The Memory Orientation Screening Test (MOST®) Accurately Separates Normal from MCI and Demented Elders in a Prevalence-Stratified Sample

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Abstract

Purpose: The Memory Orientation Screening Test (MOST) is compared with standard neuropsychological tests in a sample of elders reflecting the population prevalence of normal cognition, mild cognitive impairment (MCI) and dementia.

Methods: One hundred, forty-eight elders without dementia diagnosis completed neuropsychological tests, the MOST, and MMSE. Neuropsychological results reclassified 37 as having MCI or mild dementia. Clinically diagnosed patients were added, creating a 217-person sample reflecting the population distribution of normal, MCI and dementia.

Results: The MOST correlated highly with diagnostic severity and each neuropsychological test, demonstrating 80% correct diagnostic classification. The MOST showed a stronger relationship with dementia severity and list memory than MMSE. MOST cutting scores provided 88% sensitivity and 83% specificity for identifying MCI and dementia, yielding a PPV of .72 and NPV of .93.

Conclusion: The MOST accurately classifies patients from a diagnostically proportioned sample as normal, MCI, or demented and has high sensitivity and specificity for separating normal from impaired. Providers can use this 5-minute test to accurately identify cognitively impaired patients and to reassure elders with normal cognition, while acknowledging that no single test is adequate for making a definitive diagnosis.

Keywords: Dementia; Screening; Memory Orientation Screening Test (MOST); Cognitive assessment

Introduction

Earlier detection of dementia increases opportunities for earlier medical and social interventions in the setting of the primary care office [1]. While acknowledging that no screening test of cognition is equivalent to a diagnosis, clinicians who employ a brief, sensitive and reliable test of cognition will potentially detect cognitive loss sooner, have objective data on which to base costly diagnostic and therapeutic decisions, and will be able to more reliably assess changes in cognitive status over time -in sharp contrast to providers who rely on subjective, unreliable reports of patients and caregivers [2]. Furthermore, accurate and objective test scores will allow the intact but worried elderly patient to be reassured that their current likelihood of suffering from dementia is low. A baseline cognitive score may be used to track changes and provide a reliable disease trajectory if needed in the future.

The 5-minute, 29-point Memory Orientation Screening Test (MOST®) combines four tasks of memory and executive function, incorporating 3 word recall, orientation to six time and date variables, immediate recall of 12 pictured household items, and standardized scoring of a clock drawing. The MOST correlated highly with standard neuropsychological outcomes, and was found more accurate and reliable than the MMSE [3] and Mini-Cog [4] in a large clinical validation study [5]. In a second study comparing brief neuropsychological measures with patient and caregiver ratings, the MOST was again more accurate than the MMSE [2]. These two studies included patients with normal cognition, mild cognitive impairment (MCI), as well as all levels of dementia, which creates a methodological advantage over studies that omit MCI when contrasting normal with demented groups. However, similar to other cognitive rating studies, which utilize memory clinic population data, there was an underrepresentation of elders with more normal cognitive levels.

This study is designed to more closely approximate the distribution of cognitive levels of older patients within the practice of a primary care practitioner (PCP). We first examined a group of community dwelling elders, reportedly with normal cognition, who did not have a diagnosis of MCI or dementia and were not taking dementia medications, and accurately established their cognitive levels using standard criteria for MCI and dementia [6-9]. To complete the cognitively-balanced model, we added data from clinic patients with normal test scores and those diagnosed with MCI, mild, and moderate dementia.

We compared the MOST and MMSE scores with standardized memory, attention and executive function test results, and with their overall clinical classification as normal, MCI or demented. We used this data to establish the optimal MOST cutting scores for use in a primary care setting and tested the ability of the MOST to correctly classify patients with respect to their cognition.

Methods

Subjects

Between June, 2008 and August, 2010, 128 community

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dwellers without a MCI/dementia diagnosis, use of dementia medications, or cognitive complaints were recruited from Councils on Aging, independent senior residences, and senior activity centers in the greater Springfield, MA area. Another 20 reportedly cognitively intact volunteers were relatives of patients in the clinical practice. All participants were self-nominated.

Neuropsychological tests for story recall, list recall and divided attention detected abnormal scores (≥ 1.5 SD below normal) in 37 (25%) of the 148 participants. Twenty-three, having one abnormal test score, were reassigned as MCI. Additionally, 14 with more than one score below 1.5 SD or at least one score ≥ - 2.0 SD were reassigned as mild dementia. We added data from 69 clinic patients with normal cognition, or diagnosed using standard criteria, [7-10] as having MCI or dementia, based on age-education adjusted neuropsychological test scores, a comprehensive medical and psychiatric history, as well as separately performed patient and family informant interviews as has been reported previously [2,5]. They were randomly selected from a larger cohort in the neuropsychology practice at that time: 34 patients had normal cognition on testing despite concern for cognitive impairment, 13 were diagnosed with MCI, and 22 had mild or moderate dementia. This yielded a total N=217: 145 (66.8%) with normal cognition; 36 (16.6%) with MCI; and 36 (16.6%) with dementia.

In choosing this distribution we recognize that the reported prevalence of MCI and dementia in patients over the age of 65 varies widely. The percentages we chose are consistent with published data and are likely to represent the cognitive levels of a population with a mean age of 76 [10]. And while patients with severe dementia receive care in a primary care setting, we did not include such patients in this analysis because formal testing is generally not required to establish the presence of cognitive impairment.

Subjects ranged in age from 60-92 and had a mean age of 76.3 (± 7.2) and mean education of 14.5 (± 3.0) years. Women comprised 73% of the sample. Ninety-two percent were Caucasian; eight percent were African American. All subjects spoke English. Each of the 148 community participants granted informed consent consistent with the Sisters of Providence Health Care IRB SP2008-004. Gathered routinely in the course of treatment, de-identified archival data from 69 patients was considered exempt.

Procedure

Each community subject was tested individually. A trained psychometrician administered the MOST, the MMSE, The Shopping List Test (a list learning and recall test) [11], the Logical Memory-II subtest of the Wechsler Memory Scale-Revised (delayed story memory) [12], and Trail Making A and B (sustained and divided attention) [13]. Results from these tests were extracted from the 69 archived patient records.

MOST scores (0-29) were calculated for each patient, with 0-3 points for 3-word recall, 0-6 points for orientation to time, 0-12 points for immediate unforwarned recall of a series of 12 pictured household objects named by the subject, and 0-8 points scored for organization and abstraction elements of a clock face drawn within a 2 1/2 inch circle. The MMSE (0-30) was scored according to traditional methods, counting the first spelling error in WORLD backwards. The Shopping List Test score represents the 10-minute delayed recall of a 12-item grocery list after four serial presentations. Logical Memory scores are the number of elements from two stories remembered after a half hour delay, calculated according to standard methods. Trail making A and B scores represent seconds to completion for each test, with 500 seconds set as the maximum and the default time for Trail making B in a patient too confused to complete the test.

Chi Square calculations were computed for demographic variables among each group. Pearson correlations and their levels of significance vs. 0 were computed. Tests of significant differences between correlations used Fisher’s z-transformation and tested the normalized difference vs. 0 using SAS/STAT Software Version 9.1.3 of the SAS System for Windows (SAS Institute Inc, Cary, North Carolina). In all cases, p=.05 was set as the cutoff for significance.

Results

Demographic variables and test scores for each diagnostic group are listed in table 1. There was no significant difference among diagnostic groups in regard to age (chi-square=.073, df=2, p=.96), education (chi-square=.086, df=2, p=.96) or gender distribution (chi-square=1.18, df=2, p=.55). Age and education had low, but significant correlations with both screening tests, due to the relationship of dementia severity with age (r=0.10) and education (r=-0.19). Race was not significantly related to dementia severity (r=0.02) or the MOST (r=-0.09).

The MOST correlated highly and significantly (p<.001) with diagnosis severity and with all four neuropsychological measures (Table 2). The MOST was significantly more accurate than the MMSE in relation to dementia severity (z=2.2, p=.03) and to list recall (z=2.3, p=.02). The MOST correlation with story memory was numerically higher (r=0.66 vs. 0.56) than that of the MMSE, but was not significant (z=1.55, p=.12). The tests did not differ in their relationships to tests of attention.

We then grouped the MOST scores into three cognitive categories. Previous research indicated a MOST score ≤ 18 best reflected dementia [5]. Our clinical experience suggested that 22-29 would indicate normal cognition. The intermediate range, 19-21, was assigned to MCI.

Categorizing the sample according to these cutoffs correctly classified 80% of all subjects into the three diagnostic groups (Table 3). When compared with neuropsychological tests and clinical assessments of disease severity, 93% of subjects with a MOST score 22-29 were correctly classified as having normal cognition. A MOST score of 0-18 correctly assigned 76% of demented individuals to the dementia group. A MOST score of 19-21 correctly placed 45% of the 47 MCI individuals into that group. An equal number in this range had normal cognitive tests results.

A secondary analysis looked at the 37 individuals who thought that
their cognition was normal, yet they tested as impaired on standardized tests. The MOST correctly identified 26 (70%) of these 37 individuals.

Given the emerging conceptualization of MCI and dementia as a continuum of a disease process [14-17], we additionally analyzed the effect of using a MOST score of 22 to separate normal cognition from abnormal cognition, as might be used in a case-finding primary care setting. This cutoff correctly placed 93% of the cognitively normal individuals and 72% of MCI/demented group (Table 4), resulting in a sensitivity of 88% and a specificity of 84% (PPV=.72, NPV=.93) for identifying some level of cognitive impairment using the MOST.

### Discussion

The MOST demonstrated a strong relationship with longer and more complex neuropsychological tests and with clinical disease severity. Comparison between the MOST and MMSE shows the MOST to have a significantly greater relationship with clinical disease severity level and with list recall and a numerically higher but non-significant association with story recall. Both tests had good, but equal relationships with tests of attention and executive function. This result confirms findings from two previous studies.

This study also found the MOST to achieve a very good three-category (Normal, MCI, Dementia) classification rate of 80%, reflecting the decision matrix faced by providers who want to use a brief test to best place a patient within a category of cognitive health or illness. Age and education did not affect MOST accuracy. Previous research demonstrated that depression did not affect MOST scores [5]. The ability of the MOST to achieve this goal of accurate classification is particularly notable for a test that can be administered and scored in five minutes.

This study is unique among tests typically used by PCP’s in the United States by creating a sample closely representing the distribution of cognitive levels of elderly patients seen in a primary care setting. Rather than relying on dichotomized samples of normal vs. demented patients, where the absence of the MCI group inflates diagnostic accuracy estimates, or obscuring actual disease prevalence by arbitrarily equalizing the number of patients in each category, we evaluated the performance of the MOST in a model that includes MCI and dementia diagnoses in a ratio which more closely approximates prevalence. MCI is the most difficult population of patients to characterize, due in part to its existence as a “grey area” between normal cognition and dementia on a continuum of impairment. These patients also have a higher degree of daily variability in cognitive ability, with very early MCI patients functioning as “normals” on structured testing [18-20], particularly in patients with executive impairments that are minimized by the one-to-one nature of objective testing.

The proportional representation of patients in this study also improves confident generalization from these findings to the situation faced daily by primary care providers when encountering the individual patient, and needing to make rational decisions regarding possible presence or absence of disease, whether to undertake further diagnostic procedures, or to initiate treatment, particularly as costs for emerging treatments may be high.

While no screening test of cognition is equivalent to making or ruling out a dementia diagnosis, reassuring intact but worried patients can be aided by testing with the MOST. The provider who finds a patient with a MOST score ≥ 22 is able to reassure the patient of a 93% likelihood that they would not score in the impaired range on standardized neuropsychological tests. While this reassurance does not rule out the possibility of abnormal underlying biomarkers or neuroimaging, it does

<table>
<thead>
<tr>
<th>TEST</th>
<th>MOST</th>
<th>MMSE</th>
<th>MOST vs. MMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>p</td>
<td>r</td>
</tr>
<tr>
<td>Age</td>
<td>-0.17</td>
<td>.01</td>
<td>-0.17</td>
</tr>
<tr>
<td>Education</td>
<td>0.20</td>
<td>.003</td>
<td>0.20</td>
</tr>
<tr>
<td>Dementia Severity</td>
<td>-0.79</td>
<td>&lt;.001</td>
<td>-0.69</td>
</tr>
<tr>
<td>SLT-R (list recall)</td>
<td>0.66</td>
<td>&lt;.001</td>
<td>0.51</td>
</tr>
<tr>
<td>LM-II (story recall)</td>
<td>0.66</td>
<td>&lt;.001</td>
<td>0.56</td>
</tr>
<tr>
<td>Trailmaking A (sustained attention)</td>
<td>-0.56</td>
<td>&lt;.001</td>
<td>-0.50</td>
</tr>
<tr>
<td>Trailmaking B (divided attention)</td>
<td>-0.65</td>
<td>&lt;.001</td>
<td>-0.66</td>
</tr>
</tbody>
</table>

r, p and z are standard statistical notations. r is Pearson correlation, p is the significance level, z is Fisher’s Z which is a comparison of two correlations to determine if they are statistically different.

**Table 2: Comparison of MOST and MMSE with demographic and outcome measures.**

<table>
<thead>
<tr>
<th>MOST</th>
<th>Normal</th>
<th>MCI</th>
<th>Demented</th>
<th>Row sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>22-29</td>
<td>121 (93.1%)</td>
<td>8 (6.2%)</td>
<td>1 (0.8%)</td>
<td>130</td>
</tr>
<tr>
<td>19-21</td>
<td>21 (46.7%)</td>
<td>21 (46.7%)</td>
<td>3 (6.7%)</td>
<td>45</td>
</tr>
<tr>
<td>0-18</td>
<td>3 (7.1%)</td>
<td>7 (16.7%)</td>
<td>32 (76.2%)</td>
<td>42</td>
</tr>
<tr>
<td>Column sum</td>
<td>145</td>
<td>36</td>
<td>36</td>
<td>217</td>
</tr>
</tbody>
</table>

**Table 3: Hit rate for most score ranges by diagnosis: Overall rate=80.2%.**

<table>
<thead>
<tr>
<th>MOST Score</th>
<th>Normal</th>
<th>MCI/Demented</th>
<th>Row sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>22-29</td>
<td>120 (93.0%)</td>
<td>9 (7.0%)</td>
<td>129</td>
</tr>
<tr>
<td>0-21</td>
<td>25 (28.5%)</td>
<td>63 (71.5%)</td>
<td>88</td>
</tr>
<tr>
<td>Column sum</td>
<td>145</td>
<td>72</td>
<td>217</td>
</tr>
</tbody>
</table>

**Table 4: Hit Rate for MOST score ranges collapsing MCI and Dementia: Overall 84.3%.**
provide the clinician, the patient and the family with a greater degree of certainty than is typically found in current clinical practice. Particularly given that CSF and neuroradiological biomarkers are not available for meaningful use in general practice, and that serum and blood-based markers are in even more preliminary stages of development and testing, the availability of a 5 minute office-based test of cognition with good discriminate ability will assist in making more accurate disease-state identification and treatment initiation.

The MOST offers a more accurate assessment of cognition than does reliance on subjective complaints. In this study, we found 25% of the independent, community dwelling elders not diagnosed with cognitive impairment and not reporting use of any dementia medications who described their cognition as normal, scored at impaired levels on well-validated neuropsychological tests. This echoes our previous finding that patients, even when treated for cognitive loss in a tertiary memory center, have very poor ability to judge their cognitive level (r=0.02), and that their family informants (r=.36) are only marginally better. It would argue that clinicians should not rely on patients or family members to judge the patient’s cognitive functioning and, instead, should use an objective test. In a secondary analysis within this study, the MOST captured 70% of those reportedly “normal” patients who actually had cognitive impairment and reassigned them appropriately.

We cannot emphasize enough that thorough and comprehensive diagnosis is important in arriving at a diagnosis of dementia. Nevertheless, in practical terms, a PCP using the MOST, can have reasonable confidence in the score ranges as a starting point. For those achieving a MOST 0-18, dementia is very likely at that time, as only 7% of our sample with those scores demonstrated normal cognition on comprehensive medical evaluation and neuropsychological testing. A MOST score in this range would support prompt initiation of medical and social interventions. This study also suggests that MOST scores ≥ 22 will allow the clinician to reassure patients that their cognition is most likely normal, as less than 7% of patients in this MOST range had MCI and only 1% tested as demented. Alternatively, a MOST score of 19-21 places the patient either in MCI or a lower tier of their normal functioning, potentially making more complex the clinical decisions regarding additional diagnostics and initiation of treatment. If the provider and the patient agree that earlier intervention would be beneficial, the MOST 19-21 score would support that decision. If the patient prefers watchful waiting, the initial MOST will provide an objective and reliable baseline against which to measure future change.

Periodic retesting with the MOST will help determine the trajectory and degree of cognition over time and the patient’s response to interventions, as a 3-point change over time reflects a statistically significant (CI=95%) decline or improvement [5]. For most patients, this can be followed at a 6-month interval.

Our study is limited in several ways. Although our racial breakdown mirrors that within the larger U.S. population [21], we have not addressed differences in race or ethnicity in our sample. Similarly, although our educational level mirrors the current findings that nearly 80% of elders in the U.S. complete high school and 22.5% have college or higher education’s [21], our results may not reflect the cognitive performance of elders in other countries. Our sample is an approximation of the typical primary care setting and not an actual random sample drawn from consecutive patients in one or more clinics in diverse geographical areas. We also have not compared the MOST with brief and reportedly accurate, measures of cognition recently made available in other parts of the world [22-25]. All of these issues should be addressed in future research.

Despite these limitations and the inherent restrictions in any screening measure, we believe that the growing numbers of individuals entering the dementia target age range of 65 or older makes brief, objective cognitive testing urgently important and that this is optimally accomplished by routine office-based testing. The accuracy, brevity, and ease of use of the MOST potentially represent an attractive and reliable test of cognition for use in a busy office practice.

Acknowledgement

Author Contributions: Both authors contributed equally to this article. Dr. Mitchell Clionsky had full access to the data and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Human Subjects: One hundred, forty-eight of the 217 subjects in this study granted informed consent consistent with the Sisters of Providence Health Care IRB SP2008-004. Test data from an additional 69 subjects was retrieved from archival patient files, gathered routinely in the course of treatment, and considered exempt from IRB requirements.

Conflict of Interest: Both authors hold a copyright and trademark on the Memory Orientation Screening Test (MOST). MC (author 1) has a small research grant from Pamlabs, Inc. EMC (Author 2) shares the research grant from Pamlabs, is a consultant for Eisai and Pamlabs, and is a speaker for Avanir and Novartis Pharmaceuticals.

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References


