



# Limitations of the Mini-Mental State Examination

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■ The Mini-Mental State (MMS) Examination is perhaps the most frequently used bedside screening measure of cognition of psychiatric and neurologic patients. It represents a formal, more standardized qualitative approach to determining mental status than an unstructured interview. Initial validation efforts comparing MMS scores of psychiatric patients to the results of more informal mental status interviews were very encouraging. Subsequent research comparing the scale to other criteria has suggested some limitations of its use, however. It has been found to overestimate impairments in persons over age 60 and in persons with less than nine years of education. The MMS scale has been reported to be insensitive to cognitive impairments resulting from right hemisphere dysfunction as well as milder forms of cognitive dysfunction irrespective of cortical origin. Case studies that demonstrate its inaccuracy in identifying cognitive impairments in individuals with average and low-average verbal IQs are reviewed. These limitations have far-reaching implications for both research and clinical applications of the measure. Proper use of the MMS requires that the user be aware of instances when the scale is likely to produce misleading data.

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**T**HERE IS a clear need for a brief, objective, quantitative screening instrument to assess cognitive ability of psychiatric, neurologic, and general medical patients. As evidence of this need, it has been reported that, without the benefit of such an examination, nurses failed to identify 55% of patients with cognitive impairments; medical students, 46%; ward physicians, 37%; neurologists, 30%; and general practitioners, 87%.<sup>1-3</sup> Such failure to recognize cognitive impairments potentially has considerable im-

plications for patient care, as such changes are often the first indication of many underlying neuropathologic conditions.<sup>4,5</sup>

## DEVELOPMENT AND VALIDATION OF THE MMS

In an effort to meet this need, several bedside screening measures have been developed.<sup>6</sup> The Mini-Mental State (MMS) examination, developed by Folstein et al,<sup>7</sup> is one of the most frequently used. The MMS was specifically intended to quantify the extent of dementia or delirium in psychiatric and neurologic patients.

Having noted that the elderly are often unable to tolerate lengthy examinations, the developers of the MMS purposely limited it to 11 items. These items, derived from a routine psychiatric mental status exami-

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nation, could be administered in five to 10 minutes. These items include questions regarding orientation to time and place; registration or encoding of new information (as determined by the patient's ability to learn the names of three objects); the capacity to complete the serial-sevens task (or, alternatively, to spell "world" backwards) as a measure of attention and concentration; and recall of the three previously learned names.

The language portion of the MMS includes naming to confrontation using a pencil and watch as stimuli; repetition of the phrase "no ifs, ands or buts;" comprehension of a three-step command; the ability to read and obey the command "close your eyes;" and writing a sentence of the patient's choosing. Reproduction of a simple line drawing constitutes the visuo-constructional portion of the measure.

When these 11 items are completed correctly the MMS yields a total score of 30. Factor analysis has suggested that 66% of the scale variance actually can be accounted for by two factors: an "educational" factor consisting of the reading and writing items and the serial-sevens task, and a "recent memory" factor that includes recall and orientation items.<sup>8</sup>

Early research suggested that the scale had great promise. MMS results correlated highly with severity of cognitive impairment as determined by psychiatric review of patients' medical records. Sixty-nine psychiatric patients, assigned to various diagnostic subgroups on the basis of chart reviews by a psychiatrist, produced the following mean scores: dementia ( $n=29$ ) 9.7; depression with cognitive impairment ( $n=10$ ) 19.0; depression with uncomplicated affective disorder ( $n=30$ ) 21.1; and normal elderly ( $n=63$ ) 27.6.<sup>7</sup> Whereas clinically demented persons (in whom cognition is relatively stable for the brief periods between testings) failed to show practice effects, MMS scores improved in three psychiatric patients who responded to treatment. Scores correlated significantly with both the Verbal IQ (Pearson  $r=.776$ ,  $p<.0001$ ) and the Performance IQ (Pearson  $r=.660$ ,  $p<.001$ ) from the Wechsler Adult Intelligence Scale.<sup>7</sup> Test-retest reliability coefficients of 0.89 and 0.92 have been reported when patients are rated by the same examiner and the administrations are 24 hours apart.<sup>7,9</sup> When later administered by a different examiner, test-retest reliability coefficients range from 0.82 to 0.99.<sup>6,7,9</sup>

In the original standardization sample of 63 normal elderly subjects, Folstein et al<sup>7</sup> reported a range of scores from 24 to 30. That and subsequent research<sup>1,9-11</sup> suggested that an MMS score of 24 or higher optimally separates patients assumed to be cognitively intact from those with impairments. Using a 23/24 cutoff and psy-

chiatric judgment as the criterion, the MMS was found to be 87% sensitive (i.e. correctly identified the presence of cognitive impairment in 87% of those affected) and 82% specific (i.e., correctly identified the absence of cognitive impairment in 82% of those not affected). Its false-positive ratio was estimated to be 39.4% and its false-negative ratio 4.7%.<sup>10</sup> However, subsequent research has suggested that these data are misleading in that they overestimate the validity of the MMS.

#### LIMITATIONS OF THE MMS

Subsequent analysis revealed that unaffected control subjects who failed to reach the cutoff criteria of the MMS were typically older and/or less educated.<sup>9</sup> Recalculating the specificity of the test for particular subsamples revealed that the MMS was only 63.3% sensitive for those with eight or fewer years of education and only 65.2% sensitive for those aged 60 or older.<sup>10</sup> Of course, the fact that older or less educated patients are over-represented among the scale's false-positive errors does not imply that such individuals consistently score below the cutoff. MMS performance of those groups is highly variable; some members of those subsamples may score at or above the cutoff despite the presence of cognitive impairments.

False-negative rates have been found to be substantially higher among patients with identified neurologic abnormalities, due to the scale's insensitivity to right hemispheric lesions.<sup>6,12</sup> Schwamm et al<sup>13</sup> studied a sample of patients in whom central nervous system lesions had been confirmed by computed tomography, magnetic resonance imaging, or, in the case of tumors, biopsy studies. They compared the results of three bedside screening measures—the Neurobehavioral Cognitive Status Examination (NCSE), the Cognitive Capacity Screening Examination (CCSE), and the MMS—that had been administered to that sample and found a false-negative ratio of approximately 53% for the CCSE, 47% for the MMS, and 7% for the NCSE. Dick et al<sup>9</sup> included the MMS in their work-up of 126 neurological and neurosurgical patients with right, left, or bilateral lesions as determined by computed tomography, carotid angiography, and/or electrophysiological studies. They found that patients with left hemispheric lesions performed similarly to those with bilateral damage, while those with right hemispheric lesions performed at a level comparable to controls. As a result, they concluded that the measure was not sufficiently sensitive to distinguish left hemispheric from diffuse brain disease, nor was it able to detect cognitive impair-

ment resulting from right hemisphere dysfunction.

In addition to assessing primarily left hemispheric cognitive abilities, the MMS has been criticized for the simplicity of its items.<sup>6,12-14</sup> Consequently, the scale, in addition to being largely insensitive to right hemispheric dysfunction, is not capable of detecting milder cognitive impairments originating from diffuse or localized lesions regardless of their location. Pfeffer et al<sup>15</sup> found that, using a cutoff of 20/21, the MMS had a false-negative rate of 70% when administered to patients with mild impairments associated with early stages of senile dementia. The scale achieves a high sensitivity to those impairments only at the expense of an extremely high false-positive rate.

The characteristics of patients able to "pass" the MMS despite cognitive impairments, i.e., those who constitute its false-negative errors, have received relatively little attention. Nelson et al<sup>6</sup> speculated that persons with high IQs premorbidly would likely find the MMS items to be quite easy. To the extent that this is accurate, it is reasonable to assume that the scale's false-negative errors include individuals who have high Verbal IQs despite the presence of other cognitive deficits. In fact, it appears that the IQs of such patients need not be high. Irrespective of their ages, patients with Verbal IQs as low as the average (90-109) or low-average (80-89) range are sometimes capable of correctly responding to the items that make up the MMS, despite having cognitive deficits as detected by formal neuropsychological examination.

Consider the following cases of patients with advanced academic degrees and/or white-collar work histories, or whose overall intellectual ability remained essentially intact despite other cognitive impairments.

#### CASE REPORTS

##### Case 1

At the time of examination, this patient was 69 years of age. He had 18 years of education, had been an A and B student and had been employed as an attorney for the past 37 years. Six weeks after suffering loss of consciousness secondary to cardiopulmonary arrest, he came to The Cleveland Clinic Foundation complaining of intermittent dizziness, "progressive forgetfulness," and failing performance at work.

To obtain a comprehensive evaluation of the patient's motor, sensory, language, memory, intellectual, and higher cognitive functions, he was referred for neuropsychological examination. His neuropsychological studies revealed generalized cognitive dysfunction. His Verbal

IQ of 95, Performance IQ of 78, and Full Scale IQ of 87 were all judged to be substantially lower than his estimated premorbid level of ability. Immediate recall of information was moderately to severely impaired and delayed recall was profoundly impaired. He showed a frank dysnomia, profoundly diminished word fluency, and significantly impaired visual analytic ability.

Despite these considerable cognitive deficits, he was able to "pass" the MMS with a score of 27. Presumably, because his premorbid verbal intellectual capacity had been so high, despite the general cognitive compromise from his cardiopulmonary arrest, his Verbal IQ remained within the average range. Thus, this patient retained sufficient verbal ability to meet the demands of the MMS.

##### Case 2

This 74-year-old woman had 12 years of education and had been a B student. She had owned and operated a women's specialty boutique until her retirement one and a half years prior to being referred to The Cleveland Clinic Foundation for examination because of complaints of memory dysfunction and confusion.

At that time, her MMS score was 26. Neuropsychological findings included a Verbal IQ of 86, a Performance IQ of 85, and a Full Scale IQ of 85, profoundly reduced immediate and delayed memory for visual stimuli, frankly impaired visual analytic ability, significantly diminished confrontation naming, and profoundly impaired problem-solving capacity. Despite this general pattern of global cognitive dysfunction, she responded correctly to the majority of the MMS items.

##### Case 3

This patient, a 65-year-old man, had an eleventh-grade education and worked as a steelworker until his retirement. He sought medical advice for his increasing memory difficulties; at that time, his wife reported additional problems with his comprehension of oral and written communications, word-finding, reading, writing, spelling, and articulation. She related that her husband had been depressed and irritable and was easily upset by changes in plans.

He was tentatively diagnosed at that time as having Alzheimer's disease. Upon referral to The Cleveland Clinic Foundation five months later for a second opinion, his MMS score was 26. Intellectual assessment revealed a Verbal IQ of 82, a Performance IQ of 95, and a Full Scale IQ of 86. These indices were regarded as essentially unchanged from his estimated premorbid level of ability. However, other cognitive abilities were clearly

compromised. He showed a pronounced verbal memory deficit that was apparent on both immediate and delayed recall trials; his visual memory, while poor, was substantially better than his memory for verbal material. He showed diminished confrontation naming, reduced word fluency, literal and verbal paraphasic distortions, dysarthria, and spelling difficulty. Visual analytic reasoning and visual-motor coordination remained intact.

While an atypical early presentation of Alzheimer's disease could not be ruled out, this neuropsychological profile is more consistent with lateralized cortical dysfunction. Despite his considerable language deficits, the patient was able to surpass the cutoff criteria of the MMS.

## DISCUSSION

It is certainly not surprising that the MMS is not as sensitive or specific as a comprehensive neuropsychological evaluation. The administration and interpretation of a neuropsychological battery is both time-consuming and costly. A five- to 10-minute screening measure cannot rightly be faulted for not being as thorough or sensitive in comparison. As its developers remarked, "the MMS cannot be expected to replace a complete clinical appraisal in reaching a final diagnosis of any given patient" (Folstein et al<sup>7</sup> p. 195). The above examples are provided to illustrate this point and reveal that the MMS is not always capable of detecting cognitive impairments associated with dementing diseases or diffuse encephalopathies. It is apparent that even individuals with Verbal IQs in the low-average range are sometimes capable of passing the MMS despite the presence of documented neuropsychological deficits. Consequently, the measure has limited clinical utility with some dementia patients.

A growing body of evidence supports the theory that dementia patients can be subdivided into relatively discrete subgroups on the basis of the qualitative and quantitative characteristics of their neuropsychological profiles.<sup>16-19</sup> Despite the fact that dementia entails diffuse morphologic brain changes, its behavioral manifestations may be asymmetrical. Some patients, for example, present during the early stages of the disease process with predominant language dysfunction while others present with primarily visual-spatial reasoning deficits. By one estimate, as many as 36% of patients who are given the presumptive diagnosis of Alzheimer's disease fell within subgroups having a mean Verbal IQ in the average (90-109) range during the early stages of the disease process. Those patients tend to have at least some

college education and are more likely to be female than male. Another 46% fell within subgroups having a mean Verbal IQ in the low-average range.<sup>19</sup> Given the relative preservation of their verbal intellectual skills, it is likely that the MMS would lead to misclassification of many of the dementia patients within those subgroups.

## Research implications

These limitations have important ramifications for the use of the MMS in empirical research regarding cognitive deterioration. Any project that entails administration of the MMS to classify patients for study will likely overinclude subjects who are older, have limited academic backgrounds, or have particular difficulty with language functions. Conversely, such studies will likely not include subjects who may have cognitive impairments resulting from bilateral or diffuse brain disease but, by virtue of their high level of ability premorbidly or relative preservation of language functions, are able to pass the cutoff criteria of the MMS, or those with right hemisphere lesions.

Because of its greater likelihood to produce such skewed samples, the results of research using the MMS as a screening procedure cannot be assumed to generalize to the population as a whole. Researchers who rely on the measure for its ability to screen potential subjects or assign them to experimental conditions must be cognizant of these psychometric limitations. The scale seems best suited for use in longitudinal research as a means of monitoring some mental status changes due to transient conditions or treatment regimens, or as a component of a larger, more comprehensive assessment battery.

## Clinical implications

While the correct classification of research subjects is certainly important, avoiding misclassification among clinical patients is crucial. Failure to diagnose organic brain syndromes is particularly damaging in patients with progressive brain disease or expanding lesions. In the absence of treatment, cognitive deterioration will certainly continue in these patients—patients in whom MMS test results suggest "a clean bill of health." If an organic cause for maladaptive behavior is mistakenly ruled out and a functional etiology assumed in its stead, the patient may receive costly psychiatric treatment from which little benefit will be reaped.

It is not surprising that some regard such misclassifications as far more costly than errors in the opposite direction.<sup>20-22</sup> This led Bigler and Ehrfurth,<sup>23</sup> in their review of another cognitive screening measure, to con-



clude that "to rely on a single measure of overall neurological status, particularly when that measure has a demonstrated rate of false negatives in the neighborhood of 40% or worse, is without question poor practice" (p. 567). Misdiagnosis resulting from use of the MMS without full awareness of its limitations potentially exposes the user to malpractice claims. Given the availability of detailed, comprehensive neuropsychological assessment batteries, the continued use of the MMS for diagnostic purposes clearly seems inappropriate.

# Recommendations

The MMS seems to be a much-needed and valuable first step in the development of an objective bedside screening measure. To improve on the MMS, it has been recommended that it be modified to include a multidimensional scoring system that would be more sensitive to focal cortical dysfunction, expanded with regard to both breadth and level of difficulty of item content (with greater emphasis on visual-spatial abilities), and that corrections for age, education, and social class be

incorporated into scoring procedures.<sup>6</sup> More standardized administration procedures, graded scoring of responses, and altered order of administration have also been recommended.<sup>14</sup>

Until such changes are made, those using the MMS as a screening tool should be cautious in accepting results suggesting dementia in patients who have fewer than nine years of education or who are over the age of 60. Also suspect are results suggesting the absence of cognitive compromise in patients whose neurologic examinations or diagnostic studies suggest a lesion within the right cerebral hemisphere, individuals (irrespective of age) who by virtue of their academic and/or vocational histories are assumed to have been high-functioning premorbidly, and those whose cognitive dysfunction has not yet resulted in a significant drop in verbal intellectual functions. Obtaining a valid evaluation of cognitive functioning in such patients requires a more extensive, comprehensive, and norm-based neuropsychological examination.

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