Dementia and Physical Disability as Competing Risks for Mortality in a Community-Based Sample of the Elderly Japanese

ICHIRO TSUJI, YUKO MINAMI, JING-HUA LI, AKIRA FUKAO, SHIGERU HISAMICHI, HIROTAKE ASANO*, MAKITO SATO* and KAZUO SHINODA†

Department of Public Health, Tohoku University School of Medicine, Sendai 980-77, *Sendai City Health Department, Sendai 980, and †Shinoda Clinic, Sendai 981

TSUJI, I., MINAMI, Y., LI, J., FUKAO, A., HISAMICHI, S., ASANO, H., SATO, M. and SHINODA, K. Dementia and Physical Disability as Competing Risks for Mortality in a Community-Based Sample of the Elderly Japanese. Tohoku J. Exp. Med., 1995, 176 (2), 99-107 — To examine whether an excess mortality due to dementia is independent of coexisting physical disability, a probability-sample of the non-institutionalized elderly (n = 3,308) living in Sendai City, Japan was followed between 1988 and 1991. Of those, 128 were diagnosed as dementia in 1988 by psychiatrists, using Diagnostic and Statistical Manual of Mental Disorders, Third Edition-Revised as a diagnostic standard. Information on the ability to perform activities of daily living (ADL) was collected by self-report of the study subjects in 1988 baseline survey. The survival status was investigated three years later. The risks of dementia and co-existing ADL disability for mortality was examined by Cox proportional hazard models. The results indicated that the relation between dementia and mortality was two-fold, depending upon the physical functions. Dementia increased the risk for mortality among those without ADL disability, but it did not so among those with ADL disability, rather ADL function was a stronger predictor for mortality among the latter individuals. Prevention and treatment of physical disability would be important for improving the survival of the demented people.

Dementia is known to be associated with an excess mortality among the elderly (Goldfälbl 1969; Palmore 1969; Peck et al. 1978; Rorsman et al. 1985; Molsa et al. 1986; Martin et al. 1987; Aronson et al. 1991; Li et al. 1991; van Dijk et al. 1991, 1992). Many studies have investigated the predictive power of such characteristics as clinical type, severity, and duration of dementia for mortality (Vitaliano et al. 1981; Barclay et al. 1985; Molsa et al. 1986; Knopman et al. 1988;

Received December 22, 1994; revision accepted for publication March 11, 1995.
Address for reprints: Ichiro Tsuji, Department of Public Health, Tohoku University School of Medicine, 2-1 Seiryomachi, Aoba-ku, Sendai 980-77, Japan.
Jagger and Clarke 1988; Hier et al. 1989; Walsh et al. 1990; van Dijk et al. 1991, 1992). However, most of the studies have been concerned with dementia only, and very few have examined the risk of dementia in relation with other known risks for mortality such as physical disability (Goldfalb 1969; Palmore 1969; Peck et al. 1978; Vitaliano et al. 1981; Jagger and Clarke 1988; Walsh et al. 1990). Physical disability, measured as inability to perform activities of daily living (ADL), is more frequent among the demented patients than among the non-demented elderly. Since ADL disability significantly increases mortality (Warren and Knight 1982; Manton 1988; Koyano et al. 1989; Guralnik et al. 1991; Ho 1991; Arroz et al. 1992; Wagner et al. 1992; Tsuji et al. 1994), it is critical to answer whether the coexistence of physical disability alter the risk of death among the demented individuals. van Dijk et al. (1991), based on the review of literatures regarding the prognosis of demented patients, recommended that the prognostic value of variables (gender, age, clinical features of dementia, or comorbidity) should be expressed quantitatively, not only individually but also in combination with other variable. Vitaliano et al. (1981) proposed a question to what degree dementia is differentially life-shortening for patients stratified according to gender, functional status, and age. Answering these questions would lead us to a better understanding of the natural course of dementia and a better management of the demented patients.

The question addressed in the present study is whether the excess mortality among dementia is independent of coexisting physical disability. We investigated this issue, based on a three-year follow-up of a randomly selected sample of urban Japanese elderly living in the community.

**Methods**

The present study was performed as a part of the longitudinal observation of the elderly living in Sendai City, Japan: the Sendai Longitudinal Study of Aging (Minami et al. 1993; Tsuji et al. 1994). The purpose of this longitudinal study was to investigate the natural history of physical disability and dementia among the elderly living in urban Japanese community.

The study design has been described elsewhere in detail (Minami et al. 1993; Tsuji et al. 1994). In short, a survey was conducted to a sample of 3,704 subjects (5% random sample of the residents aged 65 years and over) on October 1, 1988. This survey consisted of two-stage investigation; Stage 1 was a questionnaire survey which aimed to screen the people with dementia suspected, and Stage 2 was physical and psychiatric examination by the trained public health nurses. Based on Stage 2 information, diagnostic evaluation of dementia was made by a committee of psychiatrists, using the Diagnostic and Statistical Manual of Mental Disorders, Third Edition-Revised (DSM-III-R) (American Psychiatric Association 1987) as a diagnostic standard. Differential diagnosis of the clinical type of dementia was not attempted, for the information obtained in Stage 2 was not
sufficient to make this determination with confidence.

Of 3,704 selected sample, 3,459 subjects (93%) responded to the Stage 1 survey. Eighty-three subjects were excluded from the analysis because they were staying at hospitals or long-term care institutions at the time of survey. Out of 3,376 subjects, 389 were screened as dementia suspected and were invited to the Stage 2 examination, and 330 subjects (85%) participated. Since the diagnosis of dementia was impossible among 59 subjects who declined to participate in Stage 2, they were excluded from the follow-up. Further nine subjects were excluded from the follow-up because one or more data were missing. Then, 3,308 subjects were followed. Of those, 128 (4%) were diagnosed with dementia. Residence in Sendai City as of October 1, 1991 was investigated by use of residents registration card held by Sendai City Government. Sixty-eight subjects (2%) had moved away from Sendai City and were lost to follow-up, thus they were excluded from the analysis. Accordingly, we analyzed mortality on 3,240 subjects, of whom 125 were diagnosed with dementia. There were 297 deaths (9%), identified through the residents registration card and verified by death certificates, during the three-year follow-up period.

**Study variables**

The variables used in the analysis were age, sex, dementia, and ADL disability. In the analysis, age at 1988 baseline survey was categorized into three groups: 65–74, 75–84, and 85+. Dementia was determined by the above diagnostic procedures. ADL disability was measured with questions about ability to perform the following four tasks: eating, dressing, toileting, and bathing. In the analysis, subjects were divided into three groups; those who were independent at all ADL tasks, those who were dependent at one or two tasks, and those who were dependent at three or four tasks.

**Statistical analysis**

We examined the risk of dementia for mortality, with or without controlling the effect of ADL disability during three-year follow-up, by using a Kaplan-Meier life-table analysis (Kaplan and Meier 1958) and a Cox proportional hazards model (Cox 1972). The length of survival for these analyses was considered as the number of days from October 1, 1988 to the date of death or censoring. Survivors were censored as of October 1, 1991. For life-table analysis, survival distributions between the groups of concern were tested by log-rank $\chi^2$ test. For Cox proportional hazards models, the dependent variable was the length of survival as above defined. An estimate of the relative hazard (RH) for mortality on each variable along with 95% confidence interval (95% CI) was derived from the coefficient and standard error of the Cox proportional hazards model. All statistical analyses were performed by using Statistical Analysis System (SAS) (SAS Institute 1992) such as PROC LIFETEST, PROC PHREG and so forth. Statisti-
Results

During three-year follow-up, 48 (38%) out of 125 demented subjects died while 249 (8%) out of 3,031 non-demented subjects died. Those with dementia showed significantly poorer survival than those without dementia ($\chi^2 = 158.1; p < 0.001$, Kaplan-Meier survival curves not shown).

Table 1 indicates RH (95% CI) of dementia for mortality by Cox proportional hazard model, adjusted for the effect of age-group and sex. Dementia significantly increased the risk for mortality, RH: 2.81 (95% CI: 2.02–3.90), if ADL disability was not taken into account. RH of dementia, however, decreased to 1.41 (95% CI: 0.97–2.07) and became non-significant if ADL disability was included into the model. ADL disability was a significant predictor for mortality, and there was a dose-response relationship between the severity of ADL disability and the subsequent mortality. RH for those who required help at one or two ADL tasks, in comparison with those who were fully independent in ADLs, was 3.06; and RH for those at three or four tasks was 3.80.

Fig. 1 shows RHs for mortality among the subgroups with various levels of mental and physical functions, which was calculated by a Cox proportional hazard model controlling for the effect of age-group and sex. In this analysis, the

<table>
<thead>
<tr>
<th>Characteristics and level</th>
<th>Relative hazard (95% CI)</th>
<th>Model 1&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Model 2&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.53 (0.42–0.66)</td>
<td>0.52 (0.41–0.65)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65–74 years</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>75–84 years</td>
<td>2.83 (2.12–3.72)</td>
<td>2.60 (1.97–3.43)</td>
<td></td>
</tr>
<tr>
<td>85+ years</td>
<td>9.50 (6.54–13.02)</td>
<td>7.84 (5.67–10.83)</td>
<td></td>
</tr>
<tr>
<td>Dementia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2.81 (2.02–3.90)</td>
<td>1.41 (0.97–2.07)</td>
<td></td>
</tr>
<tr>
<td>Number of disabled ADL tasks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>—</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>1–2</td>
<td>—</td>
<td>3.06 (2.05–4.57)</td>
<td></td>
</tr>
<tr>
<td>3–4</td>
<td>—</td>
<td>3.80 (2.57–5.61)</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>the effect of ADL disability was not adjusted in the model; <sup>b</sup>the effect of ADL disability was adjusted.
A group of subjects who were non-demented and independent in all ADL tasks at the 1988 baseline survey was treated as the reference, and fills of the other five subgroups were calculated by the model. For those without ADL disability, dementia significantly increased the risk for mortality. However, among those who required help in one or more ADL tasks, the presence or absence of dementia did not alter the risk for mortality. Rather, severity of ADL disability was more associated with increased mortality. Accordingly, the association between dementia and mortality was two-fold, depending upon the presence or absence of dementia.

Fig. 1. Relative hazard for mortality among the subgroups with different levels of function to perform ADL tasks for those without dementia (●—●) and for those with dementia (○—○), respectively.

Fig. 2. Kaplan-Meier survival curves of the demented individuals with ADL disability (-----) and without it (----), respectively.
I. Tsuji et al.

TABLE 2. Causes of death among the decedents who were non-demented, demented with ADL disability, and demented with ADL disability, respectively, at the 1988 baseline survey

| Causes of death | Non-demented | Demented | | | |
|-----------------|--------------|----------|----------|----------|
|                 | Non-disabled | Disabled | Non-disabled | Disabled |
| Cancer          | 76 (30.5%)   | 3 (18.8%) | 1 (3.1%)  |          |
| Heart disease   | 54 (21.7%)   | 3 (18.8%) | 7 (21.9%) |          |
| Stroke          | 38 (15.3%)   | 1 (6.3%)  | 11 (34.4%)|          |
| Pneumonia       | 18 (7.2%)    | 3 (18.8%) | 3 (9.4%)  |          |
| Senility        | 15 (6.0%)    | 4 (25.0%) | 7 (21.9%) |          |
| Miscellaneous   | 48 (19.3%)   | 2 (12.5%) | 3 (9.4%)  |          |
| Total           | 249          | 16       | 32       |

physical disability; dementia was associated with excess mortality among those without ADL disability, but it was not so among those with ADL disability, rather ADL dysfunction was stronger than dementia as predictors for mortality among the latter individuals.

These findings suggest us that the natural course would be different between the demented individuals with physical disability and those without it. Thus, further analyses were focused on the survival distribution and the causes of death among the demented elderly with and without ADL disability. Fig. 2 shows Kaplan-Meier survival curves of the demented individuals with and without ADL disability, respectively. The survival of the demented with ADL disability tended to be lower than those without it (log-rank $\chi^2 = 3.27; p = 0.07$), although the difference failed to reach the statistical significance. The survival curves of both groups were almost identical up until one year, however, the survival of the demented with ADL disability became poorer later on.

Table 2 indicates the causes of death among the non-demented subjects, the demented without ADL disability, and those with it, respectively. Although statistical test was inappropriate because of the small sample size, there was a remarkable difference in the distribution of causes of death among the three groups. Cancer was the most frequent cause of death among the non-demented subjects, but it was not true among the demented subjects. Among the demented elderly, causes of death were highly dependent upon the presence or absence of physical disability. Stroke was the most common cause of death among the demented with disabled ADL function, but it was rare among those without ADL disability. Senility, pneumonia, and heart disease were common causes of death among the demented with independent ADL function.

DISCUSSION

The present cohort study on the elderly Japanese living in the community
indicated that the excess mortality among the demented subjects was confounded by the effect of physical disability, and physical disability was a stronger predictor for mortality than dementia among those with disabled ADL function. Our study sample was representative of the elderly in Sendai City, Japan. Response rate was generally high, and drop-out due to migration during the follow-up was rare.

The reasons for excess mortality in dementia have been noted or speculated as concomitant presence of physical health impairment, poor nutrition, decreased functional ability, increased risk of accidental injury, secondary effects of brain failure on other organ systems, and so forth (Martin et al. 1987). Although the coexistence of physical disability has been pointed out as one of the reasons for excess mortality in dementia, well-controlled studies regarding the inter-relation of dementia and physical disability upon mortality were limited, and the results were inconclusive. Palmore et al. (1969), based on the follow-up of the non-institutionalized elderly, reported that physical functioning had stronger predictive power for mortality than intelligence performance. Another community-based observation of the elderly indicated that both physical disability and cognitive impairment were equally and independently significant predictors for mortality (Jagger and Clarke 1988). Based on a follow-up of the outpatient group of dementia, Martin and colleagues reported that physical health impairment and dementia were equally strong predictors for mortality (Martin et al. 1987). van Dijk et al. (1992) who observed nursing home patients with dementia reported that, although physical disability was a significant predictor for mortality, the predictive power of dementia for mortality was stronger than that of physical disability. The present study indicated that dementia did not significantly predict mortality.

In contrast, the analysis of mortality risks according to the subgroups of different levels of mental and physical functions, respectively (as in Fig. 3), provided us with a clear picture. The significance of dementia as a risk for mortality was different between those with ADL disability and those without it; the presence of dementia significantly increased the risk of death among the physically independent elderly, however, it did not do so among the physically disabled. This result was in agreement with Martin et al. (1987) who reported that among the severely physically impaired, survival was not significantly different between dementia and non-dementia. One could argue that the risk for mortality has already been saturated among those with physical disability. However, it is not correct because, as shown in Fig. 1, more severe degree of ADL disability further increased the risk for mortality. Thus, physical disability was a stronger risk for mortality than dementia.

The present study also demonstrated that the natural course was different between the demented with physical disability and the demented without it; the former tended to die earlier and the causes of death were different between the
groups. This difference of natural course could be attributable to the difference of clinical type of dementia; vascular or Alzheimer type. The demented subjects with physical disability would be mostly attributable to vascular origin, and those without disability could be mostly due to Alzheimer type. Molsa et al. (1986) reported that stroke was the most common cause of death among multi-infarct dementia, and that the severity of dementia was a significant predictor for mortality among the patients due to Alzheimer type but not among those due to multi-infarct. Their results were highly suggestive for the hypothesis that differential effect of dementia on mortality, observed in the present study, was in part attributable to different types of dementia. However, it should be noted that the limitation of the present study is lack of clinical information such as the differential diagnosis on the type of dementia, CT scan of the brain of the demented subjects, and so forth. The interaction between physical disability and dementia on survival among the demented elderly, stratified with clinical type and severity of dementia, should be further scrutinized, based on comprehensive clinical data.

The present results suggest that a substantial part of the excess mortality among the demented elderly with physical disability was attributable to the coexisting physical disability. Since physical disability is more frequent among those with dementia than those without dementia, this finding emphasizes the importance of prevention and treatment of physical disability to improve the survival of patients with dementia.

References


