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Nursing Home Use Across the Spectrum of Cognitive Decline: Merging Mayo Clinic Study of Aging with CMS MDS Assessments

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Abstract

BACKGROUND/OBJECTIVES—Objective, complete estimates of nursing home (NH) use across the spectrum of cognitive decline are needed to help predict future care needs and inform economic models constructed to assess interventions to reduce care needs.

DESIGN—Retrospective longitudinal study

SETTING—Olmsted County, MN

PARTICIPANTS—Mayo Clinic Study of Aging participants assessed as Cognitively Normal (CN), Mild Cognitive Impairment (MCI), Previously-unrecognized-dementia, or Prevalent-dementia (Age=70–89 years; N=3,545)

MEASUREMENTS—Participants were followed in the Centers for Medicare and Medicaid Services Minimum Data Set (including Medicare/Medicaid/commercially insured/private pay) and Rochester Epidemiology Project provider-linked medical records for 1-year after assessment for days-of-observation, NH use (yes/no), NH days, NH days/days-of-observation, and mortality.

RESULTS—In the year after cognition was assessed, for persons categorized as CN, MCI, previously-unrecognized-dementia, and prevalent-dementia respectively, the percentages who died were 1.0%, 2.6%, 4.2%, 21%; the percentages with any NH use were 3.8%, 8.7%, 19%, 40%; for persons with any NH use, median NH days were 27, 38, 120, 305, and median percentages of NH days/days-of-observation were 7.8%, 12%, 33%, 100%. The year after assessment, among persons

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with prevalent-dementia and any NH use, >50% were a NH resident all days-of-observation. Pairwise comparisons revealed that each increase in cognitive-impairment-category exhibited significantly higher proportions with any NH use. One-year mortality was especially high for persons with prevalent-dementia and any NH use (30% versus 13% for those with no NH use); 58% of all deaths among persons with prevalent-dementia occurred while a NH resident.

CONCLUSIONS—Findings suggest reductions in NH use could result from quality alternatives to NH admission, both among persons with MCI and persons with dementia, together with suitable options for end-of-life care among persons with prevalent-dementia.

Keywords

dementia; mild cognitive impairment; nursing home; long-term-care

INTRODUCTION

The burden of dementia on individuals, family members, care-providers, and society is widely-recognized. As the baby-boom generation ages and life expectancy continues to rise, the numbers of affected individuals will increase, and demands for medical- and long-term care will escalate.[1] Predictions are disconcerting. There is little evidence that underlying pathology is modified by existing pharmaceuticals designed to treat dementia.[1,2] Thus, research is expanding beyond pharmacological treatment after symptoms become apparent to 1) enhancing quality of life, improving care, and reducing care needs for persons living with dementia,[3,4] and 2) preventing/postponing disease progression by detecting and treating disease at earlier stages.[1,2,5–10] While awaiting clinical-trial confirmation, disease-modifying effects at earlier disease stages have been reported in observational studies of exercise, social engagement, and diet.[11–13] However, as noted by Gustavsson et al.,[6] if any treatments are confirmed as having a positive effect on underlying pathology, such effects must also be translatable as having real-life relevance for patients, care providers, and society-at-large (eg., improved quality of life, greater independence, reduced care needs, and lower costs).

With respect to translating the efficacy of disease-modifying treatments specifically to consequences for long-term care, analyses will require economic modeling.[6,14–18] Presently, source data for such models have ascertained cognitive status using discharge diagnosis codes or screening instruments and/or estimated utilization/ costs using self-report or single-source administrative data that fail to include all payers (i.e., Medicare, Medicaid, commercial insurance, and private pay). The serious limitations of these approaches for estimating associations between healthcare utilization and cognitive impairment are demonstrated.[14,19–22] The need for objective, complete measures of utilization by persons carefully characterized for cognition across the spectrum of cognitive decline is increasingly recognized.[6,14,15,18]

We endeavored to partially address this need in a previous [23] and the present study. Both studies employed two resources, the Rochester Epidemiology Project (**REP**)[24] and the Mayo Clinic Study of Aging (**MCSA**).[25] REP is a population-based records-linkage infrastructure affording access to detailed clinical information and line-item billing data for

essentially all medical-care encounters by Olmsted County, MN, residents.[24] MCSA is a population-based longitudinal investigation of prevalence, incidence, and natural history of cognitive decline.[25] MCSA used REP resources to construct age- sex-stratified-random samples from all Olmsted County residents age 70–89 years. All medical records of sampled individuals underwent neurologist’s review to identify persons with sufficient documentation within their medical records to qualify them as meeting Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (**DSM-IV**) criteria for a clinical diagnosis of dementia. [26] Such individuals were categorized as having ‘prevalent-dementia’.[27] Persons not meeting criteria for prevalent-dementia based on record-review were invited to participate in prospective assessments. In-person assessments included extensive nurse/coordinator and physician neurologic evaluations, and neuropsychological testing to assess cognitive function in four key domains: memory, executive function, language and visuospatial skills. [25] Persons who met DSM-IV criteria for dementia upon prospective examination, but lacked sufficient medical-record documentation, were categorized as ‘previously-unrecognized-dementia’. Persons prospectively assessed as meeting Key Symposium Working Group on Mild Cognitive Impairment (**MCI**) criteria[28,29] were categorized as ‘MCI’, a transitional state between normal and dementia. Prospective determination of cognitively normal (**CN**) individuals was based on Mayo’s Older Americans Normative Studies.[30] Assignment of cognitive status was determined by consensus of study physicians, nurses and neuropsychologists.[25]

Our previous study[23] used REP provider-linked detailed medical records and acute-care billing data to estimate medical-care utilization and costs for MCSA participants categorized as CN, MCI, previously-unrecognized-dementia, and prevalent-dementia. Long-term care was not addressed. The present study aims to investigate nursing home (**NH**) use for persons in each MCSA category by merging REP and MCSA resources with Centers for Medicare and Medicaid Services (**CMS**) Minimum Data Set (**MDS**).[31] MDS was developed following Omnibus Budget Reconciliation Act requirements that all Medicare- and Medicaid-certified long-term-care facilities assess each resident (regardless of payer) at specified times throughout their stay.[32] Each individual is assigned a unique identifier maintained for all admissions across all facilities. Regularly-scheduled standardized assessments include admission and discharge dates, thus affording NH residency status on each day. MDS assessments are a gold-standard source for objective, population-based data on NH activity.

The present study’s primary goal was to provide longitudinal estimates of NH days/days-of-observation as a function of MCSA’s cognitive-impairment-categorization scheme. Individuals were followed from the date cognition was assessed until earliest of death, emigration, or 1-year to identify those with and without any NH use, and among those with any NH use, whether they were a NH resident on each day of follow-up.

To our knowledge, of the very few estimates of NH activity for which all individuals were characterized across the cognitive-impairment spectrum using recommended criteria, none considered NH days.[33–35] The longitudinal estimates of NH days/days-of-observation provided here extend beyond cohort analyses of time to NH admission and cross-sectional analyses of any NH use (yes/no). Estimates provide empirical data to help inform economic

models constructed to investigate the cost-effectiveness of alternative approaches to both care delivery and disease-modifying treatments. Estimates can also inform predictions of and planning for long-term-care needs by individuals, care providers, and policy makers.

METHODS

This retrospective longitudinal study is set in Olmsted County, MN, and was approved by Mayo Clinic and Olmsted Medical Center Institutional Review Boards. Persons who declined authorization for use of medical records in research[36] were excluded.

Resources/Participants

REP and MCSA resources are briefly described above. Detailed descriptions are provided in Supplementary Text S1 and elsewhere.[24,25,37] For this study, MCSA sampling of all Olmsted County residents age 70–89 years was conducted on 10/01/2004 and/or 03/01/2008 (N=6,682). Supplementary Figure S1 provides a flow chart outlining study participant identification and categorization into cognitive categories. The final 3,545 participants included 461 with prevalent-dementia determined from record review plus 3,084 prospectively assessed as previously-unrecognized-dementia (N=118), MCI (N=528), or CN (N=2,438). Among prospectively-assessed persons, 2,421 were assessed in-person; 663 declined the in-person assessment but participated via telephone using the Modified Telephone Interview for Cognitive Status.[37–39]

Data Collection

Prospectively-assessed participants were assigned the cognitive status as of their initial assessment, with index date defined as assessment date. For participants with prevalent-dementia determined from record review, index date was defined as date of record review. Index dates ranged from 11/02/2004–08/02/2010.

Using MDS data from 10/01/1998–09/30/2010 (dates MDS 2.0 was obtained from CMS), we identified each unique NH resident with any assessment in any NH within or on the border of Olmsted County, MN (subsequently referred to as ‘local nursing homes’). The listing of local NH residents was then merged with the 3,545 MCSA study participants using information from REP and MDS assessments (Supplementary Figure S2, Text S2). Total NH days for each individual were accumulated 1-year after and 1-year before index separately; proportion of time in NH was estimated as total NH days/days-of-observation. All individuals had 365 days-of-observation before index. After index, days-of-observation was defined from index until earliest of death, emigration, or maximum of 1-year.

Data collected on or before index included certain characteristics associated with NH activity in the literature, including sex, age, race, marital status, education, and comorbidity. [40,41] Comorbidity was assessed using Johns Hopkins Adjusted Clinical Groups System[®] software to calculate a Resource Utilization Band (**RUB**) summary measure of comorbidity for each individual.[42]

Additional characteristics related to NH activity were obtained for a stratified-random subsample of participants. Due to small numbers, previously-unrecognized-dementia was

combined with prevalent-dementia. Randomization was stratified by sex, age at index (70–79 and 80), and cognitive category to obtain approximately 50% CN, 25% MCI, and 25% dementia. Detailed provider-linked REP medical records of 400 individuals (CN=185, MCI=96, dementia=119) were reviewed for information on residential setting, gait-aid use, and dependency level by an experienced registered nurse abstractor [J.A.E.], blinded as to cognitive category. Abstraction began with the encounter closest to, but before index; absent sufficient information, review continued in a backward fashion. The choice of variables/values depended on whether information was frequently and reliably available within the medical record, eg., information on gait-aid use/type was routinely available; household income was unavailable. Values for ‘residential setting’ (lives alone versus with spouse/care-giver versus assisted living versus NH/other 24-hour-care facility), as well as variables ‘dependency level’ and ‘gait-aid use’ are indicative of availability of care, need for care, and mobility, each of which have been associated with NH activity in the literature.[40,41,43]

Statistical Analysis

Comparisons were conducted using chi-square tests for dichotomous variables, Mantel-Haenszel chi-square tests for ordinal variables, and Kruskal Wallis or Wilcoxon rank sum tests for continuous variables. Analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC). Testing used a two-tailed alpha level of 0.05 to determine statistical significance.

RESULTS

Table 1 compares characteristics as of index for all 3,545 study participants. As cognitive-impairment category increased, age and comorbidity increased, education and percent married decreased. Pairwise analyses were conducted. Compared to CN individuals, persons with MCI were more likely male ($p=0.03$), older ($p<0.001$), and had less education ($p<0.001$) and greater comorbidity ($p<0.001$). Compared to persons with MCI, persons with previously-unrecognized-dementia were older ($p=0.002$) with less education ($p=0.005$) but similar comorbidity ($p=0.73$). Compared to persons with previously-unrecognized-dementia, persons with prevalent-dementia were similar for all available characteristics ($p=0.20$ – 0.84).

Table 2 provides information for the 400 individuals on whom characteristics before index were abstracted from medical records. Previously-unrecognized-dementia and prevalent-dementia were combined. Across-category differences in sex, age, and education were similar to those in Table 1. Pairwise analyses revealed differences between CN individuals and persons with MCI for residential status ($p=0.002$) and dependency ($p<0.001$); only 2.2% of CN individuals were in assisted living, NH, or other 24-hour-care facility versus 12% of persons with MCI; 19% of CN individuals received assistance from another individual versus 37% of persons with MCI. Both CN individuals and persons with MCI differed from persons with dementia for residency, gait-aid use, and dependency (all $p<0.001$). Among 119 persons with dementia, while nearly half were in a NH or other 24-hour-care facility, 13% lived alone; 55% used gait-aids; wheelchair/unable to walk was primary mode of mobility for 24%; 54% ($n=64$) needed 24-hour care/supervision; however, 42% (27/64) received that care outside a NH.

Table 3 provides NH activity among all 3,545 individuals for years after and before index separately. Before index, all individuals had 365 days-of-observation. After index, increasing cognitive-impairment category was associated with fewer days-of-observation and higher mortality (21% of persons with prevalent-dementia died versus <5% in other categories). Within each cognitive category, the proportion with any NH use, and among persons with any NH use, median NH days/days-of-observation appeared generally higher the year after versus the year before index. After index, the proportion with any NH use increased >2-fold with each successive category; among persons with any NH use, median values for NH days/days-of-observation ranged from 7.8% for CN individuals to 100% for persons with prevalent-dementia, i.e., among the 40% of persons with prevalent-dementia and any NH use 1-year after index, >50% were a NH resident the entire time.

P values for pairwise comparisons after index between persons with CN versus MCI, MCI versus previously-unrecognized-dementia, and previously-unrecognized-dementia versus prevalent-dementia respectively were 0.003, 0.36, and <0.001 for mortality; <0.001, 0.002, and <0.001 for percent with any NH use; and among persons with any NH use, 0.21, 0.008, and 0.02 for NH days, and 0.12, 0.008, and <0.001 for NH days/days-of-observation. Table 4 provides comparisons between persons with and without NH use within each cognitive category for both years combined. Sex was significantly associated with NH use for CN individuals only; older age was significantly associated with NH use for persons in each category, except prevalent-dementia. Being married was inversely associated with NH use for CN individuals and persons with MCI. Education was not significantly associated with NH use in any category. Except for persons with previously-unrecognized-dementia, the percentage with RUB comorbidity predictive of very high medical-care use was >50% for persons with NH use versus 30% for persons without NH use. Days-of-observation was similar between persons with and without NH use, except for persons with prevalent-dementia. Among persons with prevalent-dementia, mortality post-index differed greatly between persons with (30%) and without NH use (13%). Among persons with prevalent dementia, 58% of all deaths occurred while a NH resident.

DISCUSSION

This study provides complete, objective estimates of NH activity for persons well-characterized as to cognition. Estimates were afforded by merging data on MCSA participants who met criteria for CN, MCI, previously-unrecognized-dementia, or prevalent-dementia while resident of Olmsted County, MN, with CMS MDS NH assessments available for all local nursing home residents and for all payers (Medicare/Medicaid/commercial insurance/private pay).

Across-category comparisons 1-year after index revealed increasing cognitive-impairment category was associated with increasing proportions with any NH use, and among persons with any NH use, more NH days and higher NH days/days-of-observation. Results were unchanged following regression modeling adjusted for age, sex, education, and RUB comorbidity [data not shown—available on request]. Pairwise comparisons between MCI and previously-unrecognized-dementia and between previously-unrecognized-dementia and prevalent-dementia revealed persons in the higher cognitive impairment category exhibited

significantly higher values for each measure of NH activity. Additional pairwise comparisons for the subset of 400 individuals revealed the proportions in assisted living or NH/other 24-hour-care facility was less for CN individuals versus persons with MCI and for persons with MCI versus persons with dementia (previously-unrecognized and prevalent combined). While >50% of persons with dementia required 24-hour care/supervision, 13% of all persons with dementia lived alone; and among those requiring 24-hour care/supervision, 42% received that care outside a NH. These estimates have relevance for modeling the cost-effectiveness of community-care versus institutional-care. Existing models have focused almost exclusively on dementia,[4,6,18,44,45], with few exceptions,[4] dementia was determined using discharge-diagnosis codes. Future model construction can benefit from estimates provided here for persons well-characterized across the cognitive spectrum.

We observed higher mortality for persons with versus those without any NH use in each cognitive category; differences reached significance for CN individuals and persons with prevalent-dementia. The risk of death among NH residents is known to be especially high for persons with dementia,[46] We observed that 30% of persons with prevalent-dementia and any NH use died the year after index; 58% of all deaths among persons with prevalent-dementia occurred while a NH resident. Among the 40% of individuals with prevalent-dementia and any NH use the year after index, >50% were a NH resident the full time. The high proportion with any NH use, extended stays, and high mortality reinforce the importance of existing studies and need for additional research exploring various end-of-life care options for NH residents with dementia.[3,47,48]

Our observation of higher NH activity by persons with prevalent- versus previously-unrecognized-dementia reflects others' findings that NH use 1–2 years before persons received a clinical diagnosis of dementia was higher than NH use in that period among persons not subsequently diagnosed.[49–51] While our and others' findings might suggest that earlier detection/treatment of dementia could result in reduced NH use, findings may reflect ascertainment bias. Others' studies used clinically-diagnosed dementia; we used medical-record-documentation of DSM-IV criteria to define 'prevalent-dementia'. Absence of clinical diagnosis/documentation could occur if individuals avoided frequent medical contact or were reluctant to mention dementia-related symptoms. Importantly, such bias does not explain higher NH activity we observed in pairwise comparisons for persons prospectively assessed as CN versus MCI versus previously-unrecognized-dementia; no record review was involved. Nevertheless, findings fail to directly substantiate suggestions that earlier detection and disease-modifying interventions that delay progression from CN to MCI or MCI to previously-unrecognized-dementia would result in reduced NH activity; [16,17,52] the independent contribution of cognition to NH activity could not be assessed absent potentially confounding characteristics (eg., household income, long-term-care insurance).

Few investigations of NH activity have identified cognitive status using preferred criteria for either MCI[28,29] or Cognitive Impairment No Dementia (**CIND**).[53] Tukko et al.[33] assessed Canadian Study of Health and Aging participants for cognition at baseline; 5-years later, persons with CIND at baseline were more likely to have been institutionalized than

persons without cognitive impairment at baseline. Gnjdic et al.[34] assessed Australian men at baseline as normal or MCI; between baseline and 3.4 years, the two groups exhibited similar times to NH admission. However, time to admission 3.4 years to end-of-follow-up (post-baseline average=5 years) was shorter for persons assessed at baseline as MCI versus normal. As Gnjdic et al. recognized,[34] differences between persons assessed at baseline as normal versus MCI may be overestimated if MCI at baseline progressed to dementia over extended observation.[54] We attempted to offset concerns regarding progression of MCI after index by limiting post-index NH activity to 1-year and separately analyzing NH activity 1-year before index, i.e., during which time MCI may have progressed from CN.

While Tuokko et al.'s[33] and Gnjdic et al.'s[34] findings are broadly consistent with our results from pairwise comparisons between CN and MCI, our results differ from a recent report by Ton et al.[35] using Aging, Demographics, and Memory Study (ADAMS) data. ADAMS is a nationally-representative sample, with all participants prospectively assessed as normal or MCI using methodology similar to that used in MCSA; participants are also prospectively assessed as mild, moderate, or severe dementia.[55] Ton et al.[35] focused on amnesic MCI (aMCI) and mild, moderate, and severe Alzheimer's dementia (AD). NH activity was limited to self-report of any NH use 2-years before assessment. When analyzed across all categories, the proportion of persons with any NH use increased significantly; the proportion with any NH use was significantly lower for persons with aMCI versus persons with severe AD. However, in contrast to our findings of higher NH use for persons with MCI versus CN individuals and for persons with previously-unrecognized-dementia versus MCI. Ton et al's. point estimates were lower for aMCI versus normal individuals; confidence intervals overlapped when comparing aMCI with normal individuals and when comparing aMCI with mild and moderate AD individuals; the authors recognized the limitations of small sample sizes and the cross-sectional design, noting the need for future studies to examine utilization after assessing cognition.[35]

Strengths

Study strengths include accurate assignment of CN, MCI, and previously-unrecognized-dementia;[25,37] and objective, essentially complete data on NH use for all study participants. Merging MCSA, REP, and MDS resources allowed consideration of loss-to-follow-up, days-of-observation, and the proportion of time spent in a NH. All NH days were captured, including multiple admissions and short stays. Resulting estimates address limitations recognized in the literature,[14,15,19–22] and afford information on NH activity beyond cross-sectional estimates of the proportion of NH residents with cognitive impairment, which can be biased toward long-term residents, as well as findings limited to any NH use (yes/no) or time to NH admission.

Limitations

Estimates are for a single population (86% white in 2010). Compared with Minnesota and all other upper-mid-west states, Olmsted County residents exhibit higher income and education, but very similar chronic disease prevalence rates and age-, sex-, and racial-distributions.[56] Low racial diversity and higher income/education levels could compromise the generalizability of findings to different racial and socioeconomic groups.

Medical and NH care is delivered by few providers, potentially compromising the generalizability of findings to different health-care environments. However, published data reveal 680 Olmsted County residents were in a nursing facility/skilled-nursing facility in 2010, which was 4.1% of the County population aged 65+.[57] The rate is similar to 3.7% of MN residents age 65+ in a NH in 2011[58] and 3.9% for US white Medicare beneficiaries living in a long-term-care facility in 2011.[59]

Prevalent-dementia was based on neurologist's application of DSM-IV criteria following detailed medical-record review;[27] reliable information on dementia severity were unavailable. Prospective assessments were limited to eligible persons who agreed to participate; some assessments were conducted via telephone (Supplemental Figure S1). Previous investigations reveal that participants who refused participation were older, more likely male, with higher comorbidity (eg, diabetes); participation was not associated with history of stroke, hypertension, coronary heart disease, marital status, or prior clinical diagnosis of MCI or dementia.[25] Furthermore, persons who declined prospective participation but did not refuse use of medical records in research[36] were followed in REP records for median 3.9 years after declining prospective participation to estimate dementia incidence using neurologist's application of DSM-IV criteria; rates were similar to rates for participants followed prospectively in MCSA serial examinations.[60]

Characteristics associated with NH use did not include 1) several variables identified in the literature as contributing to NH use or 2) standardized criteria for residential setting, gait-aid use, and dependency level. Findings do not include NH costs, household income/expenditures, or informal (unpaid) care use.

Conclusions/Implications

Compared to CN individuals, persons with MCI exhibited higher mortality and a greater proportion with any NH use. For every measure of NH activity under consideration, each pairwise comparison between persons categorized as MCI versus previously-unrecognized-dementia and between previously-unrecognized-dementia versus prevalent-dementia revealed higher activity for the higher cognitive-impairment category. Findings suggest reductions in NH use could result from identifying 1) quality alternatives to NH admission for both persons with MCI and persons with dementia, as well as 2) preferable options for reducing the proportion of time spent as a NH resident by persons with dementia, especially for those with terminal illness. Further investigation is needed to explore reasons underlying the higher NH activity that was observed with increasing cognitive-impairment category. Findings provided here support arguments for earlier detection to help individuals, care providers, and policy makers predict and prepare for future care needs. Estimates can also help inform future efforts to model potential consequences both of disease-modifying treatments for reducing NH utilization/costs and alternative approaches to care-delivery.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Authors Contributions:

The following criteria were met by the listed co-authors:

1. All authors (Cynthia Leibson, Jane Emerson, Steven Hass, Amy Duhig, Ronald Petersen, Carin Smith, Jeanine Ransom, Kirsten Hall Long, Rosebud Roberts) made substantial contributions—specific contributions are as follows:
 - a. Conception and design—all authors
 - b. Acquisition of data—Emerson, Smith, Roberts, Petersen
 - c. Analysis and interpretation of data—Smith, Ransom, Long
2. All authors were involved with drafting the article or revising it critically for important intellectual content.
3. All authors gave final approval of the version to be published.

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In support of the manuscript, the National Institutes of Health had no role in the design and conduct of the study; in the collection, analysis, and interpretation of the data; or in the preparation, review, or approval of the manuscript. AbbVie was involved with the initial study design; AbbVie had no role in the collection, analysis, or interpretation of data or in the preparation, review, or approval of the manuscript.

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Table 1

Characteristics as of Index Date by Cognitive Category for All 3,545 Study Participants

	Cognitively Normal (2,438)	Mild Cognitive Impairment (528)	Previously Unrecognized Dementia (118)	Prevalent Dementia (461)	P Value ^a
Male					0.10
N (%)	1,137 (47%)	274 (52%)	52 (44%)	208 (45%)	
Age, years					<0.001
Mean $\pm$ SD	79 $\pm$ 5.2	81 $\pm$ 5.0	83 $\pm$ 4.9	83 $\pm$ 4.5	
Median (IQR)	79 (74, 83)	82 (79, 85)	84 (80, 86)	84 (81, 87)	
White race					0.053
N (%)	2,401 (98%)	517 (98%)	113 (96%)	448 (97%)	
Married^b					0.006
N (%)	1,505 (62%)	307 (58%)	57 (48%)	NA	
Education, years					<0.001
Mean $\pm$ SD	14 $\pm$ 3.0	13 $\pm$ 3.0	12 $\pm$ 3.3	12 $\pm$ 3.2	
Median (IQR)	13 (12, 16)	12 (12, 14)	12 (10, 14)	12 (11, 14)	
RUB^c					<0.001
N (%)					
No/ healthy/ low use	142 (5.8%)	20 (3.8%)	5 (4.2%)	29 (6.3%)	
Moderate use	892 (37%)	144 (27%)	36 (30%)	126 (27%)	
High use	781 (32%)	195 (37%)	38 (32%)	123 (27%)	
Very high use	623 (26%)	169 (32%)	39 (33%)	183 (40%)	

SD = Standard deviation, IQR = Interquartile range, RUB = Resource Utilization Band

^aP values were calculated using Chi Square tests for categorical variables and Kruskal Wallis tests for continuous variables.

^bFor CN individuals, persons with MCI and persons with previously-unrecognized-dementia, marital status was available from data collected prospectively for MCSA. For persons with prevalent-dementia based on record review, marital status was obtained electronically from REP medical records, and was missing for all but 32 individuals, 18 (56%) of whom were married.

^cRUB is a summary measure of co-morbidity, defined using aggregations of diagnostic groupings that have similar expected resource use, with values ranging from 0 (no encounters) to 5 (diagnosis codes associated with very high use)[42]; we calculated RUB values using diagnosis codes assigned in the year before index and excluding codes for dementia and MCI (ICD-9-CM codes 290.XX, 331.82, 331.83)

Table 2

Characteristics^a by Cognitive Category for a Stratified Random Subset of 400 Individuals Drawn from All 3,545 Study Participants

	Cognitively Normal (185)	MCI (96)	Dementia (119)	P value ^b
Male, N (%)	92 (50%)	45 (47%)	60 (50%)	0.86
Age, years				<0.001
Mean ± SD	79 ± 5.2	81 ± 5.0	82 ± 5.1	
Median (IQR)	79 (74, 83)	81 (77, 84)	82 (78, 86)	
Education, years				<0.001
Mean ± SD	13.9 ± 2.9	12.6 ± 2.7	11.9 ± 3.3	
Median (IQR)	13 (12, 16)	12 (12, 14)	12 (10, 14)	
Residential setting^a, N (%)				<0.001
Alone	52 (28%)	34 (35%)	16 (13%)	
With spouse / care giver	124 (67%)	49 (51%)	36 (30%)	
Assisted living	2 (1.1%)	9 (9.4%)	11 (9.2%)	
NH or other 24-hour-care facility	2 (1.1%)	3 (3.1%)	56 (47%)	
Unknown	5 (2.7%)	1 (1.0%)	0 (0%)	
Use of gait aid^{a,c}, N (%)				<0.001
No gait aid used	157 (85%)	68 (71%)	45 (38%)	
Cane	13 (7.0%)	10 (10%)	7 (5.9%)	
Walker	9 (4.9%)	11 (11%)	29 (24%)	
Wheelchair (including “unable to walk”)	3 (1.6%)	4 (4.2%)	29 (24%)	
Unknown	3 (1.6%)	3 (3.1%)	9 (7.6%)	
Dependency level^{a,d}, N (%)				<0.001
Grade 1	150 (81%)	60 (62%)	5 (4.2%)	
Grade 2	33 (18%)	32 (33%)	50 (42%)	
Grade 3	2 (1.1%)	4 (4.2%)	64 (54%)	

SD = Standard deviation, IQR = Interquartile range, NH = Nursing Home

^aAs determined based on manual review of Rochester Epidemiology Project provider-linked medical records. Information was obtained for encounter closest to but before index. Absent sufficient information from that encounter, abstraction continued in a backward fashion.

^bP values were calculated using chi-square tests for categorical variables and Kruskal Wallis tests for continuous variables

^cGait aid was based on the primary mode of mobility.

^dLevel of dependency was graded on a scale of one to three, based on need for assistance from another individual. Assistance with activities such as house cleaning, gardening, shopping, and transportation outside the home were not considered in our grading. Grade one was defined as able to perform usual activities without assistance. Grade two was assigned to individuals requiring assistance on a regular basis (including daily) with activities such as medication set-up, meal preparation, hygiene, or other activities of daily living, but who could be left alone in their residence. Grade three was defined as needing 24-hour care or supervision, either in-home or in another supervised setting.

Table 3

Nursing Home Activity for All 3,545 Study Participants in the Year After Index and the Year Before Index Separately.

	Cognitively Normal (2,438)	Mild Cognitive Impairment (528)	Previously Unrecognized Dementia (118)	Prevalent Dementia (461)	P Value ^a
Days-of-observation^b					
After Index					<0.001
Mean ± SD	349 ± 59	342 ± 71	313 ± 97	324 ± 91	
Median (IQR)	366 (366, 366)	366 (366, 366)	366 (366, 366)	366 (366, 366)	
Died^b, N (%)					
After Index	25 (1.0%)	14 (2.6%)	5 (4.2%)	95 (21%)	<0.001
Any NH use, N (%)					
After Index	93 (3.8%)	46 (8.7%)	22 (19%)	183 (40%)	<0.001
Before Index	75 (3.1%)	24 (4.6%)	14 (12%)	162 (35%)	<0.001
Total NH days (among those with any NH use)					
After Index					<0.001
Mean ± SD	62 ± 92	80 ± 109	161 ± 138	239 ± 139	
Median (IQR)	27 (15, 57)	38 (16, 77)	120 (31, 308)	305 (93, 366)	
Before Index					<0.001
Mean ± SD	49 ± 92	91 ± 132	154 ± 164	242 ± 142	
Median (IQR)	15 (9.0, 29)	26 (14, 79)	48 (26, 365)	357 (85, 365)	
% NH day/days-of-observation (among those with any NH use)					
After Index					<0.001
Mean ± SD	19 ± 27	23 ± 29	44 ± 37	80 ± 34	
Median (IQR)	7.8 (4.1, 16)	12 (5.5, 24)	33 (9.1, 84)	100 (67, 100)	
Before Index					<0.001
Mean ± SD	13 ± 25	25 ± 36	42 ± 45	66 ± 39	
Median (IQR)	4.1 (2.5, 7.9)	7.3 (3.8, 22)	13 (7.1, 100)	98 (23, 100)	

SD = Standard deviation, IQR = Interquartile range, NH = Nursing Home

^aP values were calculated using Chi Square tests for categorical variables and Kruskal Wallis tests for continuous variables.

^qDuring the period from index until earliest of death, emigration, or maximum of 1-year after index. By design, all subjects were alive as of index and in Olmsted County the full year before index.

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Table 4

Characteristics within Each Cognitive Category for All 3,545 Study Participants by Any Nursing Home Use (No/Yes)^a during the Year Before and Year After Combined

	Cognitively Normal (2,438)		Mild Cognitive Impairment (528)		Previously Unrecognized Dementia (118)		Prevalent Dementia (461)	
	No(2,283)	Yes (155)	No (465)	Yes(63)	No(90)	Yes(28)	No(261)	Yes(200)
Nursing Home Use								
Male								
N (%)	1,090 (48%)	47 (30%)	247 (53%)	27 (43%)	40 (44%)	12 (43%)	111 (42%)	97 (48%)
	P<0.001		P=0.13		P=0.88		P=0.20	
Age, years								
N (%)	1,090 (48%)	47 (30%)	247 (53%)	27 (43%)	40 (44%)	12 (43%)	111 (42%)	97 (48%)
Median (IQR)	79(74,83)	82(79,85)	82(78,84)	84(81,87)	83 (80,85)	86 (82,87)	84 (80,87)	84 (81,87)
	P=0.001		P<0.001		P=0.01		P=0.16	
White race								
N (%)	2,251 (99%)	150 (97%)	456 (98%)	61 (97%)	85 (94%)	28 (100%)	252 (96%)	196 (98%)
	P=0.08		P=0.63		P=0.34		P=0.41	
Married								
N (%)	1,439 (63%)	66 (43%)	278 (60%)	29 (46%)	44 (49%)	13 (46%)	-	-
	P=0.80		P=0.52		P=0.23		P=0.054	
Education, years								
Median (IQR)	13(12,16)	13(12,16)	12(12,14)	12(12,16)	12 (10,14)	12 (8,13)	12 (12,14)	12 (10,14)
	P<0.001		P<0.001		P=0.40		P<0.001	
RUB^c								
No/healthy/low use, N (%)	140 (6.1%)	2 (1.3%)	15(3.2%)	5(7.9%)	3 (3.3%)	2 (7.1%)	25 (9.6%)	4(2.0%)
Moderate use, N (%)	862 (38%)	30 (19%)	138(30%)	6 (9.5%)	32 (36%)	4 (14%)	87(33%)	39 (20%)
High use, N (%)	737 (32%)	44 (28%)	179(38%)	16(25%)	26 (29%)	12 (43%)	72(28%)	51 (26%)
Very high use, N (%)	544 (24%)	79 (51%)	133 (29%)	36 (57%)	29 (32%)	10 (36%)	77 (30%)	106 (53%)
	P=0.10		P=0.63		P=0.054		P<0.001	
Days-of-observation^d								
Mean ± SD	715 ± 59	710 ± 62	706 ± 72	713 ± 64	669 ± 103	709 ± 68	700 ± 80	674 ± 103
Median	731	731	731	731	731	731	731	731
	P<0.001		P=0.07		P=0.09		P<0.001	
Died year after index								
N (%)	14 (0.6%)	11(7.1%)	10 (2.2%)	4 (6.4%)	2 (2.2%)	3 (11%)	35 (13%)	60 (30%)

SD = Standard deviation, IQR = Interquartile range, RUB = Resource Utilization Band

^aP values were calculated using chi-square tests for categorical variables and Wilcoxon rank sum tests for continuous variables. Mean and SD are provided for observation days as reference.

^bFor persons with prevalent-dementia, marital status was obtained electronically from REP medical records and was missing for all but 32 individuals.

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RUB is a summary measure of co-morbidity, defined using aggregations of diagnostic groupings that have similar expected resource use, with values ranging from 0 (no encounters) to 5 (diagnosis codes associated with very high use)[42]; we calculated RUB values using diagnosis codes assigned in the year before index and excluding codes for dementia and MCI (ICD-9-CM codes 290.XX, 331.82, 331.83)

d Defined as days of Olmsted County residency, from 1-year before index until the earliest of death, emigration, or maximum of 1-year after index. By design, all subjects were alive as of index and in Olmsted County the full year before index.