Analysis of Cognitive, Functional, Health Service Use, and Cost Trajectories Prior to and Following Memory Loss

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Objectives. This brief report examines whether significant changes in cognition, functional dependence, health service use, and out-of-pocket medical expenditures (OOPMD) occur in the years prior to a physician-identified memory problem in a nationally representative sample of older adults.

Method. Longitudinal data from the RAND-Health and Retirement Survey were utilized. Those who reported a physician-identified memory problem (n = 387) were compared with a randomly selected control group of similar age, race, and gender who did not indicate a memory problem (n = 387). Multilevel linear models were used to construct trajectories for various measures of cognition, function, health service use, and OOPMD in the years prior to and following memory problem identification.

Results. Several trajectories demonstrated significant rates of change in the years leading up to a physician-identified memory problem, including symptoms (mental status, fine motor skills, and instrumental activities of daily living) and utilization (OOPMD and overnight stays in hospital).

Discussion. Preclinical declines in mental status and function and increases in hospital use and OOPMD are apparent prior to the formal identification of memory problems. Earlier identification of these changes might provide a basis for interventions that could alter the clinical course of dementia.

Key Words: Alzheimer’s disease—Diagnosis—Preclinical—Prodromal.

Alzheimer’s disease or related dementias (ADRDs) are characterized by insidious progression. One conceptual model of Alzheimer’s disease suggests that by the time a formal diagnosis occurs, the extent of neuropathological decline makes it too late to implement clinical interventions that could revert such processes (Jack et al., 2010). However, identifying noticeable declines in cognitive performance prior to diagnosis could allow nonpharmacological or pharmacological treatments (some yet to be developed) to exert a more beneficial impact on the progression of ADRD. Empirical studies have examined trajectories of cognitive decline prior to and after a dementia diagnosis (e.g., Bäckman, 2008; Norton et al., 2009; Treiber et al., 2011), but whether such changes exist in other key domains such as functional dependence or health service use remain relatively unexplored.

The goal of this brief report was to examine changes across a wide range of domains in the months and years leading up to a physician-recognized memory problem among older persons (who may or may not suffer from preclinical stages of dementia). Although prior studies have examined preclinical declines in cognition among nonrepresentative samples of older adults who later receive an Alzheimer’s disease diagnosis (e.g., Bäckman, 2008; Small & Bäckman, 2007), no study to our knowledge (1) examines similar trajectories of decline or change across multiple functional and health service use variables or (2) includes representative samples with which to conduct such complex, longitudinal analyses. Utilizing a nationally representative data source (the Health and Retirement Survey), we examined trajectories of functional dependence, health service use, and medical expenses in order to determine whether there exist statistically significant changes in these outcomes prior to a physician-identified memory problem.

Method

Health and Retirement Survey

Data were derived from Waves 1 through 9 of the Health and Retirement Survey (HRS). The HRS is sponsored by the National Institute of Aging (U01AG009740) and the...
Social Security Administration. The HRS includes a nationally representative sample of households with at least one member born between 1931 and 1941 and their spouses. Starting in 1992, initial interviews were conducted in person and every 2 years thereafter via telephone survey. Proxy interviews (often the spouse of the respondent) were also completed. RAND has developed a user-friendly version of the HRS data set (RAND-HRS) that enhances the consistency of data collection and includes comprehensive imputation of missing data across waves (Center for the Study of Aging: A RAND Labor and Population Center, 2012). The RAND-HRS was utilized for this analysis.

Procedure

The principal identifying variable was initially asked at Wave 4 of all respondents (“Has a physician ever told you you have a memory problem?”). If a respondent answered yes to the memory problem question, it was no longer asked in subsequent interviews. In order to be included in our analysis, RAND-HRS participants had to answer “No memory problems” to the memory question the first time they were asked. In addition, respondents had to complete at least two or more interviews in the intervals following the memory question for longitudinal modeling purposes. Those who reported “yes” to the memory problem in later intervals were considered the “memory problem” group. We then randomly selected a control group of equal size (n = 387) among a stratified subsample of HRS respondents of similar age, gender, and race (±3 years) who did not indicate a memory problem at any follow-up.

Measures

Demographics.—The following key demographic variables were included for descriptive purposes: gender, race, age, marital status, self-rated health, employment status, years of education, and total financial assets.

Instrumental activities of daily living.—The RAND-HRS includes respondent reports of any difficulty on instrumental activities of daily living (IADLs; Lawton & Brody, 1969).

Activity of daily living dependencies.—Overall degree of disability and functional dependence was derived from the commonly used activity of daily living (ADL) measure (Katz, Ford, Moskowitz, Jackson, & Jaffe, 1963).

Cognition.—A summary variable including word recall and mental status items is included in the RAND-HRS. This variable has a possible range of 0–35 and includes immediate recall (0–10), delayed recall (0–10), serial sevens (0–5), backwards count from 20 (0–2), object naming (scissors and cactus; 0–2), president naming (0–1), vice president naming (0–1), and date naming (month, day, year, day of week; 0–4) (Fisher, Hassan, Rodgers, & Weir, 2012). To allow for comparison across other studies examining cognition in adult development and aging (including the HRS), the total cognition score variable was separated into immediate recall, delayed recall, and serial sevens subscores for the purposes of our trajectory analysis.

Large muscle limitations.—Any limitations (0 = no limitation; 1 = any limitation) noted when sitting for 2 hr, getting up from a chair, stooping, kneeling or crouching, and pushing or pulling large objects were assessed at each wave of the RAND-HRS and summed (Wallace & Herzog, 1995).

Mobility, fine motor, and gross motor indices.—The mobility index sums whether respondents had any difficulty walking one block, walking several blocks, walking across a room, climbing one flight of stairs, and climbing several flights of stairs. The fine motor index sums any difficulty respondents had picking up a dime, eating, and dressing. The gross motor index sums any difficulty respondents had walking one block, walking across a room, climbing one flight of stairs, getting in or out of bed, and bathing (Wallace & Herzog, 1995).

Costs and service utilization.—Self-reported cost and service use variables included OOPMD (e.g., durable medical equipment or over-the-counter medication expenses, excluding nursing home care), number of hospital stays and overnight hospital stays, number of nursing home stays and overnight nursing home stays, and number of physician visits in the past 2 years.

Analysis Plan

A multilevel change model was used to estimate longitudinal trajectories and to test for differences in those trajectories. In these models, person-specific rates of change over time were estimated at the individual level and modeled as effects of between-subjects predictors at a second, higher-order level (Singer & Willett, 2003). All dependent variables were z-scored to the baseline mean and standard deviation. Two time-varying predictors were included in the multilevel change models: the HRS interview wave/number and the interview number after a physician-identified memory problem. These two time-varying predictors tested the overall linear rate of change and whether this linear rate of change increased (or decreased) after a physician-identified memory problem, respectively. Time-invariant (level 2) predictors included whether the case did or did not report a physician-identified memory problem. Random effects were specified for the intercept and the linear rate
of change. A memory problem case by interview number interaction effect was also included that tested whether the linear rate of change over time before the identification of the memory problem was different than the rate of those who did not report a memory problem. All models were estimated using the restricted maximum likelihood method of SAS PROC MIXED (Littell, Milliken, Stroup, Wolfinger, & Schabenberger, 2006).

**RESULTS**

**Baseline Sample Characteristics**

Three hundred eighty-seven individuals who indicated a physician-identified memory problem were matched with 387 persons without memory problems on race (Caucasian = 77.8%), gender (female = 49.4%), and within ±3 years on age ($M = 60.08$ years for controls; $M = 63.0$ years for those with a memory problem). Chi-square tests were used to conduct comparisons between the race, marital status, health status, and employment variables and t tests were used to compare age, education, and financial assets across the two groups. A similar proportion of participants who suffered from a memory problem were married (70.9%) as controls (74.4%). A higher percentage of controls indicated excellent or very good health (48.3%) or were employed (59.1%) compared with those with subsequent memory problems (29.2%, 33.4%, respectively; $p < .0001$). Participants with memory problems had fewer years of education ($M = 11.5$ years) than controls ($M = 12.7$ years; $p < .0001$). The average number of people in the households of those who suffered from a memory problem or controls was statistically similar ($M = 2.4$). Controls also reported greater total financial assets ($M = $373,352) than those who had a subsequent physician-identified memory problem ($M = $252,503; $p < .05$). Baseline means for all outcomes are included in Table 1.

**Trajectory Analysis**

As shown in Table 1 and Figure 1, a key longitudinal pattern emerged where greater increases in impairment or service use were reported by those with a physician-recognized memory problem than controls in prememory problem intervals ($p < .05$ to $p < .0001$). This pattern occurred across various domains, including mental/cognitive status (total cognition score, immediate recall, delayed recall, serial sevens), function (fine motor skills, IADLs), and health service use (OOPMD, night stays in hospitals). A second pattern emerged where significantly greater increases in impairment or service use occurred following a physician-identified memory problem when compared with the intervals prior to memory problem identification ($p < .05$ to $p < .0001$). This second pattern was also apparent across multiple domains, including mental/cognitive status (total cognition score, immediate recall, delayed recall, serial sevens), function (ADLs, fine motor skills, IADLs, mobility, gross motor skills), and health service utilization (nursing home stays, night stays in nursing homes).

**DISCUSSION**

Individuals who reported a physician-identified memory problem were more likely to report greater increases in IADL difficulties, overnight hospital stays, and OOPMD as well as decreases in fine motor skills, word recall, and mental status in the years prior to a memory problem when compared with controls. These trajectories suggest that for fine motor skills, word recall, and mental status significant declines are apparent for those who experience a later memory concern (Bäckman, 2008; Jack et al., 2010; Small & Bäckman, 2007). The results here also build on earlier research by suggesting that IADL dependencies (which may be symptomatic of cognitive decline) as well as hospital use and OOPMD increase in the years prior to a physician-identified memory problem. For several other trajectories, no significant differences in rates of change prior to a physician-identified memory problem were evident between matched controls and those who indicated a subsequent memory problem.

Several limitations are apparent in this study. Most notably, the RAND-HRS data relied on self-report or proxy reporting methods. There was no documentation or verification available as to whether a dementia diagnosis occurred for participants who indicated a physician-identified memory problem; therefore, the transition point of interest in this article may not necessarily be ADRD diagnosis. Moreover, self-reported cost or health service use data may have been subject to recall error, potentially limiting the measurement validity of some RAND-HRS items. Because of the availability of the memory problem questions and when they were asked in the HRS, analytic cohorts were constructed that by necessity excluded potential participants in the earlier waves of the HRS. The sample is young compared with other longitudinal analyses of memory complaints, dementia, and aging, and it is possible that a number of underlying causes of memory problems were apparent but not identifiable in the HRS (e.g., early onset Alzheimer’s disease, familial Alzheimer’s disease, non-Alzheimer’s types of dementia such as frontotemporal dementia or mild cognitive impairment).

The findings here lend additional empirical support to conceptual models of prediagnostic decline in Alzheimer’s disease (Jack et al., 2010). Empirical studies that have examined trajectories of cognitive function have confirmed declines in these domains prior to ADRD diagnosis (Bäckman, 2008; Small & Bäckman, 2007), and this study adds to this literature by demonstrating similar declines in functional dependency as well as increases in outpatient medical costs and overnight hospital stays in the years prior to a physician recognition of a memory problem. Although descriptive studies that utilize advanced longitudinal
Table 1. Baseline Descriptive Means and Parameter Estimates, Memory Problem Trajectory Analysis (N = 774)

<table>
<thead>
<tr>
<th>Effects</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.17** (0.06)</td>
</tr>
<tr>
<td>Overall rate of change</td>
<td>0.04* (0.02)</td>
</tr>
<tr>
<td>Postmemory problem</td>
<td>0.38*** (0.04)</td>
</tr>
<tr>
<td>Baseline variation</td>
<td>0.15 (0.08)</td>
</tr>
<tr>
<td>Rate of decline:</td>
<td>0.04 (0.03)</td>
</tr>
<tr>
<td>Baseline age</td>
<td>-0.03 (0.03)</td>
</tr>
<tr>
<td>Baseline years of education</td>
<td>-0.05 (0.03)</td>
</tr>
<tr>
<td>Baseline subjective health</td>
<td>0.30*** (0.03)</td>
</tr>
<tr>
<td>Baseline financial assets</td>
<td>-0.07* (0.04)</td>
</tr>
<tr>
<td>Baseline employment status</td>
<td>-0.11*** (0.03)</td>
</tr>
</tbody>
</table>

Notes: ADLs = activity of daily living dependencies; IADLs = instrumental activity of daily living dependencies; OOPMD = out-of-pocket medical expenditures; M = mean; SD = standard deviation; SE = standard error.

Positive coefficient represents greater increases in variable following memory problem identification.

Negative coefficient represents greater decrease prior to memory problem identification for the memory problem group when compared with controls; positive coefficient represents greater increase prior to memory problem identification for the memory problem group when compared with controls.

*p < .05. **p < .01. ***p < .001.
Figure 1. Examples of significant change in trajectories prior to physician-identified memory problems: total cognition score, fine motor skills, instrumental activities of daily living (IADLs), out-of-pocket medical expenditures (OOPMD), and overnight hospital stays ($N = 774$).
analysis techniques such as this one shed light on cognitive, functional, and service use trajectories before and after a formal identification of a memory problem, subsequent research on diagnostic events earlier in the course of ADRD is required to better understand intervention efficacy as well as the psychosocial implications and ethical dimensions of this important health transition.

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