Comparison of the quick mild cognitive impairment (Q*mci*) screen and the SMMSE in screening for mild cognitive impairment

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Abstract

Introduction: differentiating mild cognitive impairment (MCI) from normal cognition (NC) is difficult. The AB Cognitive Screen (ABCS) 135, sensitive in differentiating MCI from dementia, was modified to improve sensitivity and specificity, producing the quick mild cognitive impairment (Q*mci*) screen.
Objective: this study compared the sensitivity and specificity of the Q*mci* with the Standardised MMSE and ABCS 135, to differentiate NC, MCI and dementia.
Methods: weightings and subtests of the ABCS 135 were changed and a new section 'logical memory' added, creating the Q*mci*. From four memory clinics in Ontario, Canada, 335 subjects (154 with MCI, 181 with dementia) were recruited and underwent comprehensive assessment. Caregivers, attending with the subjects, without cognitive symptoms, were recruited as controls ($n = 630$).
Results: the Q*mci* was more sensitive than the SMMSE and ABCS 135, in differentiating MCI from NC, with an area under the curve (AUC) of 0.86 compared with 0.67 and 0.83, respectively, and in differentiating MCI from mild dementia, AUC of 0.92 versus 0.91 and 0.91. The ability of the Q*mci* to identify MCI was better for those over 75 years.
Conclusion: the Q*mci* is more sensitive than the SMMSE in differentiating MCI and NC, making it a useful test, for MCI in clinical practice, especially for older adults.

Keywords: *quick mild cognitive impairment screen, mild cognitive impairment, standardised mini-mental state examination, AB cognitive screen 135, sensitivity*

Introduction

Mild cognitive impairment (MCI) represents a heterogeneous group of disorders of memory impairment [1]. Individuals with MCI have variable, subtle, cognitive changes. Although many go on to develop dementia, the rate of progression varies considerably. The annual conversion rate from MCI to dementia is estimated at between 5 and 10% [2]. The reason for this is partly due to variability in the definitions used [3] and in the diagnostic methods employed. When people present with memory loss, it is important to differentiate between MCI and dementia, as treatment choices differ. In particular, patients with dementia benefit from cholinesterase inhibitors, while those with MCI do not have a sustained response [4]. Clinical and functional assessments are used to differentiate between these two groups. While those with MCI generally do not have functional impairment, evidence suggests that subtle functional changes are present in 31% [5].

Several cognitive screening tools have been used in an attempt to differentiate normal cognition (NC), and MCI from dementia [6, 7]. Not all are able to distinguish

between dementia and MCI, and it has been suggested that no single screening tool will fit all situations [8]. One of the most widely employed tools is the Folstein Mini-Mental State Examination (MMSE) [9]. The Standardised Mini-Mental State Examination (SMMSE) improved inter-rater reliability by the inclusion of explicit administration and scoring guidelines [10, 11]. The MMSE and SMMSE have a limited role in identifying MCI [12], lacking sufficient sensitivity to differentiate between NC and MCI, in particular, where individuals have higher levels of academic achievement [13]. The AB Cognitive Screen 135 (ABCS 135) was developed to address this problem [6].

Description of the ABCS 135

The ABCS 135, a short screening test, administered in 3–5 min, is more sensitive in differentiating NC from dementia, and more importantly, MCI from dementia than the SMMSE. The ABCS 135 evaluates five domains, orientation, registration, clock drawing, delayed recall (DR) and verbal fluency (VF) [6] (Table 1). Although, the ABCS 135 is sensitive and quick to employ, it could be argued, that much of the test is redundant. All the domains differentiate NC and MCI from dementia, but orientation, registration and clock drawing did not enhance the discriminatory properties of the test in differentiating NC from MCI. For this reason, the Quick Mild Cognitive Impairment (Q*mci*) screen was developed to enhance the sensitivity of the ABCS 135.

Development of the Q*mci*

The Q*mci*, is a modified version of the ABCS 135, scored out of 100 points, placing greater emphasis on verbal memory and fluency, along with DR, (Supplementary data are available in *Age and Ageing* online, Appendix 1). As analysis of the ABCS 135 subtests found that DR and VF, were more sensitive at differentiating MCI from NC than orientation, registration and clock drawing [14], these three subtests had their weightings reduced by a factor of 2.5, 5 and 2, respectively (Table 1). Logical memory (LM), which is highly sensitive and specific in differentiating NC from MCI [15] was added and given the largest weighting, necessitating the reduction of weightings for all the other subtests.

Table 1. Comparison of ABCS version 135 and Q*mci*

ABCS 135	Score	Q*mci*	Score
Orientation	25	Orientation	10
Registration	25	Registration	5
Clock drawing	30	Clock drawing	15
Delayed recall	25	Delayed recall	20
Verbal fluency	30	Verbal fluency	20
		Logical memory	30

LM is a linguistic memory test (for stories) [16] and is unaffected by age or education [17]. VF and DR are highly sensitive tests for distinguishing MCI from NC [14], and although their weighting were cut, by a factor of 0.66 and 0.8 respectively, to allow for the introduction of LM, their relative weighting, compared to the other subtests, increased.

The Q*mci*, has six domains; five orientation items (country, year month, day and date), five registration items and a clock drawing test, each scored within 1 min. It also has a recall section (timed at 20 s), a test of VF (60 s) and a LM test with 30 s for administration and 30 s for response. It can be administered and scored in 5 min.

The primary objective of this study was to compare the sensitivity and specificity of the new Q*mci* with the ABCS 135 and SMMSE to distinguish individuals with NC from those with MCI and dementia.

Methods

Subjects

Subjects attending four memory clinics across Ontario, Canada (Hamilton, Paris, Niagara Falls and Grand Bend) referred for the investigation of cognitive loss were recruited between 2004 and 2010. Normal controls were selected by convenience sampling. All caregivers, or those attending with the subjects, were asked if they themselves had memory problems. Those without memory problems were invited to participate as normal controls. A diagnosis of dementia was based on NINCDS [18] and DSM-IV criteria [19]. Dementia severity was correlated with the Reisberg FAST scale [20]. A diagnosis of MCI was made by a consultant geriatrician if patients had recent, subjective but corroborated memory loss without obvious loss of social or occupational function. Subjects were excluded if they were under 55 years of age, unable to communicate verbally in English, if they had depression (as defined by a Geriatric Depression Scale greater than seven [21]), or if a reliable collateral was not available. Subjects with Parkinson's disease and Lewy body dementia were excluded as these typically present with exaggerated functional deficits and a different MCI syndrome [22]. Ethics approval was obtained and subjects provided verbal consent. Assent was obtained from individuals with cognitive impairment.

Data collection

Each subject had demographic data collected which included age, gender and number of years of education. Each had a physical examination and work-up for causes of cognitive impairment including a brain CT (computerised tomogram) scan, an electrocardiogram and blood tests. Each subject had the SMMSE and the Q*mci* administered sequentially but randomly by the same trained rater, who was blind to the eventual diagnosis.

Statistical analysis

Data were entered into SPSS version 16.0 [23]. Subjects were subdivided according to age, > or <75 years and educational level achieved, > or <12 years (approximating high school/secondary school level). ABCS 135 data, based on the Q*mci*, were reconstituted from data collected from the Q*mci*. The Shapiro–Wilk test was used to test normality and found that the majority of data were non-parametric. This was analysed using the Mann–Whitney U test, whereas Student's t-tests compared scores for parametric data. Data were also analysed using Receiver operating characteristics (ROC) curves.

Results

A total of 965 participants, 551 females (57%) and 414 males (43%), were included in the study. Overall, 630 subjects had NC (65%), 154 had MCI (16%) and 181 (19%) had dementia. The median age of the total population was 70.5 years; those with NC had a mean age 67 years compared with 75.5 for the MCI group and 79 for the dementia group. The dementia group was older than the NC ($P < 0.001$) and MCI ($P < 0.001$) groups. They also had spent less time in education, 10 years compared with the normal control (13 years, $P < 0.001$) and MCI (12 years, $P < 0.005$) populations. Dementia was divided into mild ($n = 141$), moderate ($n = 33$) and severe cognitive impairment ($n = 7$). The normal population had a median SMMSE score of 29 and a median Q*mci* score of 76, the MCI group scored 28 and 62 and the dementia group scored 22 and 36 on the SMMSE and Q*mci*, respectively. These results and demographics are summarised with inter-quartile range (IQR) in Table 2. All three cognitive tests (SMMSE, ABCS
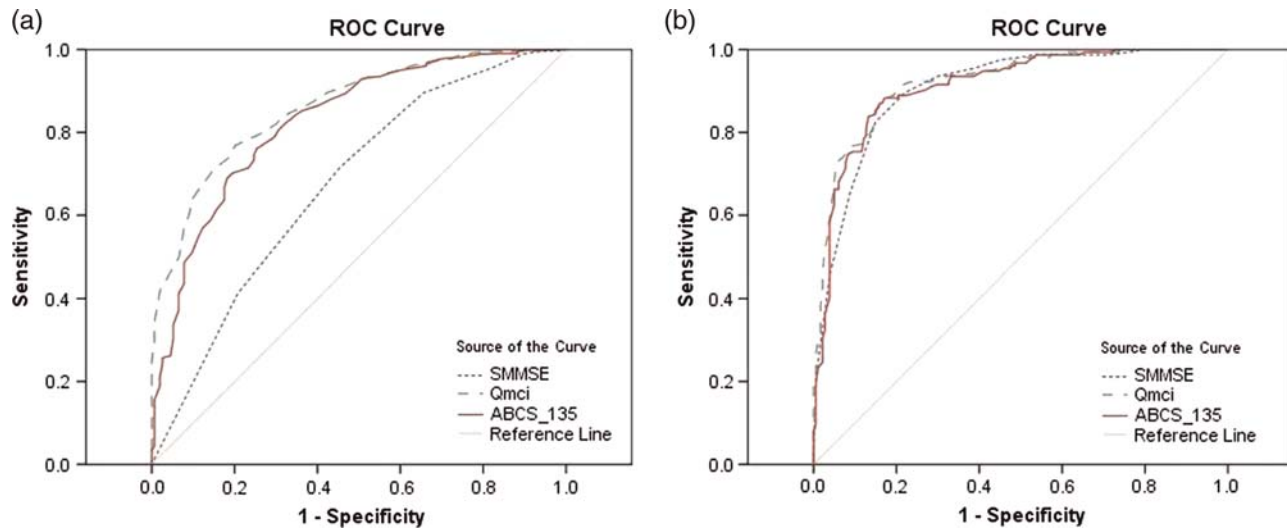
135 and the Q*mci*) were sensitive in differentiating MCI from NC. The Q*mci* was best able to do this in a clinically useful way. The median difference in scores between subjects with either MCI or NC was one for the SMMSE compared with 14 for the Q*mci*. This represents a difference of 3.33% of the total score of 30 with the SMMSE and a 14% difference for the Q*mci* (scored out of 100).

All three tests distinguished dementia from MCI. Patients with MCI, scored a median 26 points more on the Q*mci* than those with dementia ($P < 0.001$), whereas there was a 40 point difference in the Q*mci* between those with NC and dementia ($P < 0.001$). Figure 1 shows two ROC curves demonstrating the sensitivities and specificities of the Q*mci*, ABCS 135 and SMMSE in differentiating MCI from NC and MCI from dementia. Although the Q*mci*, ABCS 135 and the SMMSE were able to distinguish MCI from NC, the Q*mci* was more sensitive with an area under the curve (AUC) of 0.86 (95% CI: 0.83–0.89) compared with 0.83 (95% CI: 0.79–0.86) for the ABCS 135 and 0.67 (95% CI: 0.62–0.72) for the SMMSE. The Q*mci* was also more sensitive at differentiating MCI from dementia, AUC of 0.92 (95% CI: 0.89–0.95) versus 0.91 (95% CI: 0.88–0.94) for the ABCS 135 and 0.91 (95% CI: 0.88–0.94) for the SMMSE. When moderate and severe dementia cases were removed from analysis, the AUC of the Q*mci* and SMMSE for differentiating MCI from mild dementia cases alone was unchanged at 0.92 (95% CI: 0.89–0.95) and 0.90 (95% CI: 0.85–0.93), respectively.

Subanalysis for age (> or < 75 years of age) and education (> or <12 years) showed that the Q*mci* was more sensitive, with a larger AUC, than the SMMSE. The Q*mci* was best for distinguishing MCI from NC in an older age group, (over 75 years), with more time, (>12 years), in education, with an AUC of 0.86 (95% CI: 0. 79–0.92)

Table 2. Characteristics of the normal, MCI and dementia groups, including median Q*mci*, SMMSE and ABCS 135 scores and inter-quartile range (IQR), (Q1–Q3 = IQR; Q1 = 1st Quartile, Q3 = 3rd Quartile)

Group	Normal	MCI	Dementia
Number of subjects	630	154	181
Age			
Mean	67.4	73.6	78.1
Median	67	75.5	79
Range	44–92	50–88	49–93
Proportion female (57.0%) $n = 551$			
Mean age	67.0	73.3	78.7
Median age	66.5	75	80
Range	50–92	50–87	49–93
Proportion male (43.0%) $n = 414$			
Mean age	68.0	73.9	77.6
Median age	68	76	79
range	44–85	51–88	53–92
Education (years in education)			
Mean	13.8	12.2	11.0
Median	13	12	10
Range	5–29	5–26	3–20
Q*mci* (median with IQR)	76 (83–69 = 14)	62 (68–53 = 15)	36 (45–23 = 22)
SMMSE (median with IQR)	29 (30–28 = 2)	28 (29–27 = 2)	22 (25–18 = 7)
ABCS 135 (median with IQR)	115.5 (121–109 = 12)	102 (111–94 = 17)	70 (83.5–45.5 = 38)

Figure 1. ROC curve demonstrating sensitivities and specificities of the Q*mci,* ABCS 135 and SMMSE in differentiating (a). MCI from normal cognition, (b). MCI and dementia.

compared with 0.55 (95% CI: 0.44–0.66) for the SMMSE. The only subjects where the difference in sensitivity between the Q*mci* and SMMSE was less obvious was for younger individuals, (<75 years) with less than 12 years in education, AUC of 0.72 (95% CI: 0.62–0.82) for the Q*mci* versus 0.65 (95% CI: 0.54–0.76) for the SMMSE. The SMMSE, ABCS 135 and Q*mci* were all able to differentiate MCI from dementia, irrespective of age or educational status ($P < 0.001$).

Conclusion

This study compares the refined ABCS tool, the newly developed Q*mci*, to the established SMMSE and the original ABCS 135 in their ability to discriminate NC and MCI from dementia. The results presented here show that the Q*mci* is more sensitive than the SMMSE and the ABCS 135 in differentiating MCI from NC, whereas all three are able to distinguish NC from dementia. Although, the SMMSE was useful in differentiating MCI and NC groups, from dementia subjects, it was not able to separate MCI from NC. The small percentage difference (3.33%) of the total score for the SMMSE between those with NC and MCI shows that the SMMSE is not clinically useful in distinguishing MCI from normals. The Q*mci* had a wider and more clinically significant percentage difference in median scores to help discriminate MCI from dementia. Similarly, the median SMMSE score for MCI cases and controls, even taking the IQR into account, at 28 out of 30 (IQR: 29–27 = 2) lies within the accepted cut-off interval for NC, at greater than 25 out of 30 [11, 24]. This again suggests that the SMMSE is not adequately sensitive in detecting MCI. The Q*mci* was also more sensitive than the SMMSE in differentiating MCI from NC among older adults, over 75 years, especially those with more than 12 years in education.

Of note, age and educational level did not affect the ability of the Q*mci* or SMMSE to discriminate between MCI and dementia. The dementia group in this study was significantly older and had spent less time in formal education than either the MCI group or the NC group. The dementia group was weighted towards the mild spectrum of dementia. This is important, as differentiating MCI from mild dementia is more challenging than differentiating it from severe dementia. Removing moderate and severe dementia cases from analysis, showed that the Q*mci* retains and even improves its increased sensitivity, for differentiating MCI from mild dementia, confirming that this tool is useful across the whole range of the cognitive impairment spectrum.

Our paper has several limitations. First, we cannot be certain that all patients were classified appropriately as having normal or impaired cognition. This is difficult to do, especially where controls are drawn from a sample of convenience. Controls in this study did not have any complaints of memory loss. We acknowledge that one of the major clinical challenges is to separate symptomatic patients with NC from those with MCI, especially as approximating 50%, attending some memory clinics with subjective memory problems, have NC [25]. However, within the confines of a sample of convenience, the subjects chosen as normal controls were tested rigorously, screened for cognitive impairment and depression and underwent the same detailed assessment as cases with MCI and dementia. Future validation of the Q*mci*, will target controls with NC, referred to the memory clinic.

Second, we used NINCDS and DSM IV criteria to make a diagnosis of dementia. While there is no defined gold standard, these criteria are broadly accepted and have been validated internationally [26]. Third, the diagnosis of dementia was based on a single assessment

which may have reduced accuracy and one rater scored both cognitive tests which may have led to 'practice' effects. However, the raters were blind to the eventual diagnosis made at the clinical assessment. Finally, we compared the Q*mci* to the SMMSE and ABCS 135 which are not gold standards for differentiating MCI from NC or dementia. This said, the SMMSE is the most widely used screen for dementia and no gold standard yet exists for the diagnosis of MCI.

The strengths of this study are the large sample size, comprehensive assessment and bigger number of controls than the original ABCS 135 validation paper. The diagnosis of MCI and diagnosis and grading of dementia are based on both functional and cognitive assessments. This study was performed at multiple sites. Future research will focus on comparing the Q*mci* to other short cognitive tests such as the Montreal Cognitive Assessment [27] and further refinement of the different domains in the test.

The study confirms that the Q*mci*, a short cognitive screen, is more sensitive in differentiating NC from MCI, than the widely used SMMSE. Compared with the ABCS 135, the Q*mci* is more sensitive in differentiating MCI, takes the same time to complete and is conveniently scored out of 100, making it easy to interpret in clinical practice.

Key points

- The Qmci is more sensitive than the SMMSE in differentiating MCI from NC.
- The Qmci is more sensitive than the SMMSE in differentiating MCI from dementia.
- The Qmci is more sensitive at differentiating MCI from NC in older adults, over 75.
- The Qmci needs to be compared with other short-cognitive screening tools.

Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

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Preventing delirium in an acute hospital using a non-pharmacological intervention

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Abstract

Background: delirium is a clinical syndrome associated with multiple short and long-term complications and therefore prevention is an essential part of its management. This study was designed to assess the efficacy of multicomponent intervention in delirium prevention.
Methods: a total of 287 hospitalised patients at intermediate or high risk of developing delirium were randomised to receive a non-pharmacological intervention delivered by family members (144 patients) or standard management (143 patients). The primary efficacy outcome was the occurrence of delirium at any time during the course of hospitalisation. Three validated observers performed the event adjudication by using the confusion assessment method screening instrument.
Results: there were no significant differences in the baseline characteristics between the two groups. The primary outcome occurred in 5.6% of the patients in the intervention group and in 13.3% of the patients in the control group (relative risk: 0.41; confidence interval: 0.19–0.92; $P = 0.027$).
Conclusion: the results of this study show that there is a benefit in the non-pharmacological prevention of delirium using family members, when compared with standard management of patients at risk of developing this condition.

Keywords: *delirium, primary prevention, elderly*

Introduction

Delirium is a clinical syndrome characterised by an altered level of consciousness and cognitive disorders that develop over a short period of time (usually over hours or days) and tend to fluctuate during the course of the day [1]. The etiology of this syndrome is often multifactorial.

What makes delirium important is not only its high occurrence rate among hospitalied patients but also its consequences. The occurrence rate ranges from 6 to 56% [2, 3] in hospitalised patients. Its consequences include the contribution to increased morbidity and mortality, being cause of distress to patients and their families and increased costs [3]. An example of this is that the presence of delirium in hospitalisation is an independent factor for mortality 1 year