Clinical Interpretation of the Mini-Mental State

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Abstract: *The Mini-Mental Status Examination (MMSE) is a brief, structured test of cognitive function. The test is often used as a screening or case-finding instrument for the detection of organic mental disorders or cognitive impairment. However, many clinicians incorporate the MMSE into their clinical mental status examination. In both contexts, cutoff scores are often utilized to interpret the results, with scores below the cutoff being interpreted as evidence of cognitive dysfunction, and scores above the cutoff being interpreted as evidence against such dysfunction. However, when the test is done as part of a mental status examination, the application of a cutoff score fails to take account of prior clinical information, which is critical to the interpretation of all diagnostic tests. In this paper, an alternative approach to interpretation is proposed. In the proposed method, guidelines for interpretation are based on the probability of being free of organic disease at each potential score. Scores are interpreted in terms of their consistency or inconsistency with a prior diagnostic impression. This takes prior clinical information and clinical judgment into account. Although different from the traditional way of interpreting the MMSE, the proposed method can be implemented on an intuitive level and does not require mathematical calculations, which are inconvenient at the bedside.*

Introduction

The Mini-Mental Status Examination (MMSE) is a brief, structured test of cognitive function. The instrument is used by many general psychiatrists, consultation-liaison psychiatrists, and neurologists. The popularity of the instrument is due, in part, to its brevity (it can be administered in approximately 5 minutes), and also to the fact that no alternative brief clinical test has demonstrated superior performance.

The MMSE may be used as a screening instrument to help detect delirium, dementia, or other disease processes characterized by cognitive dysfunction in clinical or community-based populations; however, this is not its only application. Many clinicians incorporate the MMSE into their clinical interviews as a component of the mental status examination. Many of the MMSE questions replicate those routinely asked in the clinical mental status examination, including questions to assess registration, short-term memory, orientation, and attention. Hence, incorporating an MMSE into a clinical interview does not necessarily mean that many extra questions have to be asked, only that they have to be asked according to the MMSE protocol.

Shortcomings in the reliability and validity of unstructured bedside mental status tests are well documented [1–3]. Though the MMSE is not free of such difficulties [4–6], its validity as a measure of cognitive functioning is widely accepted.

When the MMSE is used as a screening or case-finding instrument, the interpretation of results are straightforward: all patients scoring less than a predefined threshold (or cutoff score) are identified as positive on the screen, and as being in need of further assessment. When the MMSE is incorporated into a clinical mental status examination, the interpretation is more complex. The major reason for the added complexity is that a clinician administering the test in clinical practice usually has considerable prior knowledge of the patient. The test result must be interpreted in the context of this information. Also, the application of a cutoff score integrates poorly into the usual process of clinical judgment. The usual cutoff score for the MMSE is

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24. In a screening program, it may be acceptable to classify all results as "pass" or "fail," based on whether they score less than this cutoff. In contrast, in clinical practice it seems less acceptable for a clinician to interpret a score of, say, 3 or 4, as equivalent to a score of 23.

One of the drawbacks of using a cutoff score to interpret the test is that this approach does not take prior clinical information into account. In clinical practice, a clinician will usually have already gathered considerable information about a patient before the MMSE is performed. For example, if the MMSE is done as a part of a mental status examination, the clinician will have already interviewed the patient before doing the test. In most cases, the interview will have provided historical information, or observable clinical data which would influence judgments about whether the patient has cognitive dysfunction. In fact, by the time experienced clinicians reach the stage of their assessment where they would normally conduct an MMSE, it is probable that most will have a strong diagnostic impression about whether the patient does or does not have an organic condition characterized by cognitive dysfunction. It is well known that pretest probability has a major impact on the predictive value of diagnostic tests, so it seems appropriate that pretest information should be incorporated into the interpretation of MMSE results.

The literature contains much discussion about the need to incorporate prior clinical information into the interpretation of diagnostic tests. The discussion has generally focused on principles of conditional probability (Bayes' theorem).

For a test that is scored "positive" or "negative" (assuming a positive result indicates pathology), and a disease that can be meaningfully defined as "present" or "absent," the following two-by-two table may be defined:

	Test positive	Test negative
Disease present	True positive (TP)	False negative (FN)
Disease absent	False positive (FP)	True negative (TN)

Using these abbreviations, sensitivity (Se) may be defined as Se = TP/(TP + FN), and specificity (Sp) may be defined as TN/(FP + TN). Both Se and Sp are conditional probabilities, however, they are conditional on disease status, which is unknown at the time of testing in clinical practice. For a patient with a positive test result, a clinician is more interested in the probability that the patient has the disease (positive predictive value) (PPV). If a patient has a negative test result, the clinician is most interested in the probability that the patient does not have the disease being tested for (negative predictive value) (NPV).

If the prevalence of disease in the population of interest is estimated by the proportion with the disease in a sample of patients from that population, then PPV could be estimated as TP/(TP + FP), and NPV as TN/(TN + FN). In clinical practice, positive predictive value could be estimated using existing estimates of sensitivity and specificity, and an estimate of pretest probability (PTP) of disease:

$$PPV = (Se)\,(PTP) \,/\, [(Se)\,(PTP) + (1 - Sp)\,(1 - PTP)]$$

Though this approach to the interpretation of diagnostic tests is sometimes advocated for general clinical use, it seems most applicable to a screening or case-finding situation. Here, the PTP may be estimated by the prevalence, or base rate, of the condition in the population screened. In the usual clinical situation, where a patient cannot be easily regarded as having been randomly selected from a meaningful population, it is unlikely that a prevalence rate can serve as a realistic estimate of pretest probability. Therefore, the estimation of PTP may depend on a global clinical judgment by the clinician. This type of numerical judgment may seem somewhat arbitrary and artificial in the course of a patient's assessment. Furthermore, application of Bayes' theorem in this way requires either some manual calculations, or the use of a nomogram, which may be inconvenient for clinicians at the bedside. Also, the result of these calculations may be difficult to integrate into clinical decision-making. For example, if the pretest probability is estimated at 60%, and the posttest probability is estimated at 70%, it is not clear how this should have an impact on clinical decisions.

The purpose of this paper is to describe an alternate approach to the interpretation of the MMSE in clinical practice. This alternate approach involves regarding a result as consistent with, or inconsistent with, a previous diagnostic impression. For example, if a clinician develops a clinical impression that a patient has an organic disorder producing cognitive dysfunction, the MMSE could provide a score that is consistent with that original diagnostic impression. In this case, the interpretation of the test is straightforward; the original di-

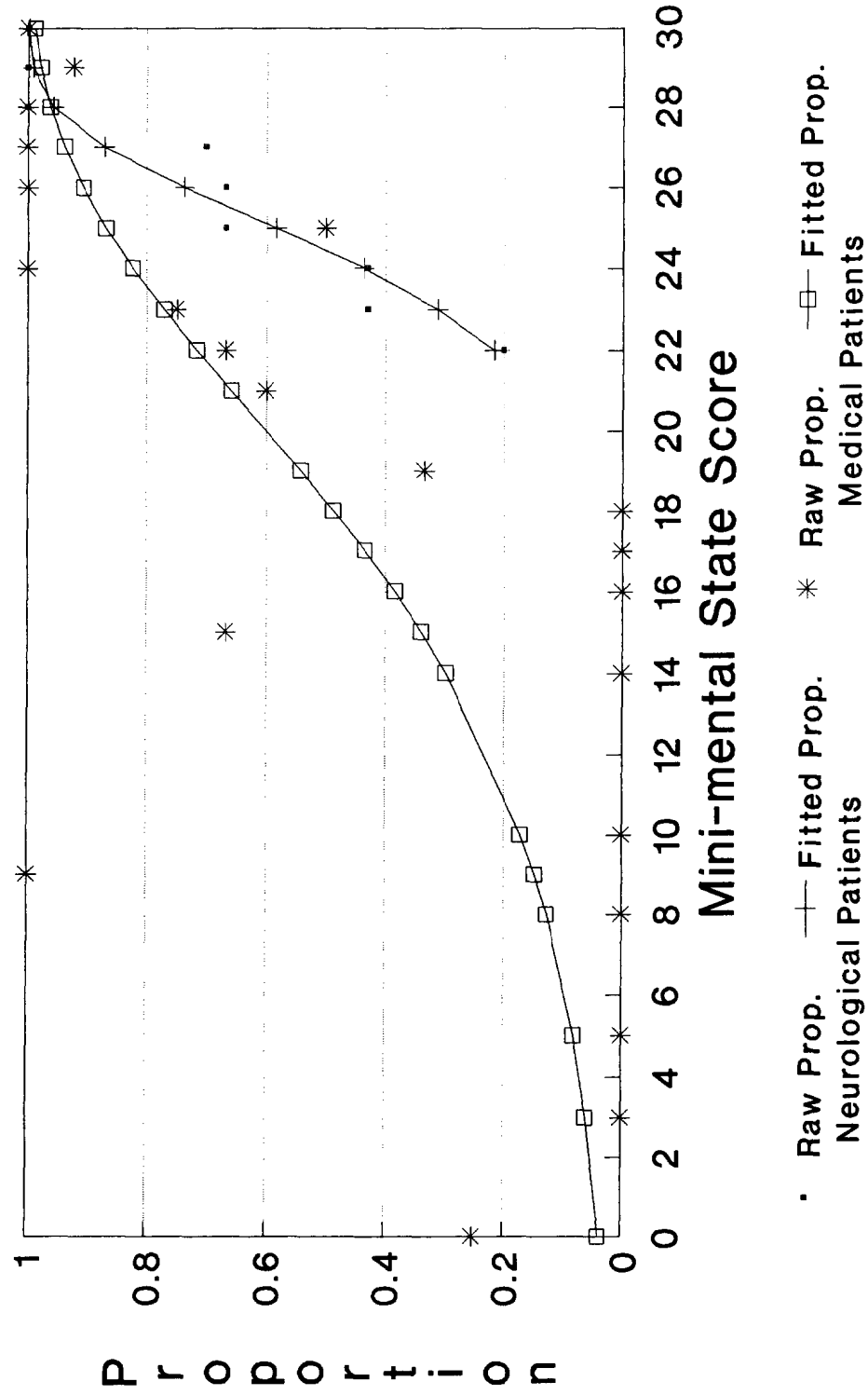

Figure 1. Proportion without cognitive impairment for both groups in relation to MMSE score.

agnostic impression remains unchallenged. Second, a result may be obtained that would challenge, or cause the clinician to rethink, the original diagnostic impression. This would occur if a diagnostic impression seemed unlikely given the score obtained on the test. Such an approach to interpretation is loosely analogous to the logical structure of a statistical test used in research; there is a prior hypothesis (in research it is usually a null hypothesis), and this hypothesis is challenged if the observed data appear inconsistent with it.

Methods

As a means of exploring this method of MMSE interpretation, data were abstracted from two validation studies of the MMSE, one in general medical patients [7] and the other in neurological patients [8]. In the study of medical patients, the "gold standard" was a psychiatric assessment (including a review of the chart, evaluation of available laboratory findings, and interviews with relatives) to determine whether the patient had delirium or dementia. In the study of neurological patients, the gold standard was a determination of whether the patient had significant global or focal cognitive impairments. The data were abstracted as the proportion of patients without delirium, dementia, or cognitive dysfunction who obtained each possible score on the MMSE. For each group of patients, the proportion without cognitive impairment was related to the test score, with statistical models utilizing a complementary log-log link function [9].

Results

The raw proportions and fitted values for both patient groups are displayed in Figure 1. The data from the two groups could not be combined, as a highly significant group-score interaction was found in a model containing the two groups (Chi-square 11.38, 1 df, $p = 0.0007$). This interaction suggests that MMSE scores may have different meanings in these different patient groups. The most probable reason for this difference relates to the different standards of diagnosis in these studies. Specifically, most patients with focal cognitive impairments due to focal neurological disease probably score higher on the MMSE than patients with delirium or dementia because focal impairments may only affect performance on a few MMSE items. The outlier from the model for medical patients at score = 9 represents one patient who was the only patient to attain this specific score, and was judged not to have delirium or dementia, hence, producing a raw proportion of 1.0.

Discussion

Among medical patients, the model suggests that scores of approximately 10–12 or less are somewhat inconsistent with a clinical impression that a patient does not have delirium or dementia. Only about 20% of patients scoring 12 would be expected to be free of those disorders. Of course, as the patient's score becomes lower, the probability becomes even less, and the scores become even less compatible with that diagnostic impression. The model for neurological patients suggests that scores less than 22 are associated with the same degree of incompatibility with a prior impression that the patients did not have cognitive dysfunction. However, for both patient groups, very low scores of approximately 10–12 or less can be regarded as providing a stimulus to reconsider a diagnostic impression that delirium, dementia, or other source of cognitive dysfunction is absent. Higher scores are increasingly compatible with the absence of these problems, and seem incapable in themselves of challenging a diagnostic impression that one of these problems is not present.

Of course, scores above 10 are not suggestive of the absence of significant organic disease, but they seem to fail to provide evidence inconsistent with a prior hypothesis that such disease is not present. In a patient with a reason other than delirium or dementia for obtaining a low score (e.g., mania, mental retardation), a low score may be interpreted, using clinical judgment, as being compatible with the absence of delirium or dementia and therefore not posing a challenge to a previous diagnostic impression.

When a clinician holds a diagnostic impression that delirium or dementia is present, it would be interesting to know which scores could be interpreted as somewhat inconsistent with, or capable of challenging, that impression. Medical and neurological patients scoring approximately 27 or greater would seem to provide such a challenge because a high proportion of these patients appear to be free of delirium or dementia (medical patients) or cognitive dysfunction (neurological patients); hence, a score of 27 or greater would be unlikely in a patient with a disorder or lesion characterized by cognitive dysfunction. Of course, if a

high score on the MMSE can be regarded as consistent with the type of cognitive impairment suspected (e.g. a mild or focal impairment), then the high score may be interpreted as being nevertheless compatible with that impression.

Conclusions

It is reasonable to query the accuracy of the proposed approach to MMSE interpretation relative to other approaches. Unfortunately, it is not possible to determine the proportion of times in which this approach would result in a correct or incorrect result, which is the usual basis for an assessment of accuracy. In fact, the approach described cannot be separated from the quality of the prior judgments made by clinicians utilizing the test. If a clinician's prior judgment is always correct, or almost certain, then there is little need for supplementary tests at all. If a clinician tends not to form diagnostic impressions prior to interpreting the test, then the approach described can contribute little to clinical judgment. However, most clinicians do tend to form diagnostic impressions, and tend to reconsider these if there is subsequent contradictory clinical information. The proposed approach to interpretation of the MMSE may be regarded as a meaningful way of integrating MMSE scores into clinical judgments, rather than a more accurate method of interpretation.

If a clinician has a prior diagnostic impression about whether a patient has significant cognitive dysfunction, one way to interpret MMSE scores is to allow a summary score from the MMSE to challenge that impression if the score obtained seems inconsistent with the prior impression. If the MMSE provides a score that is highly inconsistent with the prior diagnostic impression, then the diagnostic impression should be re-evaluated. If not, then the prior hypothesis need not be modified on the basis of the test result alone. Published data suggest that if there is a strong impression that a patient does not have delirium, dementia, or cognitive dysfunction, only very low scores, of approximately 10–12 or less, are incompatible enough with that impression to challenge it. If the opposite diagnostic impression is held, then only a very high score, say of 27 or greater, can challenge that impression. Using this method of interpretation, it appears that only somewhat extreme scores are capable, in themselves, of challenging previous diagnostic impressions. In this regard, the proposed approach to interpretation appears to give relatively more weight to clinical judgment than to the MMSE summary score. However, this may be a correct reflection of the contribution of the MMSE summary score to diagnostic decision-making.

It should be emphasized that interpretation of the test must consider factors other than the test score. For example, level of education and cultural background may affect scores [4–6]. Also, it should be noted that the MMSE only tests performance on certain specific cognitive tasks. For this reason, the test is likely to be insensitive to organic deficits that do not manifest themselves by abnormal performance in those specific areas. Furthermore, cognitive function may fluctuate in delirium, which must also be considered clinically in the interpretation of a single score. Some of these factors can be integrated conceptually into the framework described above because they are factors that may influence the degree to which the observed score is inconsistent with a diagnostic impression. For example, a low score may be regarded as not providing a major challenge to a prior diagnostic impression if the reason for the low score is judged to be a language barrier. However, it must also be recognized that in some patients, the information provided by the test may not be a valid measure of their cognitive performance, and also that the MMSE is not an inclusive measure of cognitive functioning and may therefore be insensitive to some types of clinically relevant abnormality. It should also be noted that the MMSE may be clinically valuable for reasons other than its role in diagnostic decision-making. Some of the test's usefulness may relate to its interrater and test-retest reliability properties which have generally been confirmed in the literature. For example, it may be used to provide a baseline assessment of cognitive functioning which can be repeated later for comparison to detect changes over time in cognitive functioning. Because of the interrater reliability of the test, it could be repeated by another rater if circumstances were such that the attending physician were unavailable. This may be particularly useful for hospitalized patients who may decompensate at night and be assessed by on-call personnel.

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