Cary, NC). Values are expressed as the means ± SD or the median [interquartile range] for normal and non-normal continuous variables, respectively. A level of $P < 0.05$ was considered to be statistically significant.

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Fig. 1. Maps of (A) the dialysis specialist ratio and (B) the cumulative survival rate of dialysis patients in Japan; the map in (A) indicates prefectural differences in the ratio of dialysis specialists, while the map in (B) shows the cumulative survival rate of dialysis patients at 15-year periods. Prefectures are classified into quintiles: the lowest (white areas) to the highest (black areas). Regions with higher ratios of dialysis specialists are associated with a better survival rate.
Results

Since 1983, 513,398 patients have had maintenance dialysis in Japan, and 264,473 (2070 patients per million population) were alive at the end of December 2006. The numbers of those on haemodialysis, peritoneal dialysis and home haemodialysis were 255,095 (96.4%), 9,223 (3.5%) and 147 (0.1%), respectively [16]. In 2006, kidney transplantations were performed for only 1,136 (0.4%) cases: 939 from living donors, 182 from deceased donors and 147 from brain-dead donors. The low number of transplantations was due to ethical and religious constraints. There were a total of 3,985 dialysis units in Japan (8.4 patients per unit) and 4,167 dialysis specialists (63.5 patients per specialist). The average age of the dialysis patients was 64.6 years. The overall cumulative survival rates at 5-, 10-, 15- and 20-year periods were 56.0%, 35.4%, 23.8% and 16.5%, respectively. There were more men than women (60.7% vs 39.3%). The 47 prefectures were allocated into quintiles according to the proportion of dialysis specialists. Survival rates were better in quintiles with higher ratios of dialysis specialists, while other parameters such as Age, Male, DM and Income were comparable for all quintiles.

Simple and multiple regression analyses for survival rates at every 5-year period are shown in Tables 2 and 3. On simple ecological regression analyses, we found significant correlations between dialysis specialists and survival rates at 10-, 15- and 20-year periods. Average age was positively correlated with survival rate only for the 20-year period.

Discussion

Our nationwide study revealed regional differences in the cumulative survival rates of dialysis patients at 5-, 10-, 15- and 20-year periods in Japan, which is ethnically homogeneous (Table 1). We also found regional disparities in the proportion of dialysis specialists. A higher proportion of dialysis specialists was associated with a better survival rate (Figures 1 and 2). Of note is the finding that the longer the follow-up was, the stronger the association became, which might indicate that specialist care could improve the survival of dialysis patients, particularly with longer follow-up (Table 2; Figure 3).

The present dialysis cohort possesses several distinctive characteristics. First, most (96.4%) of the patients are treated by haemodialysis (HD), with peritoneal dialysis (PD) accounting for only 3.5%. Second, renal transplantation is rarely performed (0.4%), although HD, PD and renal transplantation are fully covered by governmental insurance for those of all age groups. These two characteristics make it possible to estimate the survival of haemodialysis.

<table>
<thead>
<tr>
<th>Characteristic of dialysis patients: quintile grouping by the ratio of dialysis specialists</th>
<th>Total</th>
<th>1st (low)</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th (high)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>64.6 ± 0.8</td>
<td>64.5 ± 0.3</td>
<td>64.9 ± 0.3</td>
<td>64.5 ± 0.3</td>
<td>64.5 ± 0.3</td>
<td>64.6 ± 0.3</td>
</tr>
<tr>
<td>Male (%)</td>
<td>60.7 ± 1.9</td>
<td>60.1 ± 0.7</td>
<td>61.2 ± 0.6</td>
<td>60.6 ± 0.6</td>
<td>61.2 ± 0.6</td>
<td>60.2 ± 0.6</td>
</tr>
<tr>
<td>DM (%)</td>
<td>31.6 ± 3.5</td>
<td>31.6 ± 1.3</td>
<td>31.3 ± 1.1</td>
<td>31.8 ± 1.1</td>
<td>31.4 ± 1.1</td>
<td>30.8 ± 1.2</td>
</tr>
<tr>
<td>Income (log, 1000 yen)</td>
<td>7.9 ± 0.15</td>
<td>7.8 ± 0.05</td>
<td>7.9 ± 0.05</td>
<td>7.9 ± 0.05</td>
<td>8.0 ± 0.05</td>
<td>7.8 ± 0.05</td>
</tr>
<tr>
<td>Population density (log)</td>
<td>5.8 ± 1.0</td>
<td>5.1 ± 0.5</td>
<td>5.8 ± 0.9</td>
<td>6.2 ± 1.1</td>
<td>6.2 ± 1.3</td>
<td>5.6 ± 0.5</td>
</tr>
<tr>
<td>Dialysis specialist (×10³)**</td>
<td>1.5 ± 0.5</td>
<td>0.9 ± 0.07</td>
<td>1.2 ± 0.06</td>
<td>1.4 ± 0.06</td>
<td>1.8 ± 0.06</td>
<td>2.3 ± 0.06</td>
</tr>
<tr>
<td>Survival rate (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-year periods*</td>
<td>56.0 ± 3.9</td>
<td>53.6 ± 1.4</td>
<td>54.7 ± 1.2</td>
<td>57.3 ± 1.2</td>
<td>56.6 ± 1.2</td>
<td>57.2 ± 1.3</td>
</tr>
<tr>
<td>10-year periods**</td>
<td>35.4 ± 3.9</td>
<td>32.7 ± 1.3</td>
<td>34.2 ± 1.2</td>
<td>36.4 ± 1.2</td>
<td>35.4 ± 1.2</td>
<td>36.6 ± 1.2</td>
</tr>
<tr>
<td>15-year periods*</td>
<td>23.8 ± 3.5</td>
<td>21.9 ± 1.2</td>
<td>22.7 ± 1.1</td>
<td>24.3 ± 1.1</td>
<td>24.7 ± 1.1</td>
<td>25.3 ± 1.1</td>
</tr>
<tr>
<td>20-year periods*</td>
<td>16.5 ± 3.2</td>
<td>15.4 ± 1.1</td>
<td>15.5 ± 1.0</td>
<td>16.2 ± 1.0</td>
<td>17.2 ± 1.0</td>
<td>18.3 ± 1.1</td>
</tr>
</tbody>
</table>

*p < 0.05, **p < 0.01 and ***p < 0.0001 by Jonckheere test. Data are expressed as mean ± SD. Age, average age at the end of 2006; DM, diabetes mellitus as a cause of end-stage renal disease; Income, average income per capita; Dialysis specialist, ratio of dialysis specialists to total population of physicians. Forty-seven prefectures were allocated into quintiles according to the proportion of dialysis specialists. Survival rates were better in quintiles with higher ratios of dialysis specialists, while other parameters such as Age, Male, DM and Income were comparable for all quintiles.
patients without transplantations. A third characteristic is that the Japanese are relatively homogeneous from the genetic viewpoint, which makes it possible to ignore racial and ethnic composition factors. The fourth characteristic is that there is little disparity in wealth compared to other countries, and almost everyone is covered by medical insurance, enabling free access to specialist care without referral by a GP.

The quality of specialist care has been debated in various areas [23,27]. For predialysis management of chronic renal insufficiency, some studies have offered support for the superiority of specialist care over non-specialist care [1,6,21,26,30], but others have not [19,28]. This discrepancy may arise from the differences in target patients or study designs. However, with regard to long-term dialysis management, few have shed light on the appropriate role of dialysis specialist care. The lack of evidence may be partly due to the difficulty in estimating the survival rates of dialysis patients excluding transplant patients. In countries where renal transplantation is done for a relatively high proportion of patients, calculating the survival rates of dialysis patients without transplantation is difficult. Our cohort is suitable for analysis of dialysis survival without transplantation because Japan has an extremely low rate of transplantation (0.4%) due to ethical and religious constraints [20].

There are several plausible reasons to support the hypothesis that dialysis specialists can improve the long-term survival of dialysis patients. First, they have the ability to manage problems such as anaemia, mineral metabolism, blood pressure, nutrition, dialysis prescription, purification of water, vascular access and education of staff and patients. As dialysis specialists are very rigorously trained to manage these dialysis-related disorders, they might well contribute to a better prognosis by integrated therapies [2,7]. Second, compared to the predialysis phase, specialized management is even more important for the dialysis phase: deterioration of residual renal function hinders the balance of fluid volume and electrolytes, and dialysis-related diseases such as secondary hyperparathyroidism, dialysis hypotension and amyloidosis develop as the duration of dialysis becomes longer. These complications are outside the realm of GPs. This may be the reason why the involvement of cardiologists and nephrologists did not lead to reduction of mortality. In a highly specialized area, specialists seem more likely to confer for better health benefits than nonspecialists [11,30], while this does not always seem to be the case with common diseases [24,25]. Third, the number of dialysis specialists is not sufficient for the rapidly increasing number of patients. Thus, some dialysis patients are managed by nonspecialists. In Japan, there are less than 2000

Table 2. Simple regression analysis for survival rates at 5-year intervals

<table>
<thead>
<tr>
<th>Simple regression</th>
<th>5 years</th>
<th>10 years</th>
<th>15 years</th>
<th>20 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$r$</td>
<td>$P$</td>
<td>$r$</td>
<td>$P$</td>
</tr>
<tr>
<td>Age (year)</td>
<td>-0.21</td>
<td>0.16</td>
<td>-0.20</td>
<td>0.18</td>
</tr>
<tr>
<td>Male (%)</td>
<td>0.17</td>
<td>0.26</td>
<td>0.07</td>
<td>0.64</td>
</tr>
<tr>
<td>DM (%)</td>
<td>0.06</td>
<td>0.71</td>
<td>-0.02</td>
<td>0.91</td>
</tr>
<tr>
<td>Income (log, 1000 yen)</td>
<td>0.25</td>
<td>0.090</td>
<td>0.25</td>
<td>0.090</td>
</tr>
<tr>
<td>Dialysis specialists ($\times 10^{-2}$)</td>
<td>0.28</td>
<td>0.055</td>
<td><strong>0.30</strong></td>
<td><strong>0.040</strong></td>
</tr>
</tbody>
</table>
physicians per million of the population, which is the 26th place of the 29 in the Organization for Economic Co-operation and Development (OECD) countries; the OECD average is 2900 per million population (http://www.ecosante.fr/index2.php?base=OCDE&langs=ENG&lanh=ENG&valeur=&source=1).

Table 3. Multiple regression analysis for survival rates at 5-year intervals

<table>
<thead>
<tr>
<th>Multiple regression</th>
<th>5 years</th>
<th>10 years</th>
<th>15 years</th>
<th>20 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (per 10 years)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Male (per 10%)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>DM (per 10%)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Income (per log, 1000 yen)</td>
<td>0.07</td>
<td>0.093</td>
<td>0.06</td>
<td>0.092</td>
</tr>
<tr>
<td>Dialysis specialists ($10^{-2}$)</td>
<td>2.20</td>
<td>0.055</td>
<td>2.33</td>
<td>0.040</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.10</td>
<td>0.11</td>
<td>0.25</td>
<td>0.30</td>
</tr>
</tbody>
</table>

DM, diabetes mellitus as a cause of end-stage renal disease; Income, average income per capita; Dialysis specialist, ratio of dialysis specialists to total population of physicians; $r$, correlation coefficient by Pearson’s method; $\beta$, regression coefficient; $R^2$, adjusted multiple coefficient of determination. Significant factors ($P < 0.05$) are highlighted in **boldface** type.
Specialist care and improved survival in dialysis

Limitation

Our study has some limitations. First, due to privacy issues, we could not assess the precise roles of specialists in the treatment of dialysis patients: what kind of treatment improves the outcome should be investigated. Second, not all the known possible confounders such as anaemia, nutritional status, mineral metabolism and dialysis prescription were included in our model: data access to all these parameters was not permitted by some of the prefectures. Third, when applying a ratio, its meaning should be carefully considered. Fourth, our analysis is based on aggregated data, i.e. on an ecological regression level. Inferences found at this level cannot directly be transferred to an individual level because of the possibility of the so-called ecological fallacy [4,29]. However, ecological models are helpful tools for identifying spatial patterns of social or environmental factors. Further work is needed to test our current hypothesis that dialysis specialists improve the survival of dialysis patients.

In conclusion, our findings suggest that for patients on maintenance dialysis, specialist care seems to be associated with better survival rates, particularly with longer follow-up.

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Conflict of interest statement. None declared.

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