Published in final edited form as:

J Am Geriatr Soc. 2014 July ; 62(7): 1347–1352. doi:10.1111/jgs.12878.

Can performance of daily activities discriminate between older adults with normal cognitive function and those with Mild Cognitive Impairment?

Juleen Rodakowski, OTD, OTR/L¹, Elizabeth R. Skidmore, PhD, OTR/L¹, Charles F. Reynolds III, MD², Mary Amanda Dew, PhD², Meryl A. Butters, PhD², Margo B. Holm, PhD, OTR/L¹, Oscar L. Lopez, MD³, and Joan C. Rogers, PhD, OTR/L¹

¹Department of Occupational Therapy, University of Pittsburgh (Rodakowski, Skidmore, Holm, Rogers)

²Department of Psychiatry, University of Pittsburgh (Reynolds, Dew, Butters)

³Department of Neurology, University of Pittsburgh (Lopez)

Abstract

OBJECTIVES—Our primary aim was to examine whether preclinical disability in performance of cognitively-focused instrumental activities of daily living (C-IADL) tasks can discriminate between older adults with normal cognitive function and those with Mild Cognitive Impairment (MCI). The secondary purpose was to determine the two tasks with the strongest psychometric properties and assess their discriminative ability. Our goal was to generate diagnosis-relevant information about cognitive changes associated with MCI and DSM-5 Mild Neurocognitive Disorder.

DESIGN—Secondary analyses of cross-sectional data from a cohort of individuals diagnosed with normal cognitive function or MCI.

SETTING—Private home locations in Pittsburgh, PA.

PARTICIPANTS—Older adults with remitted major depression (N=157).

MEASUREMENTS—Diagnosis of cognitive status was made by the Alzheimer's Disease Research Center at the University of Pittsburgh. Performance of 8 C-IADL was measured using the criterion-referenced, observation-based Performance Assessment of Self-Care Skills (PASS).

RESULTS—A total of 96 older adults with normal cognitive function (mean age=72.5, SD=5.9) and 61 older adults with MCI (mean age=75.5, SD=6.3) participated. The 8 C-IADL demonstrated 81% accuracy in discriminating cognitive status (area under curve 0.81, $p<0.001$). Two tasks (shopping and checkbook balancing) were the most discriminating (area under curve 0.80, $p<0.001$); they demonstrated similar ability, as the 8 C-IADL, to discriminate cognitive status. Assessing performance on these two C-IADL takes 10–15 minutes.

CONCLUSION—This is the first demonstration of the discriminative ability of preclinical disability in distinguishing MCI from cognitively normal older adults. These findings highlight potential tasks, when measured with the observation-based PASS, which demonstrate increased effort for individuals with MCI. These tasks may be considered when attempting to diagnose MCI or Mild Neurocognitive Disorder in clinical practice and research.

Keywords

Cognitive Function; Mild Cognitive Impairment; Mild Neurocognitive Disorder; Activities of Daily Living; Instrumental Activities of Daily Living

INTRODUCTION

Mild Cognitive Impairment (MCI) is associated with measurable changes in cognitive abilities; however, performance of basic activities of daily living (ADL; e.g., dressing and bathing) remains intact.^{1–2} Thus, adequate performance of basic ADL must be demonstrated to rule-out potential dementia before making a diagnosis of MCI.² Initial criteria for MCI required that performance of instrumental ADL (e.g., medication management) remained normal.³ However, recent evidence suggests that subtle changes or preclinical disability in performance of instrumental ADL may be apparent in individuals with MCI.⁴ Preclinical disability is defined as early limitations in activities before they are clinically significant or interfere with independence.⁵ One example of preclinical disability is slow walking speed, which has been found to predict future mobility disability and mortality.^{6,7} For individual with MCI, performance in instrumental ADL may detect preclinical disability, demonstrating limitations in performance but not lack of independence. Instrumental ADL may be cognitively-focused (C-IADL, e.g., medication management) or physically-focused (e.g., home maintenance). As a whole, studies suggest that individuals with MCI demonstrate more preclinical disability performing C-IADL than individuals with normal cognitive function.^{8–11} The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) reflects these findings. One of the diagnostic criteria for Mild Neurocognitive Disorder is that cognitive deficits do not interfere with independence in ADL but subtle differences in the effort required and adaptations used may be noted (i.e., preclinical disability).¹²

While differences in effort and adaptations are acknowledged in the diagnostic criteria, they are not clearly operationalized. No established standards exist for measuring preclinical disability in performance of ADL in individuals with MCI or Mild Neurocognitive Disorder. The field acknowledges that measurement of preclinical disability could improve accuracy in the diagnostic process and potentially allow for earlier identification and intervention.^{13–14} Previous strategies in measuring instrumental ADL have been limited in two ways. First, measures, usually in the form of simplified checklists, typically assess whether individuals with MCI are able to complete instrumental ADL tasks, but neglect assessing the preclinical disability in performance of instrumental ADL.^{15–16} Second, measures frequently employ the patient or care-partner to report perceptions of performance of instrumental ADL.^{11,17–18} Neither simplified checklists nor self- and care-partner reports capture preclinical disability in performance. Observation-based measures of performance

are designed to assess precision of performance through detailed observations of independence, safety, and adequacy. These observations help to identify the point of breakdown, and document patterns of performance during instrumental ADL tasks. Observations of performance of cognitively-demanding tasks in individuals with MCI are more likely to demonstrate preclinical disability through increased effort and accommodations. While not all with preclinical disability are certain to transition to disability, these observations may yield insight into the manifestation of cognitive changes associated with MCI and similar syndromes, assisting with diagnostic medicine and early intervention.^{13–14}

We aimed to determine whether preclinical disability in performance of C-IADL, as measured with a standardized performance measure, would discriminate between older adults with normal cognitive function and those with MCI. A secondary aim, in the service of clinical utility, was to determine the two psychometrically strongest performing tasks and assess their discriminative ability.

METHODS

Study Design and Participants

Data from a maintenance intervention study of older adults with remitted depression were analyzed.¹⁹ The parent study examined whether donepezil hydrochloride and antidepressant therapy are superior to placebo and antidepressant therapy in improving cognitive performance, functional performance, and recurrences of depression. Community-dwelling older adults (age 65 or older) were recruited from primary care practices, mental health clinics, other federally-sponsored clinical research projects, and via print and electronic advertisements. Participants had a history of major depression that had been treated to remission at the time of the baseline cognitive and IADL assessments. Procedures were approved by the Institutional Review Board.

Performance of Daily Activities

The Performance Assessment of Self-Care Skills (PASS) is an observation-based assessment that assesses basic and instrumental ADL performance through standardized, criterion-referenced observations in participants' homes.²⁰ The PASS includes 26 tasks that are broken into 4 functional domains: functional mobility (e.g., bed mobility), personal self-care (e.g., dressing), instrumental activity of daily living with a cognitive emphasis (e.g., shopping), and those with a physical emphasis (e.g., sweeping).²¹ A trained clinician rater observed participants performing each task, and we analyzed independence and preclinical disability in performance of C-IADL (i.e., shopping, bill paying, checkbook balancing, bill mailing, telephone use, medication management, critical information retrieval, and small device repair). Independence was based on a hierarchical level of assistance needed from another person required to complete C-IADL. The ten types of cues collected were the following: no cues, verbal supportive, verbal non-directive, verbal directive, gestures, task or environment rearrangement, demonstration, physical guidance, physical support, and total assistance. Amount of assistance was then converted to a summary score for independence (range 0–3 where lower is more dependent). Preclinical disability was based on the number

of cues given by the clinician rater for independence, safety, and adequacy. Therefore, an individual may not have required assistance to be independent (received an independence score of 2), but demonstrated preclinical disability by the number of cues needed for independence, safety, and adequacy (received a preclinical disability score of 25). Clinician raters achieved inter-rater reliability scores of greater than 0.90 prior to administering the PASS. Cognitive status had not been conferred at the time of the performance assessment; thus, the clinician rater was not influenced by knowledge of the participant's cognitive status.

Cognitive Status

Cognitive status (normal cognitive function or MCI) was diagnosed using the National Alzheimer Coordinating Center (NACC) criteria at the Alzheimer's Disease Research Center (ADRC) at the University of Pittsburgh. Neuropsychological data (17 well established and validated individual tests measuring multiple domains)²² and clinical history were used to determine whether individuals had normal cognitive function or MCI. The individuals with MCI were required to score 1 to 1.5 standard deviations below the normative mean for their age and education matched peers in one or more domains on the neuropsychological tests. Disability in basic ADL (measured with the PASS functional mobility and personal self-care domains) helped diagnosis dementia.²¹ Participants diagnosed with dementia were excluded from the study. Participants diagnosed with MCI were further classified as amnesic or non-amnesic according to NACC criteria.²² The ADRC consensus diagnostic team was blinded on participants' performance of C-IADL; those data were not used or made available for the diagnostic process.

Analysis

Data were examined for normality and outliers prior to analyses. Data were transformed when appropriate. Demographic and clinical characteristics for the individuals with normal cognitive function and those with MCI were reported as means (and standard deviations) for continuous variables and frequencies (and proportions) for categorical variables. They were compared with independent sample t-tests for continuous data and chi-square tests for categorical data.

The ability for preclinical disability scores to discriminate between normal cognitive function and MCI was characterized in several ways. We computed preclinical disability scores from the number of cues required for independence, safety, and adequacy for the C-IADL. We conducted analysis of covariance (ANCOVA) comparing preclinical disability scores for those with normal cognitive function and MCI controlling for depressive symptoms, age, sex, and education. ANCOVA assumptions were tested.

We conducted receiver operating characteristic (ROC) curve analyses for each of the 8 C-IADL. Then, we conducted two additional ROC curve analyses using aggregate preclinical disability scores for the 8 C-IADL and, subsequently, for the 2 psychometrically strongest tasks. Finally, the sensitivity, specificity, and positive predictive values (PPV) of various cut-scores were calculated for the 8 and 2 tasks.

ROC curves were calculated with Hamilton Rating Scale for Depression (HRSD) and Mini-Mental State Examination (MMSE). Chi-square tests examined differences between ROC curves for the 8 and 2 C-IADL compared to the HRSD and MMSE. Analyses were performed using SPSS version 21.0 (SPSS, Inc., Chicago, IL) or Stata version 13.0 (StataCorp LP., College Station, TX).

RESULTS

In the parent study, 299 older adults were screened, 220 qualified and signed consent, 157 responded to open antidepressant treatment and completed the baseline assessment of cognitive function and performance of C-IADL. Of the 157 participants, 96 individuals were diagnosed with normal cognitive function (61.1%) and 61 with MCI (38.8%). No differences in preclinical disability in performance of C-IADL were found between individuals with amnesic and non-amnesic MCI. Thus, individuals with amnesic and non-amnesic MCI were combined to form one group. C-IADL data were transformed using a square-root transformation, and no outliers were found. The distribution of missingness of data was similar across the 2 groups.

Table 1 shows demographic and clinical characteristics of the individuals with normal cognitive function and those with MCI. Individuals with MCI were older, less likely to be white, had completed fewer years of education, had lower MMSE, and had higher residual depressive symptom levels than those with normal cognitive function. No differences in sex, marital or employment status were found. Individuals with normal cognitive function (2.34 ± 0.50) and those with MCI (2.0 ± 0.45) demonstrated little assistance needed to independently complete C-IADL. However, individuals with MCI showed significantly more preclinical disability in performance of C-IADL (i.e., required more cues for independence, safety, and adequacy; 28.0 ± 16.7) than those with normal cognitive function (11.8 ± 9.8 ; $F_{(1,154)} = 24.40$, $p < 0.001$) when controlling for depressive symptoms, age, sex, and education.

Figure 1 graphically presents the range of sensitivities and specificities for the preclinical disability scores for each of the 8 tasks by cognitive status in the form of ROC curves. Shopping (0.74) and checkbook balancing (0.72) revealed the largest area under the curve.

Figure 1 also presents the range of sensitivities and specificities for the preclinical disability scores for all 8 tasks and for the 2 most discriminative tasks (shopping and checkbook balancing). The 8 C-IADL had an area under the curve of 0.81 ($p < 0.001$). A score cut-point that provides the best compromise between sensitivity and specificity was 15 cues. At that cut-point, sensitivity was 75%, specificity was 73%, and PPV was 0.64. Preclinical disability scores for the 2 psychometrically strongest tasks demonstrated that individuals with MCI demonstrated significantly more preclinical disability (14.6 ± 9.9) in shopping and checkbook balancing than those with normal cognitive function (5.7 ± 5.6 ; $F_{(1,144)} = 18.39$, $p < 0.001$) when controlling for depressive symptoms, age, sex, and education. The area under the curve was 0.80 ($p < 0.001$) for the 2 tasks. A cut-point that provides the optimal sensitivity was specificity was 8 cues. At that cut-point, sensitivity was 70%, specificity was 70%, and PPV was 0.60.

The HRDS and MMSE yielded areas under the curve of 0.67 ($p < 0.001$) and 0.27 ($p < 0.001$) respectively. The area under the curve for the 8 C-IADL was significantly larger than both the areas under the curve for the HRDS ($\text{chisq}(1) = 7.31$, $p < 0.001$) and MMSE ($\text{chisq}(1) = 72.50$, $p < 0.001$). Similar findings were found for the areas under the curve for the 2 C-IADL (HRDS, $\text{chisq}(1) = 4.38$, $p < 0.05$; MMSE, $\text{chisq}(1) = 69.99$, $p < 0.001$).

DISCUSSION

Measurement of preclinical disability is essential to improve assessment, diagnosis, and potentially early intervention for individuals with MCI. Preclinical disability may be a predictor of future frank disability.⁵ This study found that older adults with MCI exhibited more preclinical disability (i.e., required more cues for independence, safety, and adequacy) in performance of C-IADL than those with normal cognitive function. The 8 C-IADL combined demonstrated that a randomly selected individual with MCI had a higher score than that for a randomly chosen individual with normal cognition 81% of the time.²³ Remarkably, 2 tasks (shopping and checkbook balancing) correctly classified 80% of older adults. These findings suggest that, more than expected, individuals with MCI demonstrate preclinical disability in C-IADL. This information may be considered in the diagnostic process.

The 8 and 2 C-IADL were significantly more accurate in classifying cognitive status than were depressive symptoms and MMSE scores. The C-IADL demonstrated adequate accuracy in classifying cognitive status whereas depressive symptoms and MMSE scores demonstrated acceptable to no discriminability.²⁴ Few other measures, whether cognitive or biological, have found similar accuracy in discriminating between individuals with normal cognition and those with MCI. The Short Test of Mental Status, Mini-Mental State Examination, entorhinal cortex volume, and hippocampal volume demonstrated AUC of 0.82, 0.75, 0.64, and 0.71 respectively when discriminating between individuals with normal cognition and those with MCI.^{25,26} These findings indicate that preclinical disability provides an accurate depiction of cognitive status when compared other cognitive and biological measures.

We used a standardized, observation-based measure to carefully characterize preclinical disability through the number of cues required for independence, safety, and adequacy. Preclinical disability scores characterize individuals who remain independent in their daily activities, but have altered C-IADL performance due to successful compensatory or adaptive strategies. The PASS is one of the few measures that provides the necessary standardization and structure to capture preclinical disability. While observation-based measures such as the PASS may not be routinely administered in encounters with individuals with cognitive deficits, tasks within the C-IADL domain appear to offer critical information regarding increased effort and adaptations individuals may require. Furthermore, a trained evaluator can administer what appear to be the 2 most sensitive tasks, shopping and checkbook balancing, in 10–15 minutes.

Observation-based standardized assessments of instrumental ADL tasks yielded insight into preclinical disability through performance of cognitively-demanding activities. Minimal

cues for independence, safety, and adequacy were required for individuals with normal cognitive function. This is not surprising, and it acknowledges that variation in performance of C-IADL is not uncommon. However, individuals with MCI demonstrated more preclinical disability in the tasks observed than those with normal cognitive function. However, only minimal differences in preclinical disability were found for telephone use and bill mailing. One potential explanation for the limited difference is that completion of these tasks may not be as cognitively demanding as other tasks. Perhaps, telephone use, for example, has become a rote skill that does not require older adults to think critically. However, other tasks (e.g., medication management) become cognitively demanding in older age; therefore, greater differences were seen between individuals with normal cognitive function and those with MCI. These findings corroborated studies reporting that individuals with MCI have impaired performance of C-IADL.^{8–11}

The findings from this study are relevant to operationalizing the DSM-5 diagnostic criteria for Mild Neurocognitive Disorder. The DSM-5 diagnostic criteria acknowledges that greater time, compensation, or adaptations may be needed for individuals to complete C-IADL.¹² In the DSM-5, bill paying and medication management are examples of tasks individuals with Mild Neurocognitive Disorder may require adaptations. Our findings substantiated that these are C-IADL that individuals with MCI may demonstrate preclinical disability, but not necessarily lack of independence. We also highlight that shopping and checkbook balancing are tasks that clinicians should consider when assessing preclinical disability.

While these findings are promising, they should be interpreted with caution. We conducted secondary analyses on an existing sample, potentially introducing biases into the analyses. Participants had a history of major depression. Although they were all in remission at the time of this study, some participants had mild residual depressive symptoms. A history of depression, and current depressive symptoms are both common among individuals with MCI²⁷; thus, this sample may not be representative of the population of all individuals with MCI or Mild Neurocognitive Disorder. While we adjusted for depressive symptoms, they may influence performance of ADL^{28,29}, further examination of these findings is warranted. This study, however, has many strengths, including a large sample, carefully diagnosed cognitive status, and standardized measurement of C-IADL performance. These findings provide a foundation for future studies seeking to examine C-IADL performance in individuals with MCI or Mild Neurocognitive Disorder. In addition, studies should consider validating the discriminative ability of instrumental ADL tasks for diagnosing cognitive status.

In summary, the need to measure the preclinical disability in performance of C-IADL is essential for understanding the relationship between cognitive decline and performance of ADL. These measurements can assist in the accurate diagnosis of MCI or Mild Neurocognitive Disorder. The present findings confirm differences in performance of instrumental ADL between individuals with normal cognitive function and those with MCI. These findings are the first to demonstrate the potential for the C-IADL to be used to discriminate between older adults with normal cognitive function and those with MCI. Thus, observation-based measurement of C-IADL may greatly enhance assessment, diagnosis, and early intervention for individuals with MCI.

Acknowledgments

Funding Sources:

Funding was received from National Institute of Health grants P30 MH090333 (Reynolds, Dew, Butters, Skidmore), R01MH043823 (Reynolds, Dew, Rogers, Holm, Butters, Lopez), T32 MH019986 (Reynolds, Rodakowski), P50AG05133 (Butters, Lopez); R01 MH072947 (Butters), Clinical and Translational Science Institute grants UL1RR024153 (Reynolds), UL1TR000005 (Reynolds); and UPMC Endowed Chair in Geriatric Psychiatry (Reynolds).

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Figure 1.

Individual and combined C-IADL Receiver Operating Characteristic curves

Note: Receiver operating characteristic curves for each for the 8 C-IADL. The areas under the curves were 0.74 for shopping, 0.65 for bill paying, 0.72 for checkbook balancing, 0.59 for bill mailing, 0.60 for telephone use, 0.67 for medication management, 0.61 for critical information retrieval, and 0.60 for small item repair. Receiver operating characteristic curves for the total scores for the 8 C-IADL and the 2 C-IADL. The areas under the curves were 0.81 for the 8 tasks and 0.80 for the 2 tasks.

Table 1

Participant characteristics and number of cues required by participants for C-IADL

	MCI	Normal cognitive function	
	(n=61)	(n=96)	
Age in years, M±SD (range 56–92)	75.5±6.3	72.5±5.9	$t_{(155)}=-3.12$, $p=0.002$
Sex, % female, n (%)	48 (78.7)	76 (79.2)	$\text{chisq}(1)=0.005$, $p=0.94$
Race, % White, n (%)	45 (73.8)	89 (92.3)	$\text{chisq}(1)=7.95$, $p=0.005$
Education in years, M±SD (range 7–20)	12.9±2.3	14.1±2.5	$t_{(155)}=2.99$, $p=0.003$
Marital Status, % Married, n (%)	27 (44.3)	47 (49.0)	$\text{chisq}(1)=0.51$, $p=0.48$
Employment Status, % Full time, n (%)	2 (3.3)	7 (7.3)	$\text{chisq}(1)=2.18$, $p=0.14$
HRDS - 17 item, M±SD (range 0–14)	6.9±3.2	5.0±3.2	$t_{(154)}=-3.60$, $p<0.001$
MMSE, M±SD (range 24–30)	27.8±1.5	28.9±1.1	$t_{(149)}=5.33$, $p<0.001$
<u>Number of cues required by participants for C-IADL, M±SD</u>			
Shopping, # cues	7.49±6.25	3.34±3.59	$F_{(1,154)}=8.23$, $p=0.005$
Bill Paying, # cues	3.47±4.31	1.39±2.75	$F_{(1,148)}=7.52$, $p=0.007$
Checkbook Balancing, # cues	7.11±6.81	2.49±3.85	$F_{(1,143)}=12.10$, $p<0.001$
Bill Mailing, # cues	3.66±3.96	1.92±2.25	$F_{(1,148)}=2.03$, $p=0.16$
Telephone Use, # cues	1.13±1.82	0.65±1.38	$F_{(1,154)}=1.45$, $p=0.23$
Medication Management, #cues	3.28±3.58	1.57±2.24	$F_{(1,153)}=7.10$, $p=0.009$
Critical Information Retrieval, # cues	0.79±1.49	0.26±0.76	$F_{(1,154)}=4.51$, $p=0.04$
Small Device Repair, # cues	1.85±3.31	0.43±1.05	$F_{(1,151)}=3.81$, $p=0.05$
Total for 8 C-IADL, #cues	28.03±16.69	11.75±9.78	$F_{(1,154)}=24.40$, $p<0.001$
Total for 2 C-IADL, #cues	14.63±9.86	5.74±5.63	$F_{(1,144)}=18.39$, $p<0.001$

Note: Means for C-IADL are reported prior to transformation. Transformed data were used in the statistical analyses. ANCOVAs adjusted for depressive symptoms, age, sex, and education.

Abbreviations: MCI, Mild Cognitive Impairment; HRDS, Hamilton Depression Rating Scale; MMSE, Mini Mental State Examination; #, number; C-IADL, cognitive instrumental activities of daily living

Table 2

Classification Functions at various cut-points

	8 C-IADL					2 C-IADL				
	10	15	20	25		5	8	11	14	
Number of Cues										
Sensitivity	0.89	0.75	0.62	0.49	0.88	0.70	0.63	0.51		
Specificity	0.52	0.73	0.80	0.92	0.56	0.70	0.82	0.88		
PPV	0.54	0.64	0.67	0.79	0.56	0.60	0.69	0.73		

Note:

Abbreviation: PPV=Positive Predictive Value