


A Mini-Mental Status Examination for the hearing impaired

SIR—The Folstein Mini-Mental State Examination (MMSE), developed in 1975 as a bedside test of cognitive function, has been extensively used in clinical practice and research and is widely accepted as a clinical tool for diagnosing and monitoring dementia [1]. Despite its low sensitivity and specificity (0.56 and 0.73, respectively, in one recent study) [2], comparable tools, including the Modified MMSE of Teng and Chui [3] have not received such widespread acceptance.

It contains 11 questions that test orientation, registration, attention, calculation, recall, language and visuospatial functioning, with a maximum score of 30. It takes minutes to administer and is practical for routine clinical use. Most questions are administered verbally. Hearing loss reduces performance on the verbal parts of the examination even in cognitively intact patients, with potential diagnostic error and alteration of management [4]. This is of concern, as hearing impairment affects over one-fourth of people over 65 years of age, and half of those over 75 years in most industrialised nations [5].

Uhlmann [6] tested 71 Alzheimer’s disease subjects with varying levels of hearing, using both written and standard versions of the MMSE. Paradoxically, they found that hearing-impaired subjects scored higher in the standard than the written version, while subjects with normal hearing performed better using the written version, although these findings were not statistically significant.

We (M.M.) developed a written version of the MMSE, found it clinically useful, and report here an evaluation of its performance in a hospital-based population of older people.

Methods

Subjects

The study population consisted of subjects over the age of 65 years with a range of cognitive function and normal, moderately or severely impaired hearing. Subjects with profound hearing loss or inability to read or comprehend instructions were excluded. Subjects were recruited from the geriatric, neurological and audiology departments at...
Research letters

Dunedin Hospital over 4 months, and were tested in inpatient and outpatient settings. The study was approved by the Lower South Regional Ethics Committee.

Study design

Informed written consent was obtained from all participants. Hearing aids and glasses were permitted. The whispered voice test was used to test hearing [7]. The subjects were asked to repeat a number whispered at a distance of 60 cm on the side the patient claimed to have the best hearing. The standard and hearing-impaired versions of the MMSE were administered in random order separated by at least 3 days, to counterbalance for practice effect.

Mini-mental status examination

The written MMSE included the same items, the difference being that patients read them. It was set in large font (Times New Roman, 72 point). The question on ‘repeating a sentence’ was verbally administered in both versions. Serial sevens and spelling ‘world’ backwards were both tested but only the serial sevens question was included in the final score. Written calculation was not permitted. Both the standard and written tests were timed.

Clinical dementia rating scale

The Clinical Dementia Rating Scale [8] was used to stratify the subjects by degree of dementia and was completed after evaluation of the patient’s history and notes. Patients were rated in the six domains of memory, orientation, judgement and problem solving, community affairs, home and hobbies and personal care into one of five levels of impairment, ranging from 0 (no impairment) to 3 (severe impairment). A score of 1 or above represents dementia, while 0.5 represents questionable dementia [9].

Data analysis

Using SAS 9.1.2 software, a linear mixed model was employed to identify any differences between the standard MMSE and the written version. Besides modelling the group (hearing impaired/not hearing impaired), test modality and their interaction, the cross-over design was modelled using a period effect. The presence of a carryover effect was checked for. Age, sex and dementia category were also included in the model as potential predictors of performance. The matched design was modelled using a random subject effect. The Kenward-Roger approximation to the denominator degrees of freedom was used. Statistical significance was determined at the 0.05 level. A difference of 3 or more points between the two versions of the MMSE was considered clinically significant.

Results

We studied 82 patients, 27 with moderately or severely impaired hearing and 55 with normal hearing. Their mean age was 81.2 years and 38% were male (Table 1). Hearing-impaired patients were slightly older than those with normal hearing and included a greater proportion of males. Eight patients had hearing aids and wore them during the examination. The dementia rating scores for the study population ranged from 0 to 1.

There was no significant difference between the written and the standard MMSE score in hearing-impaired patients (mean difference = 0.0 higher in written form, 95% CI −0.8 to 0.9, P = 0.954) (Table 2), but the normal hearing group performed slightly better on the standard MMSE (mean difference = 0.8 higher in standard form, 95% CI 0.2–1.4, P = 0.006). There was no statistically significant difference between written and standard version scores in the study population as a whole (P = 0.116) (Table 2).

As expected, less cognitively impaired patients had higher MMSE scores than those with dementia. Patients with a dementia rating score of ‘0’ scored on average 4.1 (95% CI 2.5–5.6) more than those with a dementia rating score of ‘0.5’ (95% CI 2.5–3.6) and 5.8 (95% CI 3.9–7.8, P < 0.0001) higher than the group with a dementia rating score of ‘1’. There was no evidence of a difference between those with a dementia rating score of ‘0.5’ and patients with a score of 1 (mean difference = 1.8, 95% CI −0.5 to 4.0, P = 0.120).

The scores in each component of the MMSE were similar in the written and standard tests.

It was found that 75% of hearing-impaired subjects and 58% of the normal hearing group preferred the written MMSE to the standard version. The standard MMSE took a mean time of 7 min to perform, while the written version took about 8 min in both study groups.

Discussion

Contrary to expectations, there was no clinically significant difference between the two MMSE scores in the hearing-impaired group. Hearing loss has been shown to impair performance in the standard version of the test [4], but the written MMSE made no difference in our population, which included subjects with hearing that ranged from normal to severe impairment. Our study did not include subjects with profound hearing loss, as the standard version of the test would not have been practical. In this group, the written version of the MMSE is probably the only option and it

<table>
<thead>
<tr>
<th>Table 1. Study population</th>
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<tbody>
<tr>
<td>Normal hearing group</td>
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<tr>
<td>------------------------</td>
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<tr>
<td>n</td>
</tr>
<tr>
<td>Mean age (years)</td>
</tr>
<tr>
<td>Sex (% male)</td>
</tr>
<tr>
<td>Use of hearing aid (%)</td>
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<tr>
<td>Dementia rating score 0</td>
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<tr>
<td>Dementia rating score 0.5</td>
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<tr>
<td>Dementia rating score 1</td>
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For detailed analysis and discussion, refer to the paper for further insights.
Table 2. Comparison of the standard and written Mini-Mental Examination scores

<table>
<thead>
<tr>
<th></th>
<th>Normal hearing (n = 55)</th>
<th>Hearing impaired (n = 27)</th>
<th>All subjects (n = 82)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard test</td>
<td>25.8 ± 3.6</td>
<td>25.4 ± 4.0</td>
<td>23.9 ± 0.4</td>
</tr>
<tr>
<td>Written test</td>
<td>24.9 ± 4.2</td>
<td>25.4 ± 3.3</td>
<td>23.5 ± 0.4</td>
</tr>
<tr>
<td>Difference</td>
<td>0.84 ± 0.3</td>
<td>0.02 ± 0.4</td>
<td>0.41 ± 0.3</td>
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would not be feasible to do a comparison with the standard version. Subjects with normal hearing performed slightly better on the standard MMSE. As the written version was in large font, it is unlikely that this was due to visual problems, but visual acuity was not formally tested.

A written version of the test has been previously used in Alzheimer’s dementia, having a trend to superior scores with the standard version in hearing-impaired subjects and the converse in hearing-unimpaired subjects [6]. The authors suggested that this supported a non-artefactual correlation between cognitive and hearing impairment. Our results suggest that the written MMSE is comparable to the standard MMSE in a population with normal or mildly impaired cognitive function. However, the written MMSE was preferred to the standard version in the hearing-impaired group, presumably because it required less effort, with no significant preference in the normal hearing group.

Audiometry was not used to stratify subjects. As we were evaluating a test for clinical practice, the use of the (bedside) whisper test had some advantages. A possible source of bias was the variation in the baseline characteristics of the target population. However, the analysis was adjusted for gender and age as much as possible.

The written MMSE was thus comparable to the standard MMSE in a population which included subjects with normal and impaired hearing and cognition. Hearing-impaired subjects performed no better with the written version but preferred it, suggesting that the written MMSE may be a more acceptable version of this test in the hearing impaired. In subjects with profound hearing impairment, the standard version of the MMSE is clearly impractical and in this group, the written version is indispensable.

Key points

- The written MMSE produced similar scores to the standard version in normal and hearing-impaired patients.
- Most hearing-impaired patients preferred the written version.
- The written MMSE or an equivalent is essential in patients with profound deafness.

Acknowledgements

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Conflicts of interest

We do not have any commercial interest in this research and any other conflicts of interest with respect to this paper.

References


ERCP in octogenarians: a safe and efficient investigation

SIR—The demographic development in the Western world and in some developing countries over the coming decades will lead to higher incidence of aged population [1].

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595