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Predictive Factors for Hospitalized and Institutionalized Care-giving of the Aged Patients with Diabetes Mellitus in Japan

TOSHIOKI MATSUZAWA[1], TAKASHI SAKURAI[1*], MASAKO KURANAGA[1], HIDETOSHI ENDO[2], and KOICHI YOKONO[1]

[1]*Department of General Medicine, Kobe University Graduate School of Medicine, Kobe, Japan*

[2] *Department of Geriatric Medicine, National Hospital for Geriatric Medicine, Obu, Japan*

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ABSTRACT

To identify predictive factors for hospitalized and institutionalized care-giving among a group of aged patients with diabetes mellitus in Japan, retrospective chart review was performed in 288 diabetic subjects aged 65 years or older. Independent variables, based on the chart review, were age, sex, diagnosis, diabetic control and complications. Comprehensive geriatric assessment was performed to obtain information on the functional capacity and demographic variables, including physical and mental function, and socioeconomic status. 131 diabetic patients were considered as frail elderly and characterized for their higher age, longer duration of diabetes, higher frequency of insulin use, lower cognitive function, and lower QOL, in comparison with those of non-frail patients. All non-frail diabetic patients were independently treated at their homes, while 38 subjects out of 131 frail diabetic patients were hospitalized or institutionalized. Apparent clinical features of hospitalized/institutionalized patients were higher age, higher serum creatinine, and higher prevalence of stroke episodes, advanced cognitive decline and absence of key caregiver in the family members, in comparison with those of in-home frail diabetic patients. The predicted probabilities from the multivariate logistic regression analysis in predicting hospitalized and institutionalized care-giving were as follows: $\text{Log } p/(1 - p) = -19.801x_1 - 54.269x_2 + 721.405$; where x_1 = cognitive function (score), x_2 = social support (score). Receiver operating characteristic curve analysis revealed a satisfactory discrimination for hospitalized and institutionalized care-giving in frail diabetic elderly with 92.9% of sensitivity and 91.4% of specificity, when the cutoff point of the model was set at 0.992. We concluded that cognitive decline and low social support are the predictive for hospital and institutional care-giving, and that demographic and mental information as well as diagnostic data should be analyzed to predict the hospitalization/institutionalization among frail diabetic elderly.

INTRODUCTION

Successful management of diabetes mellitus in the elderly population is a major public health challenge. The aging population (over 65 years) now makes up 23.1% of the overall

Phone: +81-78-382-5901 Fax: +81-78-382-5919 E-mail: sakurai@med.kobe-u.ac.jp

population in Japan, and the prevalence of diabetes in this population is over 16% (1). Along with the increasing duration of diabetes in the elderly, diabetes-related complications frequently occur and propagated: not only vascular complications such as diabetic foot, retinopathy, and nephropathy, but also age-associated illness and frail homeostasis, which produce a high rate of disablement and decay of quality of life. The complexity of physical and mental disability, coupled with the vulnerability to frailty often disturbs the day to day diabetes self-management at their homes. In the previous reports (2-4), diabetes is a significant predictor for the institutionalization among the frail elderly; the aged diabetic patients are 1.8 times more likely to enter a nursing home (2). Therefore, for the achievement of successful medical treatment of diabetic elderly, the cooperative long-term caregiving should be conducted, involving community-based and institutional care services.

Japan moved toward socialization of care for the frail elderly by initiating public, mandatory long-term care insurance in 2000. Everyone aged 65 and older is eligible for benefits based strictly on physical and mental disability. The long-term care insurance covers chronic-care beds in hospital, institutional and community-based caregiving. By improving the health outcomes, community-based caregiving can reduce the cost of the frail elderly, and the ability to identify patients who are at high risk for hospitalization and institutionalization could be useful not only in setting the medical treatment of the frail elderly, but also in developing policy for the long-term care insurance. Several studies have looked at factors that might predict hospitalization among populations of community dwelling older adults (5, 6) hospitalized patients (7), and those with dementia (8). However, information on the hospitalized and institutionalized care-giving of frail elderly with diabetes is scarce.

The present study attempts to identify predictive factors for hospitalized and institutionalized care-giving among the elderly with diabetes. For this purpose, we reviewed the charts of diabetic elderly who were treated at the Kobe University Hospital. Relationship between medical, functional and demographic variables of the diabetic elderly and the subsequent hospitalization and institutionalization was examined.

MATERIAL AND METHODS

Participants

Retrospective medical chart of 288 patients aged 65 years or older with known diabetes mellitus (164 women; mean age, 72.8± 7.7 years) were reviewed. This study was conducted from 2006-2009. The institutional review boards of Kobe University Hospital approved the research protocol, and written informed consent was obtained from each patient and his or her family members. All subjects met the criteria of diabetes from Japan Diabetes Society (9). At entry into this study, geriatricians routinely examined all patients to estimate diabetic control and complications, and assessed the functional and socioeconomic status. Professionals in neurology, psychiatrics, orthopedics, urology, and ophthalmology examined their specific problems.

Among 288 diabetic elderly, 131 patients were considered as frail elderly by their chief physicians. In this study, frail elderly was defined as persons who are vulnerable and at high risk of a range of adverse health outcomes, such as dependency, institutionalization, falls, injuries, acute illness, hospitalization, slow recovery from illness and mortality, and also included persons who have relatively preserved physical function, but easily become supported or cared condition (so-called ‘‘specified elderly individuals’’) in the modified Japanese long-term care insurance (10). Frail diabetic patients often had nonlocalizing or

constitutional symptoms such as weakness, fatigue, poor appetite, undernutrition, and/or dehydration.

Measurements of diabetic control and complications

Glycemic control and diabetes-related complications were analyzed by data chart. Fasting and postprandial blood glucose and HbA1c examined diabetic control in each individual. Information on duration of diabetes and on pharmacological therapeutics for diabetes was obtained. Diabetic retinopathy was classified into three subclasses, normal, nonproliferative, and proliferative diabetic retinopathy. Diabetic neuropathy was diagnosed by subjective symptoms and by objective examinations; autonomic function was tested by beat to beat variation test and Schellong test, and conduction velocity of the peripheral nerve was measured. Based on these observations, diabetic peripheral neuropathy was classified into three subclasses, normal, asymptomatic, and symptomatic neuropathy. Renal complication of diabetes was estimated by quantification of serum creatinine and Urea-N in dialyzed and non-dialyzed patients. Abnormal findings in electrocardiogram, chest X-ray, and cardio-echogram diagnosed coronary artery disease and congestive heart failure. Previous stroke episodes were re-evaluated by neurological examinations and presence of the cerebral vascular disease was investigated by MRI brain scanning.

Assessment of functional and socioeconomic status

Information on physical, mental, and demographic status among the aged diabetic patients was collected through personal interviews and supplemented by corroborative data from nursing staff. Comprehensive Geriatric Assessment Form, a standardized data sheet was completed by the physicians and clinical psychologists (11, 12). Geriatric assessment consisted of following 8 examinations, which were shown to be important predictors of institutionalization (4): physical measurements, basic activities of daily living (ADLs), instrumental ADLs, cognitive function, quality of life (QOL), depression, and socioeconomic status. Functional measurements included visual acuity, auditory acuity, communication, and bladder incontinence. Each of the dichotomous variables was coded so that 3=normal, 2=slightly disturbed, 1=severely disturbed, 0=functionally disrupted. Ability of communication was tested to ask every subject to read a short paragraph and answer questions about the paragraph. Basic ADLs were determined using the Barthel index, including the ability for bathing, dressing, toileting, transferring, and eating. Instrumental ADLs were estimated by Roken score, established in the Tokyo Metropolitan Geriatric Hospital, Japan (13), which referred to going outside the home, shopping for groceries, preparing meals, managing finances, reading the newspapers and magazines, interests in health management, and communicating to family members and friends. For the self-administered screening instruments for depression, we used geriatric depression scale-15 (14). For measuring the cognitive function, mini-mental state examination (MMSE) was used (15). QOL was tested by the questionnaires of Morale scale of the Philadelphia Geriatric Center (16). To evaluate the socioeconomic status, we used the elderly diabetes impact scales (17). For caregiving conditions, 8 positive questionnaires and 4 negative questionnaires were asked, to know presence of and relationship with a key caregiver. Information on economical status was obtained from the patients and their caregivers, and coded so that 4=excellent, 3=good enough for daily life, 2=partially shortened, 1=asking for assistance.

Statistical analysis

Data were reported as mean ± SD. Two-tailed Student's t-test and χ^2 test were used to compare the variables between the frail and non-frail diabetic groups, and between the

institutionalized and in-home diabetic patients. Logistic regression analysis was employed to determine the predictive factors for institutionalization in frail diabetic elderly. Any significant items were entered into a multivariate logistic regression, using stepwise selection with an inclusion criteria of $p < 0.05$ and exclusion criteria of $p > 0.1$. Using a developed model, a receiver operating characteristic (ROC) curve was constructed to test the relationship between sensitivity and specificity using varying cutoff points of the model for predicting hospitalized/institutionalized care-giving. The area under the curve was calculated. Statistical analysis was performed using SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA). The level of significance was set at $p < 0.05$ for all statistical analyses.

RESULTS

Clinical characteristics of frail diabetic patients were shown in Tables I-III. Frail elderly were significantly older and had longer duration of diabetes than non-frail diabetic patients. However, there was no significant difference in gender (Table I). Type 1 diabetes was significantly frequent in the frailty group. Insulin user was more predominant in frail subjects than in non-frail patients. In the frail diabetic patients, HbA_{1c} levels were significantly higher than those in the non-frail group.

Table I. Clinical profiles of the non- frail and frail diabetic elderly

	Non-frail	Frail
Number (M/F)	157 (68/89)	131 (56/75)
Age (year)	70.3±6.3	75.3±9.0*
Duration of diabetes (years)	13.8±9.3	18.1±12.6*
Type 1 diabetes (%)	1.6	10.2 *
Insulin use (%)	22.9	43.5 *
HbA_{1c} (%)	7.4±1.4	7.9±1.1 *
Fasting blood glucose (mg/dl)	162±60	168±73

Data are presented as mean± SD. Student's t-test and χ^2 test were used to compare the variables between non-frail and frail patients. ＊P<0.05.

Underlying causes of the frailty in 131 aged diabetic patients were shown in Table II. Most common complication among the frail subjects was cognitive impairment including all types of dementia (30.5%), followed by visual disturbances (15.3%), depression (13.7%), cerebrovascular disease (13.7%), and end-stage renal disease (12.2%). MMSE of the frail diabetic subjects was 21.0±4.5, as shown in Table III, and thirty-two subjects of the frail diabetic patients were diagnosed as dementia. Visual disturbance was mostly due to diabetic retinopathy and/or cataracts. Coronary artery disease, congestive heart failure, and Parkinsonism were also frequently observed in the frail subjects. 5 frail patients had orthopedic disturbances such as hip and knee joints instability.

Table II. Underlying causes of frailty in 131 diabetic elderly

	Number (%)
Cognitive decline and Dementia	40 (30.5)
Visual disturbances	20 (15.3)
Depression and Other psychiatric disorders	18 (13.7)
Cerebrovascular disease	18 (13.7)
End-stage renal disease	16 (12.2)
Coronary artery disease and congestive heart disease	9 (6.9)
Parkinsonism	5 (3.8)
Orthopedic disturbances	5 (3.8)

Incidence of frailty is shown as a number of patients (%).

TableIII. Comprehensive geriatric assessment in non-frail and frail diabetic elderly

	Non-frail	Frail
Number (M/F)	157 (68/89)	131 (56/75)
Physical measurements (/12)	11.9 ± 0.3	11.3 ± 0.9
Basic ADL (/20)	19.6 ± 2.2	18.1 ± 3.0
Instrumental ADL (/13)	10.6 ± 2.3	9.9 ± 3.1
Cognitive function (/30)	24.8 ± 2.7	21.0 ± 4.5*
QOL (/17)	12.4 ± 3.1	11.3 ± 3.2*
Depression (/15)	4.2 ± 2.2	4.1 ± 3.5
Social support (/12)	9.3 ± 1.3	7.3 ± 3.3
Economic status (/4)	3.2 ± 0.4	3.2 ± 0.9

Data are presented as mean± SD. Student's t-test and χ^2 test was used to compare the variables between non-frail and frail patients. * $P<0.05$. Functional measurements included visual acuity, auditory acuity, communication, and bladder incontinence. Basic ADL and instrumental ADL were determined using the Barthel index and the Roken score, respectively. For measuring the cognitive function, mini-mental state examination was used. QOL was tested by the questionnaires of Morale scale of the Philadelphia Geriatric Center. Screening of depression was evaluated by geriatric depression scale-15. To evaluate the socioeconomic status, the elderly diabetes impact scales was used.

Demographic and functional status was assessed by comprehensive geriatric assessment (Table III). Of the physical measurements, visual acuity was slightly depressed in the frail subjects, other functional measurements including auditory acuity, communication, and bladder incontinence, were not different between non-frail and frail subjects (data not shown).

Basic ADLs and instrumental ADLs tended to decrease in the frail diabetic patients, which did not reach statistical significance in this study. MMSE of the frail diabetic patients was significantly lower than that of non-frail subjects. Depression was screened by the GDS-15, in which more than 5 positive answers were reported to indicate the possible geriatric depression (18). Scores of GDS-15 in frail and non-frail diabetic patients of this study were not elevated. Although an association between diabetes and depression has been recently postulated (19), our diabetic patients did not seem depressive, but rather in reasonably self-satisfactory condition. QOL was measured by Philadelphia Morale scale, and an average QOL was reported approximately 4 through 7 (20). QOL of our frail diabetic patients was slightly lower than that of non-frail diabetic patients. Socioeconomic status was not different between non-frail and frail diabetic elderly.

Table IV. Clinical profiles of in-home and institutionalized patients with diabetes mellitus

	In-home	Hospitalized/ Institutionalized
Number (M/F)	**93 (40/53)**	**38 (16/22)**
Age (year)	**73.0±9.2**	**81.2±4.9***
DM duration (years)	**17.8±13.3**	**18.7±10.9**
HbA_{1c} (%)	**7.8±1.0**	**8.2±1.3**
Blood glucose (mg/dl)		
Fasting	**165±77**	**173.7±68**
Postprandial	**259±76**	**285±80**
Insulin use (%)	**45.2**	**39.5**
Proliferative retinopathy (%)	**38.0**	**44.0**
Symptomatic neuropathy (%)	**75.5**	**69.7**
Dialysis treatment (%)	**11.4**	**23.7**
Serum creatinine (mg/dl)	**1.3±1.4**	**2.4±2.8***
Cerebrovascular diseases (%)	**12.0**	**41.1***
Coronary artery disease and heart failure (%)	**21.1**	**27.3**
Peripheral vascular disease (%)	**9.5**	**23.1**

Data are presented as mean± SD. Student's t-test and χ^2 test were used to compare the variables between in-home and institutionalized patients. ＊P<0.05. Diabetic retinopathy was classified into three subclasses, normal, nonproliferative, and proliferative diabetic retinopathy. Diabetic neuropathy was diagnosed by subjective symptoms and by objective examinations. Previous stroke episodes were re-evaluated by neurological examinations and presence of the cerebral vascular disease was investigated by MRI brain scanning. Abnormal findings in electrocardiogram, chest X-ray, and cardio-echogram diagnosed coronary artery disease and congestive heart failure.

All of 157 non-frail diabetic patients were independently living at their homes, whereas thirty-eight out of 131 frail diabetic patients (29%) required hospitalized/institutionalized care-giving. Next, we compared the medical, functional, and demographic variables of in-home and of hospitalized/institutionalized patients among frail diabetic subjects (Tables IV and V). Hospitalized/institutionalized patients were older than in-home subjects, while difference in gender was not significant (female gender was 57.0% and 57.9% in in-home and hospitalized/institutionalized patients, respectively). Blood glucose and HbA_{1c} levels were considerably higher in the hospitalized/institutionalized patients, but the difference in the glycemic control did not reach statistical significance. Prevalence of proliferative retinopathy and symptomatic neuropathy tended to be equally common among frail diabetic patients. In contrast, diabetic nephropathy was more propagated in the hospitalized/institutionalized diabetic patients. One fourth of the

hospitalized/institutionalized patients received dialysis treatment, and mean concentration of serum creatinine was significantly higher in hospitalized/institutionalized patients than in in-home patients. Of the macroangiopathic disease, cerebrovascular disease was more prevalent in the hospitalized/institutionalized patients, while coronary artery disease and peripheral vascular disease were not different between in-home and hospitalized/institutionalized patients.

Comprehensive geriatric assessment in the hospitalized/institutionalized patients with diabetes demonstrated that physical measurements including visual acuity, auditory acuity, communication, and bladder incontinence were not different, compared with those of in-home patients (data not shown). Basic and instrumental ADLs tended to decrease in the frail diabetic subjects with hospitalized/institutionalized care-giving, however, which did not reach statistical significance in the study. (Table V). In the super-old individuals aged 85 or over, basic ADL of the hospitalized/institutionalized patients was significantly impaired than that of in-home frail elderly (13.1±3.4 and 16.8±4.5, respectively) and instrumental ADL of the hospitalized/institutionalized patients was also lower than that of in-home frail elderly (5.2±4.0 and 9.0±4.2 in the respective group, $P<0.05$). In contrast, basic and instrumental ADLs of young-old (65-74 years old) and old-old (75-84 years old) were not altered between in-home and hospitalized/institutionalized patients. Cognitive function of the hospitalized/institutionalized patients was more seriously impaired than that of in-home frail elderly. However, scores of GDS-15 and Morale scale were similar in the in-home and hospitalized/ institutionalized patients. Social support for the hospitalized/institutionalized patients was significantly decreased and the presence of a caregiver in their family members was apparently lower in the hospitalized/institutionalized patients than in in-home patients (50.0% and 90.0%, respectively). Economic status did no differ between the in-home and the hospitalized/institutionalized elderly with diabetic mellitus.

Table V. Comprehensive geriatric assessment in the in-home and institutionalized patients

	In-home	Hospitalized/ Institutionalized
Number（M/F）	93 (40/53)	38 (16/22)
Physical measurements (/12)	11.3±0.9	11.2±1.0
Basic ADL (/20)	18.4±2.7	17.3±3.5
Instrumental ADL (/13)	10.3±3.0	9.0±3.5
Cognitive function (/30)	22.2±4.2	17.7±3.6*
QOL (/17)	11.4±3.1	10.9±3.6
Depression (/15)	4.0±3.2	4.4±4.1
Social support (/12)	8.7±1.9	2.4±2.2 *
Economic status (/4)	3.3±0.7	2.4±1.6

Data are presented as mean± SD. Student's t-test and χ^2 test was used to compare the variables between in-home and institutionalized patients. * $P<0.05$. Physical measurements, basic ADL, instrumental ADLs, cognitive function, QOL, depression, socioeconomical support were determined as described for Table III.

Finally, to develop a model for predicting the hospitalized/institutionalized care-giving in frail diabetic elderly using stepwise selection, clinical variables that were shown to be different at $p < 0.05$ (Tables IV and V) were entered into a multivariate logistic regression. This showed that cognitive dysfunction and low social support were predictive factors for hospitalization/institutionalization in frail diabetic elderly subjects. The predicted probabilities from the multivariate logistic regression analysis in predicting hospitalized/institutionalized care-giving were as follows: $\text{Log } p/(1 - p) = -19.801x_1 - 54.269x_2 + 721.405$; where x_1 = MMSE (score), x_2 = social support (score). ROC analysis revealed a satisfactory discrimination for hospitalization/institutionalization in frail diabetic elderly subjects with a sensitivity of 92.9% and a specificity of 91.4%, when the cutoff point of the model was set at 0.992.

DISCUSSION

This study first indicated that factors to predict hospitalized/institutionalized care-giving of frail diabetic elderly are cognitive decline and low social support, namely absence of a caregiver in the family members. These results indicated that cognitive dysfunction with changes in self-care behavior and treatment of diabetes may increase the use of care beds in hospital and institutional caregiving when social support is limited. In contrast, clinical features of frailty of diabetic elderly including aging, longer duration of diabetes, insulin use and decreased QOL were not critical for hospitalized/institutionalized care-giving.

Of the physical measurements, visual activity, auditory acuity, communication, and bladder incontinence did not differ between in-home and hospitalized/institutionalized frail diabetic patients. Basic and instrumental ADLs of the hospitalized/institutionalized super-old patients aged 85 or over were significantly impaired, but ADLs of the overall frail subjects were not changed in this study, which presumably due to the relatively preserved physical activities of the younger frail diabetic elderly. Our results in diabetic subjects were consistent to the previous reports that ADLs were not significantly associated with nursing home replacement (2), at least in the young-old and old-old diabetic populations. Among the general population, physical and mental disabilities have consistently been found to be the primary predictor for nursing home placement (2, 6-8, 21). However, in the selected frail elderly, the relative importance of functional limitations was lessened or even insignificant if caregiver conditions were taken into account (22). Follow-up of frail subjects recruited to the National Long-Term Care Survey (2-year mortality: 22%; 2-year nursing home replacement rate: 8%) showed that caregiver burden was the strongest predictor among the variables and that ability to perform ADLs was not associated with institutionalization (21). Follow-up studies of demented individuals (1.5-year nursing home placement rate: 51%) also indicated that the predictive power of caregiver burden was stronger than ADL level of the care receivers (22).

Recent population-based cohort studies have suggested that older subjects with diabetes have an increased risk of dementia (23, 24). A critical review of 19 controlled studies concluded that sufficient evidence exists to link cognitive dysfunction with type 2 diabetes (24). We have reported the characteristics of cognitive dysfunction of Japanese diabetic patients (25-27). In this study, we found that lower MMSE was closely related to hospitalized/institutionalized care-giving in frail diabetic elderly. Our results confirmed to earlier studies that found that cognitive impairment is important in predicting institutionalization (3, 4). Sinclair et al. provided evidence that demonstrates that subjects with lower MMSE required significantly more assistance with personal care behavior, and were more likely to have been institutionalized (28). In addition, physical function was more

compromised in those with cognitive impairment. In this connection, it should be noted that our hospitalized/institutionalized patients were not so severely demented and maintained relatively preserved physical activities. However, even mild to moderate cognitive decline often disturbs the treatment of diabetes, including medication, exercise and diet therapy. Importantly, chronic hyperglycemia further worsens the cognitive dysfunction vice versa. Thus, it would seem more likely that the cognitive deterioration leads to poor self-management of diabetes, resulting in the increased need for hospitalized/institutionalized care-giving.

Another critical factor for hospitalized/institutionalized care-giving in diabetic elderly was caregiver issues, namely increased caregiver burden. Tsuji et al (2) pointed out three caregiver characteristics for the strong predictors of the nursing home placement: living separate from the patients, having time conflicts attribute to work, and being stressed by caregiving. In addition, they suggested that having a secondary caregiver in the family tended to decrease and using a formal caregiver tended to increase the risk of nursing home replacement (2). Although these findings were obtained in the general frail elderly in the defined area of southeast Baltimore, U.S., we felt that this was the case in Kobe, Japan. Therefore, clinicians must be alert to caregivers' burden, and have to pay much attention to use a formal caregiver under the long-term care insurance.

A major limitation of this study among diabetic elderly is the nature of the study population, who entered into this study at the Kobe University Hospital. Elderly subjects participating in research are likely to have lots of health problems, including a series of diabetes-related complications and age-associated illness. On the other hand, most diabetic elderly recruited in this study were highly motivated for receiving careful medical follow-up of diabetes. In fact, our diabetic patients seemed in reasonably self-satisfactory conditions and not depressive. These characteristics of our diabetic population were advantageous to investigate the possible risk factors of hospitalized/institutionalized care-giving, although we have to be cautious to consider the risk in general diabetic population. Second limitation is the reliability to assess physical activity, because we obtained information on ADLs from the patients themselves. Patients with dementia often overestimate their functional abilities. In this respect, it should be mentioned that the capacity for self-observation is considerably preserved in patients with mild to moderate dementia, although a decline in patient self-reporting on this issue is less dramatic than that seen in family reports (29, 30).

As noted, Japan started mandatory long-term care insurance in 2000. In respect of long-term care insurance, institutionalization is defined as entry into nursing homes or health facilities for the elderly and hospitalization is defined as entry into designated care beds in hospitals. In the nursing homes, frail elderly can be placed for long, but with limited medical facilities. Health facilities for the elderly can provide rehabilitation toward the independent self-care management for the frail elderly. Medical treatment can be provided in the care beds in hospitals, but only for the limited term. For the institutionalized patients with diabetes, medical follow-up for glycemic control and diabetes-related complications is additionally required, when compared with that for non-diabetic frail elderly. In particular, diabetes-specific medical requirements such as daily insulin injection, continuous dialysis therapy, and functional rehabilitation are often limiting factors for the institutionalization. These medical requirements for institutionalization in the frail elderly with diabetes should be overcome in near future.

Conclusively, cognitive decline and low social support are the predictive factors for hospitalized/institutionalized care-giving in diabetic elderly. We believe the current study emphasizes an obvious but critical fact, when caring for disabled and dependent diabetic

patients, clinicians should be sensitive to the people on whom they depend. The present study also indicated that the subsequent risk for hospitalization/institutionalization could be predicted at the time of entry into in-home care program by comprehensive understanding of risk, including medical problems, mental status, and social factors of the frail diabetic elderly.

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