Risk Factors for Nursing Home Placement in Alzheimer’s Disease: A Longitudinal Study of Cognition, ADL, Service Utilization, and Cholinesterase Inhibitor Treatment

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Purpose of the Study: To identify risk factors for early nursing home placement (NHP) in Alzheimer’s disease (AD), focusing on the impact of longitudinal change in cognition, activities of daily living (ADL), service utilization, and cholinesterase inhibitor treatment (ChEI). Design and Methods: In an open, 3-year, prospective, multicenter study in a routine clinical setting, 880 AD patients were treated with either donepezil, rivastigmine, or galantamine. At baseline and every 6 months, they were assessed with several rating scales including Mini-Mental State Examination, Instrumental Activities of Daily Living scale (IADL), and Physical Self-Maintenance scale. Moreover, the dose of ChEI, the amount of weekly assistance (home help service and adult day care), and the date of NHP were recorded. Cox regression models were constructed to predict the risk of NHP. Results: During the study, 206 patients (23%) were admitted to nursing homes. Factors that precipitated institutionalization were lower cognitive and functional abilities at baseline, faster rate of decline in IADLs, female gender, solitary living, and a lower mean dose of ChEI. The men living alone and patients with a substantial increase in adult day care also demonstrated shorter time to NHP. Implications: The rate of functional but not cognitive decline was a strong risk factor for NHP. The results could be used to identify the care recipients that might risk early NHP to ensure that these individuals receive a sufficient level of assistance. Furthermore, higher doses of ChEI might postpone institutionalization in AD.

Key Words: Adult day care, Home help service, Predictors

Cognitive impairment is one of the strongest predictors of nursing home placement (NHP) (Gaugler, Duval, Anderson, & Kane, 2007), and the cost of care in patients with Alzheimer’s disease (AD) rises dramatically with increasing severity of dementia. In 2003, the described total annual cost of care in AD was an average of 172,000 SEK (~23,200 USD) per individual, ranging from 60,700 SEK (~8,200 USD) in mild dementia to 375,000 SEK (~50,500 USD) in severe dementia. About half of these costs referred to special accommodations and community-based care (Jonsson et al., 2006). In a survey from the National Board of Health and Welfare in Sweden (Engstrom, 2001), approximately half of the nursing home residents were found to suffer from severe cognitive impairment. Similarly, the prevalence of dementia in new admissions to nursing homes in the United States was estimated to be 48%–54% (Magaziner et al., 2000).
The institutionalization process is complex; individual studies have reported several sociodemographic variables that predict early NHP in subjects with dementia, such as older age (Hatoum, Thomas, Lin, Lane, & Bullock, 2009; Heyman, Peterson, Fillenbaum, & Pieper, 1997), a lower level of education (Smith, Kokmen, & O’Brien, 2000), and solitary living (Gaugler, Kane, Kane, Clay, & Newcomer, 2003; Yaffe et al., 2002). Conflicting results regarding gender have been shown (Gaugler et al., 2003; Hatoum et al.). Furthermore, clinical factors such as lower cognitive (Gaugler et al., 2003; Heyman et al.; Yaffe et al.) and functional abilities (Gaugler et al., 2003; Hebert, Dubois, Wolfson, Chambers, & Cohen, 2001; Heyman et al.), behavioral and psychological symptoms (Gaugler et al., 2003; Yaffe et al.), and caregivers’ poor health and burden (Gaugler et al., 2003; Hebert et al.) were also described as predictors for reduction of time to NHP.

The majority of previous publications have investigated sole predictors; however, few authors have analyzed the potential interactive effects between the critical predictors (Fisher & Lieberman, 1999; Gaugler, Yu, Krichbaum, & Wyman, 2009). Moreover, most prior studies only consider baseline predictors, which offer little insight into the effect of possible longitudinal events that precipitate NHP. Gaugler et al. (2003) requested inclusion of predictors that measured long-term change, for example, functional status and service utilization, and sufficient follow-up to produce a more conclusive understanding of the institutionalization process.

A recent systematic review (Gaugler et al., 2009) reported that studies regarding cholinesterase inhibitor (ChEI) treatment in AD with NHP as an outcome measure were few and inconclusive. Some studies show that ChEI treatment delays admission to nursing homes (Gillette-Guyonnet et al., 2006; Lopez et al., 2002), others do not (Courtney et al., 2004). Furthermore, extension studies have suggested that effective dosages and sustained use might postpone institutionalization (Geldmacher, Provenzano, McRae, Mastey, & Ieni, 2003; Knopman et al., 1996).

There are no previously published naturalistic AD studies that consider the effect of the different ChEI agents and dosages on the time to institutionalization. Moreover, prognostic NHP models that include cognitive and functional rates of decline and long-term changes in service utilization are scarce.

Identifying factors that precipitate NHP in persons with dementia can be an important tool in clinical research as well as in planning for future care needs. Such information may also affect the targeting of clinical interventions and social strategies that allow those individuals to stay in their homes as long as possible (Gaugler et al., 2009; Luppa, Luck, Brahler, Konig, & Riedel-Heller, 2008).

The aim of this study was to investigate sociodemographic and clinical factors leading to early NHP in AD, focusing on the impact of longitudinal change in cognition, ADL, service utilization, and ChEI treatment.

**Methods**

**Study and Subjects**

The Swedish Alzheimer Treatment Study (SATS) was started in order to investigate the long-term efficacy of ChEI treatment (donepezil, rivastigmine, and galantamine) and to evaluate the longitudinal course of AD using ADL and service utilization measures such as assistance and NHP in naturalistic AD patients in a routine clinical setting. SATS is a 3-year, open-label, observational, nonrandomized, multicenter study, and the treatment and follow-up protocol have been thoroughly described earlier (Wallin et al., 2007). The subjects were prospectively recruited from 14 memory clinics in different parts of Sweden. Most patients are in the mild to moderate stages of the disease and the study is still ongoing. A total of 880 subjects with baseline Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975) scores ranging from 10 to 26 were included up until the end of October 2004, thus having the opportunity to complete the full 3-year SATS program. The MMSE score limits of 10–26 are often used when the intention is to include a population of mild to moderate AD patients (Gillette-Guyonnet et al., 2006). This level of disease severity was considered suitable for the analysis. Thus, the instrumental ADL (IADL) ability should already have been impaired and the ability to perform basic ADL functions essentially unaffected.

Before inclusion, all patients underwent a thorough clinical investigation including medical history, physical and neurological examinations, laboratory tests, and a cerebral computerized tomography in order to rule out other causes of dementia. Outpatients aged 40 years and older who received the clinical diagnosis of dementia as defined by the Diagnostic and Statistical Manual of
Mental Disorders, 4th edition (DSM-IV) (Frances & American Psychiatric Association, 1994) and possible or probable AD according to the criteria of the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer’s Disease and related Disorders Association (NINCDS-ADRDA) (McKhann et al., 1984) were considered for inclusion. In addition, the patients lived at home with or without community-based service at the time of diagnosis, had a responsible caregiver (in most cases the spouse or an adult child), and had to be assessable with the MMSE (i.e., had to have the capacity to communicate and sufficient visual and hearing abilities) at the start of ChEI treatment (baseline). Medications other than antidementia drugs were allowed and documented during the study, and the reason for study withdrawal was recorded.

All patients and/or caregivers gave their informed consent to participate in the study, which was conducted according to the provisions of the Helsinki Declaration and approved by the Ethics Committee of Lund University, Sweden.

The SATS patients were assessed in a structured 3-year follow-up program, which evaluated cognition, global functioning, ADL, and the amount of service utilization (home help service and adult day care) every 6 months. Trained dementia nurses obtained the ADL evaluation and the amount of service per week from an interview with the caregiver. Following inclusion and baseline assessments, the patients were prescribed ChEI as a part of the ordinary health care system in accordance with the approved product labeling. The patients paid for their own medication obtained from the pharmacy according to routine clinical practice. The SATS is an open and nonrandomized study and the choice of drug and dosage for the individual patient was left entirely up to the physician’s discretion and professional judgment.

Outcome Measures

Cognitive ability was assessed with the MMSE, ranging from 0 to 30, a lower score indicating a more impaired cognition. The Instrumental Activities of Daily Living scale (IADL) (Lawton & Brody, 1969) consists of eight different items: ability to use telephone, shopping, food preparation, housekeeping, ability to do laundry, mode of transportation, responsibility for own medications, and ability to handle finances. Severity was scored per item (1 = no impairment to 3–5 = severe impairment), giving a total range of 8–31 points. A score of 5 (unable to participate in any housekeeping tasks) had been added to the item “housekeeping.” If an item was not applicable to the individual, that is, not performed in their remorbid state, the score of this item was 0. Furthermore, a mathematical correction of the sum of the IADL scores was performed to prevent gender-dependent activities from having an affect on the results. The transformation used the data from the rated items to estimate a total score within the range of the total IADL scale (8–31). The formula was adapted from Green, Mohs, Schmeidler, Aryan, and Davis (1993).

Estimated IADL score

\[ I_{\text{AADL}} = 8 + \frac{(23(I_{\text{IADL}_0} - \text{min})/(\text{max} - \text{min}))}{\text{AADL}_0}, \]

where \( I_{\text{IADL}_0} \) = original IADL score, that is, the sum of the rated items; \( \text{min} \), minimum possible score for \( I_{\text{IADL}_0} \); \( \text{max} \), maximum possible score for \( I_{\text{IADL}_0} \).

The Physical Self-Maintenance scale (PSMS) (Lawton & Brody, 1969) consists of six different items: toilet, feeding, dressing, grooming, physical ambulation, and bathing. Each item was scored (1 = no impairment to 5 = severe impairment), allowing a total range of 6–30 points.

The widely used generic IADL scale and PSMS have the advantages of good reliability and validity, being easy to use, and not being as time-consuming as many of the more detailed dementia-specific ADL scales. Disease-specific scales might be more sensitive to functional losses that result from cognitive deficits; however, a scale that separated standard items of functioning into cognitive aspects of that function may be measuring cognition and not function (Desai, Grossberg, & Sheth, 2004; Spector, 1997).

Nursing Home Placement

NHP was defined as admission to a licensed skilled nursing facility with 24-hr care. The date of placement was obtained from study records and was only applied for permanent care, that is, rehabilitative NHP and respite care were not included. If hospitalization occurred prior to NHP, the date of hospital admission was used. Time was defined as the actual number of months between the start of ChEI treatment and each assessment or NHP. The subjects lost to follow-up were censored,
which implies they contributed with information during the time they participated in the study.

**Predictors.**—The research is based on the World Health Organization’s framework, “The International Classification of Functioning, Disability and Health,” which is a classification of health and health-related domains. These domains are classified from the perspective of the body functions and structure, individual (activity and participation), and environment (e.g., societal). In the first Cox regression model, the investigated predictors were classical risk factors such as age at baseline, age at onset, gender, level of education, carrier of the apolipoprotein E (APOE) ε4 allele, the number of medications at baseline, and living status (living alone or not). The impact of ChEI treatment was analyzed using the different drug agents and dosages. In addition, based on the findings of the clinical dementia investigation, cognitive and functional ability at baseline and the rate of change in cognition and function per month were included in the models to provide measures of the severity of AD and the progression rate. Finally, changes in the amount of community-based services per week during the past 6 months before NHP were included as measures of resource utilization given by the social services.

The rates of cognitive and functional change for the individuals who were admitted to nursing homes were calculated as the change in score from baseline to the last assessment before NHP, divided by the number of months between these assessments. For those not admitted, the rates of change were computed as the change in score from baseline to their last assessment, divided by the number of months. To facilitate comparisons of rates in MMSE, IADL and PSMS scores, change of score was converted to positive values indicating improvement and negative values showing decline.

The ChEI dose could vary during the treatment period for the individual patient and between the patients. Therefore, the mean dose used during the entire follow-up period was calculated for each patient. The impact of dose (high versus low) was analyzed using the median for each drug as the cutoff value; that is, donepezil 6.9 mg, rivastigmine 6.0 mg, and galantamine 16.0 mg.

The amount of home help service was defined as the number of hours per week, and adult day care as the number of days per week. The majority of subjects did not receive community-based service at baseline, 740 used no home help service, and 837 no adult day care. Thus, these potential predictors were treated as categorical variables due to the skewed distributions. Home help service was categorized: up to 0.5 hr/day in average (≤3.5 hr/week), 0.5–1 hr/day in average (3.75–7 hr/week), etc.

In the second Cox regression model, some biologically plausible interaction terms among the demographic variables (gender, age, and living status) and cognitive and ADL ability at baseline were included in the analysis, together with the variables from the first model. The interaction term Type of ChEI × Dose was also included. Because most individuals used no service at baseline and thus the events analyzing changes in service utilization were few in this cohort of mild to moderate AD patients, the possible interactions between cognitive and functional abilities or its change versus service utilization were not analyzed in this study.

**Statistical Analyses**

The Statistical Package for Social Sciences (SPSS) software (version 17.0; SPSS Inc., Chicago, IL) was used to perform the statistical analyses. The level of significance was defined as $p < .05$ if not otherwise specified.

Independent sample $t$ tests were used to compare the differences between the means for the patients admitted to NHP and the other subjects, as well as between the groups with different sociodemographic and clinical characteristics. One-way analysis of variance with Bonferroni correction was performed if more than two independent groups and chi-square test was computed for analyses of categorical variables.

Kaplan–Meier graphs were used to illustrate the differences in time to NHP regarding the categorical variables gender, living status, and dose of ChEI. The distribution of time for the categorical variables was compared using the log-rank test.

Cox proportional hazards models were used to separately estimate the effects of different risk factors on the relative risk of time to NHP. The analyses were done with adjustment for potential confounding of the baseline sociodemographic variables gender, age, and living status. The assumption of proportional hazards was tested with log minus log plots for the categorical covariates, and with time interaction test (the interaction term between the covariate and time was added to the model and generated a regression coefficient not significantly different from zero) for the time-dependent variables. No violation of the assumption of proportional hazards was detected.
Backward stepwise elimination Cox regression models were used to (a) simultaneously estimate the effect of all the previously described candidate predictors (main effects model) on the time to NHP, and (b) explore the possibility of two-way interactions among the demographic variables (gender, age, and living status) and cognitive and ADL ability at baseline by adding all such terms to the first model. The hierarchical principle was observed in these analyses; variables were not considered for elimination if they appeared in interactions. Variables with $p > .05$ were removed from the stepwise models.

The backward elimination analysis begins with a full model, including all the candidate predictor variables. It then removes the least significant variable, that is, the one with the highest $p$ value at each step. The fit of the model is tested after eliminating each variable to ensure that the model still fits the data adequately. When no more variables can be eliminated from the model, the analysis has been completed and should contain the most important predictors. In our Cox regression analyses, the models for selecting the predictor variables and their $p$ values were stable.

### Results

#### Baseline Characteristics

Of the 880 patients, 206 (23%) were admitted to nursing homes during the study, 53 of those admitted were able to fulfill the entire study. The remaining 674 subjects completed the 3-year study ($n = 286, 33\%$) or withdrew for reasons other than NHP ($n = 388, 44\%$).

The demographic and clinical characteristics of the patients divided into two groups, admitted or not admitted to a nursing home, are given in Table 1. Gender and living status significantly influenced the event NHP. During the study, 18% of the men and 27% of the women were admitted to a nursing home ($p = .002$). Of the patients living alone, 34% were admitted compared with 18% of those living with their spouse or another family member ($p < .001$). This difference was not explained by variations in age, disease severity, or the number of medications at baseline between these groups. At the start of ChEI treatment, the patients later admitted to nursing homes were older ($p = .001$) and more cognitively ($p < .001$) and functionally impaired ($p < .001$) compared with those not admitted (Table 1). No differences regarding level of education, carrier of the APOE $e4$ allele, age at onset, number of medications at baseline or mean ChEI dose during the follow-up period were found between the two groups. The variable living status was not associated with high versus low drug dose ($p = .125$).

#### Nursing Home Placement

Median time from the estimated onset of AD to NHP was 56 months (4.7 years), and median time
from the start of ChEI treatment to NHP was 20 months (1.7 years). Figure 1 demonstrates Kaplan–Meier graphs for the significant category variables gender, living status, and drug dose. Analyses of the distribution of time from the start of treatment to NHP showed differences between gender ($p = .001$), solitary living ($p < .001$), and dose of ChEI ($p < .001$). The median time from baseline to NHP was 24 months for men versus 18 for women, and 17 months for subjects living alone versus 23.5 for those residing with a spouse or relative. The patients who received a high dose of ChEI exhibited longer median time to NHP, 23.5 months, compared with 16.5 for those who received a lower dose.

Univariate Cox Regression Models.—Univariate Cox proportional hazards modeling suggested several risk factors to be associated with time to NHP. Shorter time to NHP was associated with lower cognitive and functional ability at baseline or a faster rate of decline; younger age at onset or older age at baseline, solitary living; a lower (0.25–3.5 hr) or higher (>7 hr) increase in home help service per week; more adult day care at baseline or an increase in three or more days per week; and a lower dose of ChEI and treatment with donepezil or rivastigmine. The hazard ratios with 95% confidence interval (CI) and $p$ values for these variables are listed in Table 2.

The association between living status and increase in service utilization was investigated; the individuals living alone receive a greater increase in home help service per week ($p < .001$). No significant difference was found regarding living status versus increase in adult day care per week. IADL ability at baseline differed between the treatment groups. Individuals treated with galantamine showed better function at baseline, IADL mean ± standard deviation (SD) score: 14.6 ± 5.4 versus donepezil 16.8 ± 5.6 and rivastigmine 15.5 ± 5.3, $p < .001$. After adjusting for baseline IADL ability in the Cox univariate type of ChEI model, no significant difference in the time to NHP between the specific drugs was found ($p = .368$).

Multivariate Cox Regression Models.—When subjected to multivariate backward elimination modeling, only seven of the variables from the univariate analyses were retained in the model. These variables were living status, dose of ChEI, MMSE, and IADL score at baseline; rate of change in IADL score per month; weekly increase in more than 7 hr of home help service; and an increase in three or more days per week in adult day care. Basic ADL ability, the rate of change in cognition and basic ADLs, age at onset and age at baseline, weekly assistance at baseline, and the type of ChEI were not significant predictors for the time to NHP in the multivariate models. The coefficients, hazard ratios with 95% CI, and $p$ values for the significant predictors are described in Table 3, Model 1.

In Model 2, including the interaction terms, the variable home help service, increase in hours per week was eliminated from the model. Instead, gender and the interaction effect, Gender × Living status were retained (Table 3). The interaction terms incorporating the variables age, cognitive
and ADL ability at the start of ChEI treatment were not significant nor was the term Type of ChEI × Dose. Because of the interaction, the effects of gender and living status cannot be interpreted in isolation. For the men living alone, the hazard ratio for the time to NHP was 3.73 compared with 1.0 for those men not living alone, and for the women living alone, the hazard ratio was 2.94 versus 1.69 for women living with their spouse or another relative. The relative hazards for various combinations of risk factors can be computed based on the coefficients listed in Table 3. Figure 2 illustrates the cumulative survival function for the interaction term Gender × Living Status. Analyses of the distribution of time from the start of treatment to NHP showed a significant difference (p < .001) for all pairwise comparisons except for the combination men living alone–women living alone.

**Differences in Clinical Characteristics at the Last Assessment Prior to Nursing Home Entry**

At the last assessment prior to NHP, 114 (55%) of the 206 subjects were living alone, and their mean ± SD age was 78.0 ± 6.1 years. The last cognitive and functional mean ± SD outcomes before admission for these subjects were MMSE score 17.4 ± 6.0, IADL score 22.8 ± 4.7, and PSMS score 10.6 ± 3.8.

The individuals living alone prior to NHP had better cognitive (MMSE score: 18.4 ± 5.3 vs. 16.1 ± 6.6, p = .007) and IADL ability (IADL score: 21.7 ± 4.7 vs. 24.2 ± 4.3, p < .001) before admission compared with those living with a spouse or other relative. No significant differences in age or basic ADL ability were detected. The interaction term Gender × Living Status was also analyzed concerning the cognitive and functional outcomes at the last assessment prior to NHP. The patients living alone exhibited IADL scores of 21.8 ± 4.1 (men) and 21.5 ± 5.0 (women) compared with those not living alone, men: 24.6 ± 4.0 and women: 23.9 ± 4.4 (p = .001). There were no significant differences in age or MMSE, or PSMS scores before admission regarding these groups. The classical risk factors gender, level of education, carrier of the APOE ε4 allele, and the received dose of ChEI demonstrated no differences on the last cognitive and functional outcomes before NHP nor did the type of ChEI regarding the difference in cognition and function between the start of treatment and NHP.

**Table 2. Univariate Cox Proportional Hazards Modeling of Time to Nursing Home Placement**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hazard ratio (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (male = 0, female = 1)</td>
<td>1.31 (0.95–1.81)</td>
<td>.100</td>
</tr>
<tr>
<td>Level of education (≤9 years = 0, &gt;9 years = 1)</td>
<td>0.92 (0.67–1.28)</td>
<td>.636</td>
</tr>
<tr>
<td>Carrier of APOE ε4 allele (no = 0, yes = 1)</td>
<td>1.25 (0.90–1.72)</td>
<td>.178</td>
</tr>
<tr>
<td>Solitary living at baseline (no = 0, yes = 1)</td>
<td>1.94 (1.45–2.60)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>ChEI doseb (low = 0, high = 1)</td>
<td>0.58 (0.44–0.76)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Type of ChEI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rivastigmine</td>
<td>0.76 (0.53–1.10)</td>
<td>.143</td>
</tr>
<tr>
<td>Galantamine</td>
<td>0.59 (0.39–0.89)</td>
<td>.011</td>
</tr>
<tr>
<td>Estimated age at onset, years</td>
<td>0.95 (0.91–0.99)</td>
<td>.026</td>
</tr>
<tr>
<td>Age at first assessment, years</td>
<td>1.03 (1.01–1.05)</td>
<td>.010</td>
</tr>
<tr>
<td>MMSE score at baseline</td>
<td>0.88 (0.85–0.91)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>IADL score at baseline</td>
<td>1.11 (1.08–1.14)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>PSMS score at baseline</td>
<td>1.13 (1.07–1.19)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>MMSE score, rate of change per month</td>
<td>0.53 (0.32–0.86)</td>
<td>.010</td>
</tr>
<tr>
<td>IADL score, rate of change per month</td>
<td>0.22 (0.13–0.38)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>PSMS score, rate of change per month</td>
<td>0.11 (0.06–0.20)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Number of medications at baseline</td>
<td>0.98 (0.92–1.04)</td>
<td>.427</td>
</tr>
<tr>
<td>Home help service at baseline, hr/weekcd</td>
<td>1.55 (0.94–2.57)</td>
<td>.088</td>
</tr>
<tr>
<td>Adult day care at baseline, days/weekd</td>
<td>1.68 (1.00–2.84)</td>
<td>.051</td>
</tr>
<tr>
<td>Adult day care, increase in hr/weekd</td>
<td>1.65 (0.91–3.00)</td>
<td>.099</td>
</tr>
<tr>
<td>Adult day care, increase in days/weekd</td>
<td>1.94 (1.04–3.59)</td>
<td>.036</td>
</tr>
<tr>
<td>Adult day care, increase in days/weekd</td>
<td>3.67 (1.93–6.97)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Notes: Hazard ratios are expressed per 1 unit increase for continuous variables and for the condition present in categorized variables. ChEI = cholinesterase inhibitor treatment; CI = confidence interval; IADL = Instrumental Activities of Daily Living scale; MMSE = Mini-Mental State Examination; PSMS = Physical Self-Maintenance scale.

aAdjusted (if applicable) for the baseline variables gender, age, and solitary living.

bCutoff median values for ChEI dose were donepezil 6.9 mg, rivastigmine 6.0 mg, and galantamine 16.0 mg.

cDonepezil was the reference category.

d0 hr/day/week was the reference category.
Discussion

In this longitudinal study, we found that the rate of change in IADL decline, but not in cognitive deterioration, was an important predictor of the time to NHP, after controlling for multiple factors previously shown to be of importance. Moreover, higher doses of ChEI, regardless of the specific drug agent, might postpone institutionalization in AD. Other factors that precipitated admission to nursing homes in the multivariate Cox regression model were lower cognitive and functional abilities at baseline; female gender; solitary living; and the interaction effect, men living alone. A substantial increase in adult day care predicted shorter time to NHP as well.

This study shows that a more rapid deterioration in IADL increases the risk for early NHP. One possible explanation could be that the subjects who undergo change or decline in functional health status while living at home may cause greater strains to caregivers and support services than those who remain stable over time, even with low ADL ability. Considerable changes in function can make it difficult for the caregivers and the service providers to adapt to, and offer sufficient home-based care (Wolinsky, Callahan, Fitzgerald, & Johnson, 1993).

In the present study, which includes patients from routine clinical settings, the multivariate Cox regression models demonstrated that individuals with an average decline of -0.2 IADL points/month were 1.54 times more likely (hazard ratio) to be admitted to nursing homes as those with no decline. Consistent with our findings, results from a long-term clinical trial (Hatoum et al., 2009) suggested that deterioration in ADL provided a
better predictive measure for NHP than deterioration in cognition. A patient with mean ADL decline participating in that trial exhibited a hazard ratio of 1.65 for NHP. Similarly, a large-scale 3-year dementia evaluation (Gaugler et al., 2003), which controlled for a considerable number of discrete variables, showed that subjects who had an increase of one or more ADL limitations were 1.48 times more likely to be institutionalized earlier.

A faster decline in IADL ability leading to early NHP may also have an impact on the amount of service utilization. In the present study, a lower (0.25–3.5 hr) or higher (>7 hr) increase in home help service per week, and an increase in three or more days per week in adult day care predicted early admission. The individuals living with a spouse or other relative received a smaller increase in home help service per week than did those living alone. A low increase in home help service that preceded NHP indicated that the increased level of care was not sufficient to support the caregiver and prevent institutionalization. This is in agreement with the observations made by Gaugler et al. (2003), who described a similar relationship between community-based service and admission to nursing homes. By identifying the care recipients at risk of an inadequate level of service, and focusing on their actual needs, it might be possible to postpone NHP for these individuals.

The increase in adult day care of more than 2 days/week remained a predictor of early NHP in the multivariate models in this study. Consistent with our findings, Hope, Keene, Gedling, Fairburn, and Jacoby (1998) described in a dementia study that one of the four best characteristics predicting NHP was, being away from the caregiver for more than 16 hours/week (the majority of time due to day care). When the care recipient gradually spends more time away from the home, the caregiver might become more accustomed to leaving the daily care to the social services, thus experiencing some relief in their burden, which perhaps facilitates the decision to resign care (Gaugler et al., 2003). Similarly, a previous AD study of adult day care services (McCann et al., 2005) suggested that those using more adult day care per week had an increased risk of NHP, even after adjusting for disease severity and caregiver burden. This indicates that adult day care served more as a transitional period to institutionalization than a form of respite, and thus precipitated NHP.

In this longitudinal naturalistic study, we found that a higher mean dose of ChEI, regardless of the specific drug agent, might postpone institutionalization in AD. Previously, few studies have investigated the impact of pharmacological interventions such as ChEI treatment on the outcome of NHP. In a recent review of predictors of NHP by Gaugler et al. (2009), the utilization of various types of medication yielded no consistent outcome. In an early open label extension of tacrine (Knopman et al., 1996), patients who remained on the drug and received effective doses of more than 80 mg/day were less likely to have entered a nursing home than those on lower doses. No similar dose—time to NHP effect was detected in a long-term naturalistic tacrine study from our group (Wallin, Gustafson, Sjogren, Wattmo, & Minthon, 2004); however, these patients received the higher effective doses during the 5 years. In a pooled study of AD patients previously enrolled in randomized placebo-controlled trials and subsequent extensions, Geldmacher et al. (2003) proposed that the use of effective doses of donepezil (>5 mg/day) and longer term sustained donepezil use was associated with significant delays in NHP. Lopez et al. (2002, 2005) showed in a comparison between treated and untreated matched AD cohorts that ChEI use was associated with a delay in institutionalization. In summary, these results suggest the clinical importance of prescribing sufficient doses of ChEI to the individual patient.

When investigating possible interaction effects between the risk factors in this study, the only significant interaction term was the association between gender and living status. The effect of these variables should therefore be interpreted
together. A substantial number of previous dementia studies have separately analyzed the effects of gender and marital status but hardly any considered the interaction (Luppa et al., 2008). In our study, the risk of NHP was almost fourfold for a man living alone compared with a man living with the spouse or relative. For a woman living alone, the risk was less than double compared with a woman living with a family member. A prior study of AD patients (Heyman et al., 1997), focusing on this interaction effect, found that the median time from enrollment in that study to NHP was at least a year less among the unmarried men compared with the married men and all the women.

The strengths of the 3-year SATS study are the prospective, regular, well-structured, semiannual follow-up investigations of large cohorts of ChEItreated AD patients in routine clinical settings. This longitudinal study adds to the current knowledge, regarding NHP, measures of change in cognition, function, and service utilization. Moreover, it enables analyses of clinical characteristics before the event NHP, as well as of potential differences between the ChEI agents and doses. The scheduled 6-month visits at the memory clinic and the presence of an identified contact nurse for each individual represent security and continuity for the patients. This work procedure reduces the risk that it is mainly the patients with active informal caregivers whose clinical and functional problems are reported to the attending physician and therefore receive better management of treatment and service utilization. The SATS study design has evolved into a clinical follow-up program, within the context of offering individualized care, which is nowadays applied to all AD patients in our memory clinic. One implication of this study, which is directly applicable to clinical praxis in our clinic, was that the occupational therapists would observe and follow up, in particular, the male patients living alone.

In Sweden, the amount of community-based care or admission to a nursing home is based solely on the individual’s need and is almost exclusively publicly funded (Holm, Liss, & Norheim, 1999). Decisions on the adequate level of care are made in a similar way within the social services system regardless of the care recipient’s place of residence. The family’s income or insurance coverage is rarely an issue when deciding the necessary amount of care given by the social services. Another advantage of the SATS is that only patients fulfilling the diagnostic criteria for AD are included. Prior studies regarding NHP mainly included the diagnosis of dementia in general and different diagnostic criteria were used or not reported, complicating the possibility of comparisons (Luppa et al., 2008). Different dementia diagnoses may yield different outcomes and costs. Bostrom, Jonsson, Minthon, and Londos (2007) showed, in a comparison between AD and dementia with Lewy bodies (DLB) cohorts, matched for identical cognitive severity, that the DLB patients utilized more community services and care resources than the AD patients.

The limitations of this study are that other factors that may influence the time to NHP, such as concomitant somatic diseases, behavioral symptoms of dementia, and the caregivers’ situation, were not evaluated in the SATS program. The inclusion of additional candidate predictors might influence the multivariate models. Yet, our results are consistent with other studies and there are no indications that the significant predictors would be less important even if mediated by other variables. For example, past research (Fisher & Lieberman, 1999; Severson et al., 1994) showed that when caregiver factors are predictive of NHP, they interact with the severity of the disease. Moreover, half of the individuals in this study later admitted to nursing homes were living alone at baseline. The influence of caregiver factors for those subjects, therefore, may be limited.

Future research should focus on how the service providers can best identify care recipients at risk of an inadequate level of service utilization. Moreover, identifying the interventions that would be most effective in helping the individuals at risk—for example, those with a faster rate of functional decline—remain at home longer. To provide a more conclusive understanding of the association between AD and resource utilization given by the social services, longitudinal analysis of the possible interactions between changes in disease severity, service utilization, and ChEI treatment are needed.

In conclusion, this study shows that a faster rate of IADL decline and a lower dose of ChEI were essential predictors for early NHP. Other risk factors were lower cognitive and functional abilities at baseline, female gender, solitary living, the interaction of men living alone, and a substantial increase in the use of adult day care. These critical characteristics could be used as a tool by the clinician in the multifaceted AD investigation and treatment process, involving both medication and support to patients and caregivers. Furthermore, the use of an effective dose of ChEI is important because this appears to prolong the
time to NHP in AD. Service providers might use the results to identify care recipients at considerable risk of NHP, thus ensuring that they receive a sufficient amount of home care intervention.

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