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Can You Have Dementia With an MMSE Score of 30?

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Objective. To investigate the possibility that a patient with a diagnosis of probable Alzheimer's disease (AD) can still obtain a score of 30/30 on the Mini-Mental State Exam (MMSE). *Design*. Chart review. *Setting*. The McGill University/Jewish General Hospital Memory Clinic. *Participants*. Participants were selected from the Memory Clinic's patient database. All underwent comprehensive evaluations, including relevant blood work and a computed tomographic scan or a magnetic resonance imaging scan of the brain to rule out other causes of dementia. *Measurements*. All patients had one or more neuropsychological evaluation. Data of all psychometric testing, including the MMSE, were gathered from these visits. *Results*. Eight patients were found to meet the criteria of AD although achieving a score of 30/30 on the MMSE. Four of 8 patients achieved this score although they were taking cholinesterase inhibitors. *Conclusion*. Although rare, it is possible to achieve a score of 30/30 on the MMSE even if a subject is suffering from a dementing illness.

Keywords: Mini-Mental State Examination; Alzheimer's disease; memory

Introduction

Few clinical screening tests have had as successful a history as the Mini-Mental State Examination (MMSE). It was first introduced as a method to differentiate "patients with cognitive disturbance from those without such disturbance"[1] and is taught to residents and medical students as a useful, rapid approach to cognitive assessment.[2]

The success of the MMSE is likely because of its brevity, its ability to objectify cognitive status as a single global score, and its ability to track decline from mild to severe dementia.[3] What is somewhat surprising is the high regard that the test has achieved in diverse circles, often above and beyond the reasonable claims that the authors have made. For instance, some studies have defined "normal intellectual function" as an MMSE score of more than 24/30.[4-6] Certain governments, such as the one in Quebec, have approved reimbursement of prescriptions for cholinesterase inhibitors only for patients who have an MMSE score of less than 25. Furthermore, the same government body insists on annual scores showing no more than a decline of 4 points to continue to defray their costs. As a result, the government has been forced to reimburse physicians specifically for the performance of the MMSE as a specific "medical act," an almost unique level of regard given to a screening test. Even the examination's creators warned that "accurate diagnosis, including appraisal of the significance of cognitive disabilities documented in the MMSE, depends on evidence developed from the psychiatric history, the full mental examination, the physical status and pertinent laboratory data."[1]

The MMSE is used widely across the spectrum of researchers working with dementia, and the original

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Table 1. Subject Demographics

Patient	Sex	Age	Formal Education (Years)	Score at Diagnosis (Out of 30)	Medication Taken at Time of MMSE Score of 30/30
GS	F	77	15	27	None
SV	F	57	17	30	None
RF	F	75	12	30	None
KI	F	80	16	30	None
UN	F	78	14	27	Donepezil
HH	F	73	11	26	Rivastigmine
GG	M	83	11	27	Donepezil
ND	F	81	14	29	Donepezil
Mean		75.5	13.75	28.25	
Range		57-83	11-17	26-30	

limitations noted by the authors need to be attended to. For instance, two of the authors of this article (HC, HS) have encountered manuscript reviewers who doubted that a diagnosis of dementia was compatible with an MMSE score of 30, 29, or even 28. Clinicians experienced with dementia are much more circumspect. After all, the first three points lost on the MMSE in the course of dementia are usually those involved in recall of 3 words after a 1-minute delay, along with some loss of orientation for day or date.[3] There is certainly nothing absolute about using 3 words at a 1-minute delay. For example, a similar screening test, known as the Montreal Cognitive Assessment (MoCA), showed 100% sensitivity when using 5-word recall after 5 minutes.[7] Many clinicians agree that they have seen patients meeting criteria for dementia, who nevertheless displayed an MMSE score of 29 or 30.

We have therefore carried out a chart review of an extensive database from Montreal's Jewish General Hospital of well-ascertained patients with dementia, specifically Alzheimer's disease (AD), who obtained at one time or another an MMSE score of 30. We present these cases to demonstrate that such individuals do in fact exist. Specifically, we hypothesized that dementia with an MMSE score of 30 may be rare, but it is possible.

Methods

Subjects

A database search of the Jewish General Hospital/McGill Memory Clinic was carried out on past files of 632 AD subjects evaluated between 1997 and 2006. Chart review was performed on all patients achieving a score of 30/30 on the MMSE on the same visit as their AD diagnosis or thereafter. Subjects showed no evidence of other neurological disease on history or neurological examination. All underwent comprehensive evaluations, including relevant blood work and a computed tomographic (CT) scan or magnetic resonance imaging scan of the brain, to rule out other causes of dementia. All scored 4 or less on the Hachinski Ischemic Scale.[8] These individuals were all mildly demented, scoring as stage 4 to 5 of the Global Deterioration Scale.[9] These patients received a diagnosis of "probable dementia of the Alzheimer's type" under the National Institute of Neurological and Communication Disorders and Stroke–Alzheimer's Disease and Related Disorders Association criteria[10] following a consensus meeting of the assessing physician, Memory Clinic nurse, and neuropsychologists. A neuropsychological evaluation was carried out, including the following tests: Block Design, Digit Symbol, Similarities, and Number-Letter Sequencing subtests of the Wechsler Adult Intelligence Scale (WAIS-III)[11]; Mental Control, Logical Memory I and II, Visual Reproduction I, II, and Copy, and Spatial Span subtests of the Wechsler Memory Scale (WMS-III)[12]; the Rey Auditory Verbal Learning Test (RAVLT)[13]; the Controlled Oral Word Association Test (COWAT)[14]; the Boston Naming Test (BNT)[15]; the Gestalt Closure test of the Kaufman Screening Neuropsychological Assessment Procedure (K-SNAP)[16]; the Clock Drawing Test[17]; the Trailmaking Test A[18]; and the Stroop Color Test.[19] To assess general emotional state, the Beck Anxiety Inventory[20] and the Geriatric Depression Scale[21] were also administered. The relevant history and physical and mental status assessments were summarized.

Results

Eight patients were found who satisfied the above criteria. Their demographics are described in Table 1. Three patients had their MMSE scores of 30 at the time of their AD diagnosis, whereas 5 patients had a score of 30 at a subsequent visit. The 4 case summaries presented below are of the patients who obtained MMSE scores of 30 without the use of cholinesterase inhibitors (Group A). The neuropsychological tests in which they scored below average are presented in Table 2.

A second group of 4 AD cases presented initially with MMSE scores of 26-29 (Group B). Four to

Table 2. Tests and Levels of Impaired Performance on Neuropsychological Testing at Time of MMSE Performance of 30/30

	Patient			
Neuropsychological Test	GS	SV	RF	KI
Clock Drawing test		Mild visuospatial deficits		Poor circle; L hemineglect on number placement
WAIS III subtests				
Similarities				
Digit Symbol		1st percentile		
Block Design	<10th percentile	1st percentile	5th percentile	9th percentile
Number-Letter Sequencing			2nd percentile	
WMS III subtests				
Mental Control				
Logical Memory I		<10th percentile		
Logical Memory II		<10th percentile	5th percentile	1st percentile
Visual Reproduction I		1st percentile	2nd percentile	
Visual Reproduction II			9th percentile	5th percentile
Visual Reproduction Copy			2nd percentile	
Spatial Span	<10th percentile			
Trailmaking Test A		<10th percentile		
Rey Auditory Verbal Learning Test				
Immediate Recall		>2 SD below mean		
Learning Over 5 Trials	>2 SD below mean	>2 SD below mean	>2 SD below mean	>2 SD below mean
Retention	>2 SD below mean	>2 SD below mean	>2 SD below mean	>2 SD below mean
Delayed Recall	>2 SD below mean	>2 SD below mean		>2 SD below mean
Recognition	>1 SD below mean		>2 SD below mean	
Letter Fluency (COWAT)				
Category Fluency (COWAT)	<10th percentile		<10th percentile	10th percentile
Boston Naming Test	<10th percentile			<10th percentile
Gestalt Closure subtest	2nd percentile			<10th percentile
Stroop Color Word Test				>1 SD below mean

9 months following treatment with cholinesterase inhibitors, each improved to an MMSE score of 30. At that time, all were still confirmed to be demented. For brevity, these case reports have been submitted as supplemental material (see Appendix).

Patient Group A: MMSE Score of 30 in Patients Not Using Cholinesterase Inhibitors

GS. GS was a 77-year-old woman with 15 years of formal education. She had previously worked as a secretary for 10 years and remained socially active. GS had a family history of AD, depression, and cardiovascular disease. GS began to experience memory loss 3 years before presentation. Her first visit was in 1997, at which time she had an MMSE score of 29/30. She was reported to have subjective memory impairment with no evidence of objective deficits. She was followed annually and noted to have slow, insidious decline of cognitive function. Thirty-six months after initial presentation, she was diagnosed with probable AD. GS had 2 CT scans of the head that showed age-related atrophy. Her blood work was unremarkable. Her MMSE score at the time of AD diagnosis was 27/30, demonstrating a decline from initial presentation. She started to forget conversations and did not recall her prior visit to the Memory Clinic. GS also exhibited some functional decline. Her housekeeper performed the domestic chores, and her sister reminded her of appointments and supervised bill payments. GS continued to cook for herself. She suffered from mild depression as a result of her husband's death the previous year.

Twelve months after AD was diagnosed, GS's MMSE score was 30/30. A neuropsychological evaluation was performed 2 weeks prior to her test. During this evaluation, her sister noted that GS had called her several times and hung up because she forgot why

she was calling. GS continued to rely on her sister to run the finances and her housekeeper for household chores. GS continued to cook simple meals but often burned pots. During conversation, the patient presented with significant anomia despite fluent speech. She was unable to name current politicians or recall any current events although she claimed to read the newspaper daily. In addition to the deficits outlined in Table 2, the neuropsychologist described her visuoconstructional skill as abnormal. She consistently broke global configuration but was unable to correct the construction even though she perceived it as incorrect. Aspects of perceptual processing and executive function were noted as "poor." The patient was also noted to be "mildly depressed" with intact attention. GS had very little insight into her memory deficits. The physician reconfirmed that GS was suffering from mild dementia.

SV. SV was a 57-year-old woman with 17 years of formal education. She had previously worked as a teacher and later as a part-time secretary. She was active socially, participating in a writer's group, and was in the process of writing a book. SV had a family history of depression and dementia. She began to experience memory loss in 1990, which was slow and progressive with insidious decline. SV presented to the Memory Clinic in 2004. At that time there were complaints of cognitive decline involving deficits in concentration, short-term memory, and behavioral changes (increased irritability and agitation). One of the major changes cited by her husband was her declining capacity to organize activities. SV's ability to take notes at her husband's business meetings had deteriorated and her working pace was slower. She complained of forgetting people's names, including some she knew well. Furthermore, she had problems recalling events that occurred within the last 2 days and had trouble with dates and times. She also repeated questions and stories. SV often misplaced things such as keys and her credit cards and frequently forgot her PIN number.

At her initial visit, SV had a score of 30/30 on the MMSE. However, the physician noted that she "demonstrated significant difficulty in completing the tasks." Her blood work was unremarkable. Her CT scan showed questionable loss of volume and some possible focal areas of loss because of previous ischemia. The clinician rated her as having cognitive and functional deficits compatible with dementia, likely of the Alzheimer type.

In addition to the deficits outlined in Table 2, on the Beck Anxiety Inventory[20] SV scored in the "mild anxiety" range. The physician concluded that SV's cognitive decline appeared to be progressive and that "her profile suggests that she is suffering from early dementia."

SV was prescribed donepezil 2 weeks after her neuropsychological evaluation (approximately 3 months after initial presentation). The patient's score had declined to 25/30 on the MMSE and to 21/30 on the MoCA. Six months after her first visit, both the patient and her husband stated that donepezil had been of benefit. The patient scored 29/30 on the MMSE and 23/30 on the MoCA. Her last visit was 18 months from initial presentation, where she exhibited both functional and cognitive decline compared with previous visits. Her MMSE score at this final visit was 22/30.

RF. RF was a 75-year-old woman at initial presentation with 12 years of formal education. She had previously worked as a secretary and had limited social interactions. The patient had a family history of hypertension, stroke, and depression. RF was diagnosed with bipolar disorder. She experienced a depressive episode 20 years prior and had panic attacks with a frequency of 1 per week.

The patient began to experience memory loss in 2001, which declined slowly and progressively. She presented in July 2002. At that time, she received a diagnosis of mild cognitive impairment, possibly of vascular origin. Cognitive symptoms at this time included deficits in name finding and easy distractibility. She wrote important dates and appointments down but often misplaced household items. She forgot to turn off the stove more frequently, compensating by using a timer. The patient reported that she was independent for instrumental activities of daily living. Her MMSE score was 28/30 at that visit. A prior CT scan revealed no ischemic lesion. Blood work was unremarkable. A neuropsychological evaluation was carried out 2 months later, confirming that RF was suffering from mild cognitive impairment. Psychometric testing revealed deficits in immediate, delayed, and working visual memory. Delayed auditory memory was also impaired, and the patient exhibited visuoperceptual problems and anomia.

RF was reevaluated 38 months after initial presentation. At this time, she was diagnosed with probable AD. Both RF and her sister reported that there had been a decline in memory, particularly short-term

memory. She occasionally forgot to take her medications. RF was now being treated for anxiety and dysphoria with some suicidal ideation. At that time, her scores were 30/30 and 21/30 on the MMSE and MoCA, respectively.

A neuropsychological evaluation had taken place 1 month prior. In comparison with the results obtained the previous year, there was evidence of a general cognitive decline with multiple deficits, and the patient's cognitive profile was consistent with degenerative dementia (see Table 2). Also, RF's Geriatric Depression Scale[21] score suggested moderate depression.

RF refused cholinesterase inhibitor therapy. Over the following 18 months, she displayed progressive deterioration. On her last visit, RF obtained an MMSE score of 25/30, whereas her MoCA score was 18/30.

KI. KI was an 80-year-old woman at presentation with 16 years of formal education. She had worked as a salesperson at a clothing store until she got married. KI was socially active, taking courses and volunteering at a museum once a week. She stopped driving in 2001 because she felt insecure. Her family history was positive for depression, and the patient had a history of hypertension.

KI began experiencing memory loss in 2003 and presented to the Memory Clinic in October 2004. She had trouble remembering recent events and tended to repeat questions. She relied on the newspaper to orient to date and depended more on her written agenda. She had word-finding difficulties and problems relating the gist of written text. Her cognitive impairments interfered with cooking, self-medication, use of credit cards, and her performance as a museum tour guide. KI was impatient and had limited insight. She received a diagnosis of AD. She scored 30/30 on the MMSE and 22/30 on the MoCA. Blood work was unremarkable. Her CT scan showed mild diffuse age-related atrophy. There were vascular calcifications and some evidence suggesting chronic microvascular disease.

KI refused to complete a formal neuropsychological evaluation at that time. She was finally seen 8 months after initial presentation. Along with the symptoms described in her earlier visit, KI noticed that she misplaced personal items more frequently. She forgot birthdays and new information such as recent conversations. The patient also had difficulty recognizing faces of people she had not seen in some time. During conversation, KI displayed mild anomia. Although she provided the correct names of her children, she estimated their ages to be half their real age. See Table 2 for neuropsychological deficits.

Discussion

The notion that the MMSE can yield false results is not a new concept. Many have questioned the influences of factors such as age, education, and socioeconomic background with regard to abnormal low scores.[22-28] Although many studies use the MMSE as a screening process for dementia, few of them have examined patients with scores in the "normal" range to verify if they were in fact nondemented. One study observed that 5 out of 27 subjects diagnosed with mild AD obtained a score of at least 27/30.[29] Another mentioned that "a small proportion of those who scored between 26 and 30 points were almost certainly demented," which they estimated to be about 2% based on previous data.[30] No more recent studies have addressed this issue.

In some subjects with dementia who score high on the MMSE, other tests can indeed demonstrate abnormal cognitive functioning. In one study, 28 out of 32 subjects in a memory clinic setting with "normal" MMSE results scored abnormally on tests of clock drawing or executive function.[31] In our series, 4 out of the 4 AD subjects who were tested with the MoCA at the time they had an MMSE score of 30 scored abnormally low (below 26/30). The MoCA was designed to be more sensitive to abnormal performance in memory, language, and executive function domains in mildly impaired individuals. Thus, it can be argued that the sensitivity of the MMSE for detecting dementia is not 100% and exceptions are to be expected.

The patients in this study were in no obvious way atypical in terms of age or initial complaints (Table 1). They represented about 1.3% of AD patients seen in the clinic. They all initially complained of memory loss, which was supported by psychometric testing. None had predominant frontal/executive dysfunction. Furthermore, their neuropsychological profiles were all typical for early AD. The only atypicality was that 7 of the 8 cases were women. Were there particular features in our cohort that might have been related to their high MMSE scores? We consider a number of possibilities below.

Although the influence of low education on false-positive MMSE scores has been widely discussed, few have questioned if the inverse is possible: Can patients with high education obtain "abnormally"

high scores? All 8 patients in our study had at least 11 years of formal education. A comprehensive review of the MMSE noted that "higher education levels may produce classification errors," citing 2 sources with evidence of false-negative scores because of high levels of education.[3] The authors continued by stating that "studies have reported that although educational levels and MMSE scores were correlated, number of years of education was not related to the diagnosis of dementia." Another study has reinforced this notion.[32] Age-based and education-based norms for the MMSE have also been proposed.[28,32-35] A recent study demonstrated that patients with high education exhibited greater impairment of abstract thinking, whereas patients with low education showed greater impairment of memory and attentional skills.[36] Because the latter (but not the former) are stressed in the MMSE, it should not be surprising that highly educated individuals would obtain unusually good scores on MMSE testing.

Occasionally, patients have been observed rehearsing test sections. In one case, at a retirement home, a patient obtained the "answers" to the MMSE from a fellow resident. During an initial evaluation, the patient asked, "How about those questions? Don't you want me to subtract sevens from a hundred?" The patient proceeded to name the three objects from the recall task and asked if the examiner wanted her to spell the word "world" backward.[37] In some instances, a patient or family member has noted that the only reason the patient knew the correct orientation was because he or she was reminded several times about the appointment. Although it is hard to say how much "studying" for the MMSE is a factor, clearly it can lead to scores that misrepresent a patient's level of cognitive impairment. Orientation, which accounts for 10 points on the examination, seems likely to be the section at greatest risk for rehearsal bias.

It is also possible that AD medication could play a role in high test scores. Cholinesterase inhibitors have been observed to stabilize or increase MMSE scores within the first year of their administration.[38] However, this explanation cannot apply to the 4 cases reported here (group A) because none of them were taking cholinesterase inhibitors at the time of diagnosis. The 4 patients in group B were on cholinesterase inhibitors at the time they scored 30/30 on the MMSE. A diagnosis of dementia was still confirmed in these individuals by formal neuropsychological testing.

The fact that 7 of the 8 cases were women is intriguing. One possible explanation that struck us as plausible is that in the traditional household the responsibility for upkeep and meal preparation usually falls on the woman. As these are fairly complex functions involving memory, planning, and executive function, they may be noticeably affected even in very mild dementia and thus alert caregivers to bring the woman to medical attention earlier than a man who may not be engaged in these functions. This is quite speculative but deserves empirical attention.

The primary objective of this report was to demonstrate the existence, albeit rare, of perfect MMSE scores in individuals with well-ascertained dementia. An MMSE score of 30/30 does not exclude a diagnosis of probable AD when criteria for the latter are met on the basis of rigorous clinical, laboratory, and neuropsychological evaluations. We do not dispute the use of the MMSE as a quick screen for dementia severity, a sort of "dementia shorthand" in the clinical assessment. However, it (as every short screening tool does) has its limits, and it is not equivalent to a full mental status assessment. The assessment of mildly impaired subjects is probably the most important limitation of the clinical use of the MMSE. There may be a role for more sensitive instruments such as the MoCA[7] in determining cognitive impairment in very mildly demented individuals.

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Appendix

Supplemental Material

Patient Group B: MMSE Score of 30 in Patients Using Cholinesterase Inhibitors

UN. UN was a 78-year-old woman at presentation with 14 years of formal education. She worked as a bookkeeper for 10 years and later managed a store.

The patient volunteered with a seniors group and leading discussion groups and spent time at the library. Her family history was unremarkable.

UN presented to the Memory Clinic in May 2000. She complained of memory loss that had begun 3 years earlier and that exhibited slow progression with insidious decline. Symptoms included increasing difficulty in remembering names of acquaintances and details of recent conversations. She frequently forgot appointments and reported difficulties with many remote memories related to her childhood. UN frequently misplaced personal items. Her husband reported that she was more easily angered and cried more than before. He remarked that the patient no longer cooked at home because of "increased slowness of thinking." UN seemed less motivated to participate in social events, which she attributed to fatigue. Additionally, UN's husband was responsible for reminding her to take her medication.

The clinical and neuropsychological evaluations suggested the presence of a "dementing process," and the diagnosis of AD was made 1 month later following normal blood work and a CT scan. At that time she received an MMSE score of 27/30.

On her neuropsychological evaluation, UN performed in the 3rd and 1st percentile range for the Letter-Number Sequencing (Auditory) and Logical Memory II (Auditory Delayed) subtests of the WMS-III, respectively. The patient scored below the 10th percentile range on the COWAT in both "FAS" and "ANIMALS" categories. She also scored below the 10th percentile on the BNT and the Trailmaking Test A.

UN was started on donepezil 12 months after initial presentation. This time she scored 28/30 on the MMSE. At a follow-up visit 20 months following initial presentation and 8 months subsequent to being prescribed donepezil, she received a score of 30/30 on the MMSE. It was noted that "despite her excellent performance on the MMSE she is in the early stages of AD."

She had a repeat neuropsychological evaluation at that time. According to both the patient and her husband, there had been a subtle decline in cognitive functioning regarding word and name retrieval along with general forgetfulness. UN demonstrated diminished functional status. Psychometric testing revealed deficits in auditory and visual memory. She performed in the 2nd percentile range for the Logical Memory II (Auditory) and Visual Reproduction I subtests of the WMS-III. Also on the WMS-III, she scored in the 5th percentile on the Visual Reproduction II and Spatial Span Forward subtests. The results of the "ANIMALS" category of the COWAT were below the 10th percentile range, as was her BNT score. She performed in the 2nd percentile range for K-SNAP.

HH. HH was a 73-year-old woman at presentation with 11 years of formal education. She had worked as a secretary. Socially, the patient attended book review clubs and met regularly with friends. She also spent her time playing bridge, golfing, and traveling. There was no family history of psychiatric illness. HH had a history of hypothyroidism, hypertension, and transient ischemic attack. A CT scan in late 2001 revealed chronic ischemic changes.

The patient began to experience memory loss in 2001, which was slow and progressive with a subsequent insidious decline. She presented to the Memory Clinic in June 2002. At that time it was clear that she was suffering from significant cognitive impairment. HH exhibited deficits in short-term memory, often repeating herself and forgetting immediate details. She reported getting lost while driving on occasion and her husband noted that the patient had organizational deficits. HH had difficulty with remote memory and was unable to recall the name of one of her grandchildren. Her MMSE score was 26/30 at that visit. The physician noted that her presentation "suggest[ed] a diagnosis of dementia." Her blood workup was unremarkable.

A neuropsychological evaluation was performed 2 weeks later. Her profile revealed deficiencies in both language and memory. Her psychomotor speed and mental tracking skills were described as "generally poor." HH was diagnosed with AD 1 month after her initial visit and prescribed donepezil. However, the patient did not tolerate the drug and was switched to rivastigmine 2 weeks later.

HH was reevaluated 12 months after initial presentation and 9 months following her prescription of rivastigmine. Her husband reported that her memory had stabilized since taking the medication. Nevertheless, the problem of remembering people's names had worsened since the prior assessment. She often misplaced household items and compensated for her memory deficits by writing all her activities on a calendar. Although HH continued to drive without incident, her husband reported that she occasionally became disoriented when driving in an unfamiliar area. At that visit she scored 30/30 on the MMSE.

A neuropsychological evaluation was performed over the following weeks, although she refused to perform some subtests on the WMS-III and the

RAVLT. HH scored below the 10th percentile range on all subtests of the WAIS-III. All the visual subtests of the WMS-III performed were in the 5th percentile range or below. Furthermore, the Letter-Number Sequencing and Logical Memory I and II subtests were all below the 10th percentile. She performed in the "below average" range in all aspects of the RAVLT except for Immediate Recall A. She had scores below the 10th percentile range in the "ANIMALS" category of the COWAT and the BNT. She scored 7/10 on the Clock Drawing Test. On the K-SNAP, HH scored below the 1st percentile range, whereas on the TMB, she scored below the 10th percentile range. The evaluation concluded that there was a "significant decline in her visual work memory, ability to indicate a clock time, and visual shifting." Her profile remained consistent with the diagnosis of early dementia.

Subsequent visits revealed cognitive deterioration along with a diminished MMSE score. Eight months following her MMSE score of 30/30 (20 months following initial presentation), a repeat MMSE score was 23/30. Her next score increased to 27/30. Afterward, the patient's subsequent visits demonstrated a steady decline in her MMSE score to 14/30. Twenty-eight months from initial presentation, HH was noted to require constant care and supervision.

GG. GG was an 83-year-old man at presentation with 11 years of formal education. He owned his own company before retiring. GG was involved in many community boards and committees. He played cards with his friends and attended a senior's group. His family history was positive for AD.

GG began to experience memory loss 2 years before presentation. He was first seen at the Memory Clinic in February 2001. The patient complained of a complete inability to recognize acquaintances. There were occasions where he got lost while driving in his own neighborhood. GG relied on his calendar to know the date and had more difficulty organizing his finances. In addition, he also felt diminished confidence, which prevented him from engaging in some of his previous social activities. It was also noted that there had been mild changes in his language abilities. At that time he was diagnosed with early AD. His physical exam also revealed very mild right-sided Parkinsonism. His MMSE score was 27/30 at that visit.

His wife reported mood and personality changes that occurred within the past year. GG was more sad, worried about the future, and short-tempered. His wife also mentioned that his attention and concentration were poor. GG's decline was described as slow and progressive. He had difficulty understanding what people were saying during conversations. His daughter explained that he had a difficulty in processing information. The patient often had a "blank look" on his face, and his daughter often needed to reexplain information. He repeated questions and no longer watched movies because of difficulty in following the themes. GG could not recall old friends and often misplaced objects. The patient compensated by writing information in his agenda book. He suffered momentary episodes of confusion when driving and needed to stop to reorient. His daughter became more involved in his banking work. Even after several attempts to teach him, GG was unable to learn how to operate his cellular phone and personal computer.

Formal psychometric testing revealed deficits in several aspects of memory, language, clock drawing, visuospatial function, and attention. GG was also diagnosed with moderate depression, supported by his Geriatric Depression Scale result.

Blood work was unremarkable. His CT scan showed moderate cortical atrophy "predominantly in a frontotemporal distribution." Very mild periventricular leukoencephalopathy was observed and noted as consistent with chronic small vessel disease. The clinical diagnosis of early AD was maintained.

GG was prescribed donepezil 3 months after initial presentation. He scored 26/30 on the MMSE at that visit. Three months later, his daughter noted that GG had stabilized, although the neuropsychological testing demonstrated a decline in visual and auditory working memory. Six months later, the patient scored 30/30 on his MMSE. During psychometric testing, GG scored below the 10th percentile on all the subtests of Visual Working Memory on the WMS-III. He also performed in the 2nd percentile range for Logical Memory II (Auditory Delayed). On the RAVLT, he performed in the "below average" range for the Delayed Recall and Recognition List A subtests. He was below the 20th percentile for the BNT and in the 2nd percentile for the K-SNAP. He also scored 6/10 on the Clock Drawing Test. The clinical diagnosis remained AD with good response to donepezil medication.

A neuropsychological evaluation was performed 1 year later. The result suggested that donepezil was having a positive effect on his cognition, but GG's profile was still noted as consistent with early AD.

His last visit was 5 years after initial presentation, where he scored 27/30 on the MMSE. GG's cognitive status was noted to be "remarkably stable."

ND. ND was an 81-year-old woman at presentation with 14 years of formal education. She had worked as an elementary school teacher and later became the owner of a retail business. The patient was never a socially active person but spent considerable time on the phone with her sisters. She tended her garden, read the newspaper, watched television, and did daily crossword puzzles. When ND exhibited confusion regarding the administration of her triplex, her daughter took over the finances. Nevertheless, ND continued to do her independent daily banking. Her family medical history was negative for psychiatric illness, neurological disorders, and vascular disease.

The patient began to experience memory loss in 2003, which was described as slow and insidiously progressive. She presented to the Memory Clinic in May 2004. ND's initial complaints included a change in handwriting, name and word retrieval deficits, speech repetition, and loss of mental tracking. She misplaced personal items more frequently. The patient's daughter felt that her concentration was lacking intermittently. ND's children became more involved with administrative affairs and scheduling of medical appointments. The patient restricted her driving to familiar areas. She began using an automatic boiler after she burnt several pots. Her son began to assist with cooking and domestic chores. Her MMSE score was 29/30, and her MoCA score was 25/30. Her blood work was noncontributory. A CT scan performed 3 months later suggested chronic microvascular disease. ND was diagnosed with mild AD and donepezil was prescribed.

During psychometric testing, ND scored in the 9th percentile range in the Number-Letter Sequencing subtest of the WMS-III. She was "below average" for the Immediate Recall/Interference and Learning Over Trials subtests of the RAVLT and the Color Words subtests of the Stroop Color Test. She performed below the 10th percentile range in both the BNT and the COWAT ("ANIMALS").

Four months after initial presentation (and treatment with donepezil), ND scored 30/30 on the MMSE. According to ND and her daughter, her memory had deteriorated further and she was becoming more easily distracted. The patient cited an instance where she took her medication for the wrong day even though she relied on a pillbox. ND now had someone to do the household cleaning and no longer prepared meals. In comparison with her first performance, the results of a repeat psychometric testing were noted as stable. However, she was unable to complete the Number-Letter Sequencing because she could not follow the instructions.

ND received another perfect score on the MMSE 13 months after her initial presentation. At that time she scored 26/30 on the MoCA. The subsequent neuropsychological evaluation performed 5 months later revealed further memory deterioration. Day–night behavioral reversals were reported. The patient required assistance with several activities of daily living (dressing, showering, etc).

Her last visit was 22 months after her initial presentation. She again scored 30/30 on the MMSE and 22/30 on the MoCA. Her family noted a further decline in her activities of daily living.

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