Due to an oversight resulting from inadequate communication, the papers of Shinzato et al. (Nephrol Dial Transplant 1996; 11: 2139–2143 and 2143–2151) were published without tables. Since the tables are crucial to the understanding of the text, NDT reprints these two articles with apologies to the authors.

Survival in long-term haemodialysis patients: results from the annual survey of the Japanese Society for Dialysis Therapy


**Abstract** The prognosis for haemodialysis patients is reported to be more favourable in Japan than in Europe or North America. Consequently, evaluation of the death predictors for haemodialysis patients in Japan is of considerable interest outside Japan. The Patient Registration Committee of the Japanese Society for Dialysis Therapy annually surveys the individual patient case mix, laboratory data and important events occurring in the previous years. Thus, using case mix data and laboratory data (including $K_t/V$ and protein catabolic rate) from the 1993 questionnaire survey and the individual patients' life/death statistics from the 1994 questionnaire survey, a logistic regression analysis was conducted on 53,867 patients. The analysis indicated that important death risk predictors were: (i) advanced age, (ii) occurrence of diabetes mellitus, (iii) male sex, (iv) $K_t/V$ lower than 1.8, (v) haemodialysis time less than 5 h, (vi) protein catabolic rate less than 0.9 g/kg/day, and (vii) percentage body weight decrease less than 4% and more than 8% during the first haemodialysis session of the week.

**Key words:** haemodialysis; renal failure; mortality; nutrition; diabetes mellitus

**Introduction**

The prognosis for haemodialysis patients in Japan is reported to be more favourable than in Europe or North America [1]. Thus, determining the death predictors for haemodialysis patients in Japan would provide worthwhile information not only for nephrologists in Japan, but for the nephrological community around the world.

In the present study, using material from the 1993 and 1994 surveys of the Patient Registration Committee of the Japanese Society for Dialysis Therapy, logistic regression analysis was carried out on patients receiving thrice-weekly centre-based haemodialysis to characterize potential predictors for death, based on case mix and laboratory data.

**Subjects and methods**

**Survey methods [2]**

The Patient Registration Committee of the Japanese Society for Dialysis Therapy performs annually a nationwide survey on the individual patient case mix and laboratory data and important events occurring during the previous year. For the present investigation, we used the case mix and laboratory data obtained from the 1993 survey and information on patient deaths occurring in the 1994 survey year. Completed survey forms were obtained from 2478 (93.8%) of the 2641 institutions surveyed in 1993. In 1994, the survey forms were mailed out to 2759 institutions of which 2616 (94.8%) replied.

**Patient sample**

Of the 131,492 patients on whom information was acquired with regard to the type of renal replacement therapy in the 1993 survey, 121,560 (92.4%) were centre-based haemodialysis patients. Information on the number of haemodialysis sessions per week was not given for 19,713 of the centre-based haemodialysis patients. After exclusion of such patients, the majority underwent haemodialysis three times per week, i.e. 88,693 (87.1%) among the total of 101,847 for whom such information was given. Among these patients receiving thrice-weekly centre-based haemodialysis, case mix and/or laboratory variables were not satisfactorily clear for analysis in 16,947 patients. Excluding these patients, 71,746 remained who received thrice weekly centre-based haemodialysis.

To calculate $K_t/V$ and protein catabolic rate (PCR) correctly, it is necessary to know the value of the residual renal urea clearance. Unfortunately, this was not among the items surveyed. Thus, assuming that it can be ignored in patients who had been on haemodialysis treatment for more than 2 years, some 15,315 patients who had been on haemodialysis...
for less than 2 full years were further eliminated from the cohort.

According to the 1994 survey, of the 56,431 patients selected for analysis in the 1993 survey, some 50,765 were alive and still on haemodialysis as of the end of 1994, 3,102 had died, 1,182 were on renal replacement therapies other than centre-based haemodialysis, such as continuous ambulatory peritoneal dialysis or haemodiafiltration, and 1,382 were lost to follow-up. In the logistic regression analysis, the 2,564 (4.5%) patients who were on therapies other than centre-based haemodialysis or who were lost to follow-up as of the end of 1994 were excluded (censored cases). As a result, there were 53,867 patients available for final analysis. The attributes of the sample are summarized in Table 1 (see footnote).

Assessment of the risk of death

A baseline analysis was performed using a stepwise logistic regression procedure to evaluate case mix variables such as age, sex, haemodialysis time, and occurrence of diabetes mellitus. Case mix variables found to be significantly associated with the probability of death were then fixed, and laboratory variables were added to this logistic regression model.

The Kt/V and PCR were both considered ‘laboratory variables’. For the sake of convenience, haemodialysis time and body weight decrease during haemodialysis were also included among the laboratory variables. Table 2 indicates the case mix and laboratory variables analysed in the present study. In the analyses, the Statistical Analysis System version 6 [3] was employed.

Calculation of Kt/V and PCR

Kt/V and PCR were determined according to the procedure of Shinzato et al. [4]. The Kt/V or PCR value determined by this method is virtually identical with that calculated by the three-point method of Gotch et al. [5].

Besides Shinzato et al., Daugirdas et al. [6] have reported methods to calculate Kt/V from the pre- and postdialysis serum urea nitrogen (SUN) levels. To compare the Kt/V parameters obtained by the methods of Shinzato et al. [4] and Daugirdas et al. [6], we randomly selected 2,000 patients from the present group of subjects. Among these patients, the Kt/V values determined using the methods of Shinzato et al. and Daugirdas et al. were virtually the same.

In addition to the method of Shinzato et al. to determine PCR from the pre- and postdialysis SUN levels, the method of Depner et al. [7] can be used. Using the above 2,000 patients randomly selected from the present subjects, a comparison was made between the PCR values obtained by Depner’s and Shinzato’s methods. The result indicated that PCR values obtained by the two methods were completely identical (r = 1.000; P < 0.0001).

Results

Association of case mix variables with the probability of death

Table 3 presents the results of the stepwise logistic regression analysis of the case mix variables. The age-related χ² values were the highest of all the case mix variable χ² levels. This shows that age indeed was the most important death risk predictor. With every 10-year increase in age, the risk of death rose 1.81-fold (95% confidence limits 1.76–1.86). Moreover, the risk relative risk of death for diabetic patients was 3.13 (95% confidence limits 2.82–3.48). Moreover, the risk of death for women was 0.76 times (95% confidence limits 0.71–0.82) that found in men. The duration of haemodialysis treatment was not found to be associated with the risk of death.

Association of laboratory variables with the probability of death

Table 4 gives the analytic results of the stepwise logistic regression model, including the laboratory variables together with the case mix variables which were found to be significantly associated with the probability of death. As is obvious from the table, every laboratory variable analysed turned out to be a significant predictor of death.

Figure 1 presents the adjusted relative risk of death for patient groups with different Kt/V, selecting 1.0–1.2
Table 4. Analytic results of the stepwise logistic regression model, including the laboratory variables together with the case mix variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regression coefficient</th>
<th>SE</th>
<th>$\chi^2$</th>
<th>$P$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case mix variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>intercept</td>
<td>−3.1749</td>
<td>0.2154</td>
<td>217</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>sex (female = 1)</td>
<td>−0.2365</td>
<td>0.0405</td>
<td>34</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>age in 1992 (every 1 year)</td>
<td>0.0554</td>
<td>0.0015</td>
<td>1304</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>diabetes (yes = 1)</td>
<td>1.0001</td>
<td>0.0539</td>
<td>344</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td><strong>Laboratory variables</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>percent weight decrease</td>
<td>0.0725</td>
<td>0.0104</td>
<td>48</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>haemodialysis time</td>
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<td>0.0413</td>
<td>68</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>$K_t/V$ for urea</td>
<td>−0.2454</td>
<td>0.0693</td>
<td>13</td>
<td>0.0004</td>
</tr>
<tr>
<td>protein catabolic rate</td>
<td>−1.2956</td>
<td>0.1069</td>
<td>147</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Fig. 1. Relative risks of different $K_t/V$ values. There was a progressive decrease in the probability of death as the $K_t/V$ became larger until it reached 1.8. But once the $K_t/V$ climbed beyond 1.8, no further decrease in the probability of death was observed. *: $P$ < 0.005; **: $P$ < 0.0001.

Fig. 2. Relative risks of different haemodialysis time. There was a progressive decrease in the probability of death as the haemodialysis time grew longer until it reached 5 hours. *: $P$ < 0.05; **: $P$ < 0.01; ***: $P$ < 0.0001.

Fig. 3. Relative risks of different protein catabolic rates (PCR). There was a progressive increase in the probability of death as PCR fell in the range of less than 0.9 g/kg/day. Especially under 0.5 g/kg/day, the probability of death was remarkably high. *: $P$ < 0.0001.

The decrease in body weight during haemodialysis reflects the body weight gain in between haemodialysis sessions. Thus, we attempted to assess the importance of the decrement in body weight during haemodialysis sessions. This was expressed as the ratio of the difference in the weight before and after haemodialysis relative to the weight after the treatment (i.e. percentage weight decrease). Figure 4 shows the adjusted relative risks of death for patient groups with different percentage decrease of body weight during the first haemodialysis session of the week. Values of 2–4% were taken as the reference range. As shown in the figure, both a small percentage weight decrease (less than 2%) and a large decrease (more than 8%) were associated with a greater risk of death.
Survival in haemodialysis patients

The death risk decreases progressively up to a $Kt/V$ of 1.8, which is in agreement with the findings of Charra et al. [10]. They reported that survival was better in patients whose $Kt/V$ (by the Daugirdas method) was over 1.6 compared with patients whose $Kt/V$ was lower. Moreover, the present results do not contradict the report of Nakai et al. [11], that the risk of hospitalization was greater in patients whose $Kt/V$ (by the Shinzato method) was less than 1.4, compared with those whose $Kt/V$ was higher.

The present analysis suggests that short haemodialysis times are associated with a greater risk of death. This corroborates the findings of Laurent et al. [12] and of Held et al. [13] who reported that the risk of death is lower in patients given haemodialysis for more than 4.25 h. Nevertheless, one cannot exclude the possibility that the higher risk of death associated with shorter haemodialysis times is attributable to the higher risk associated with lower $Kt/V$. However, even when the risk of death associated with shorter haemodialysis times was adjusted for $Kt/V$, there was no change in the risk of death (data not shown).

Numerous reports pointed to an association between low PCR and greater risk of hospitalization or death [14,15]. The present results indicate that patients with a PCR of less than 0.9 g/kg/day have a greater risk of death than patients with a PCR greater than 0.9 g/kg/day.

We assume that the decrease in body weight during haemodialysis sessions reflects the increase in body weight between haemodialysis sessions. In our analysis, patients with a weight decrease of less than 2% have a greater risk of death than patients with a weight decrease of 2–4%. It seems possible that among patients with a low body weight decrease during haemodialysis, at least some consume an insufficient amount of food and therefore of water and salt. Thus, the high risk of death in patients with a body weight decrease of less than 2% during haemodialysis sessions may in part be attributable to malnutrition. On the other hand, patients whose body weight decrease exceeded 8% also had a higher risk of death, supporting the idea that excessive water and salt intake is an important risk factor.

In order to eliminate the influence of diet on the risk of death associated with greater or less body weight decrease during haemodialysis, the risk was adjusted for PCR. As a result, in patients with a body weight decrease of less than 2%, the risk was no longer significant, whereas in those experiencing body weight decrease of over 8%, it became greater (data not shown). Thus, the higher risk of death associated with a body weight decrease of more than 8% may be underestimated because of the positive effect of greater protein intake.

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The mean $K_t/V$ and haemodialysis time of the subjects of the present study differ from those elsewhere reported for haemodialysis patients in Japan because patients on haemodialysis for less than 2 years were excluded from the present study.

References


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