A simple screening test with a potential to detect diabetic cognitive impairment in the geriatric population: a preliminary study

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Abstract
Objective: To identify a test to screen for cognitive impairment due to diabetes which can be used easily, without specialized training, by all healthcare professionals in the primary care setup.

Methodology: The study was conducted in five healthy and five diabetic male subjects using a neurocognitive screening instrument named the 7 Minute Screen which consisted of a battery of four tests, each focusing on an area of cognition compromised in mild cognitive impairment – orientation, memory, visuospatial ability and expressive language.

Results: A significant reduction in orientation was seen in chronic diabetics compared to healthy age matched control group along with a higher risk of developing dementia, suggesting a role for type-2 diabetes mellitus in aggravating normal cognitive derangement with age. But further studies have to be done to rule out other confounding factors.

Conclusion: Though similar studies have been conducted in the past using other tests, this test has the added benefits of simplicity, affordability and convenience with potential use as a routine screening test for early detection of people with high risk of developing diabetes induced dementia. It can be a promising follow-up tool to check for improvements or deteriorations in cognitive functions of diabetic patients in the primary care setup.

Introduction
Cognitive abilities include perception, memory, judgment, perceptual speed, spatial manipulation and reasoning. Different cognitive abilities have different developmental trajectories across the lifespan, and may be grouped into two broad types; 'crystallised', which involves accumulated knowledge and expertise and relies on long term memory and 'fluid', which involves novel problem solving, spatial manipulation, mental speed, and identifying complex relations among stimulus patterns and relies on short term memory (1).

Cognitive abilities, especially fluid cognition, decline with normal ageing, the phenomenon being termed cognitive ageing (2). There are large individual differences in the amount and pattern of decline. The most common complaint encountered in older adults is varying degrees of memory deficit which form diagnostic criteria for mild cognitive impairment (MCI), which is a transitional stage between normal cognitive aging and dementia (2). In the absence of curative treatments for dementia, identification of subjects at increased risk of dementia and modifiable risk factors may allow interventions that prevent progression from preclinical to frank clinical manifestations which are detrimental to a normal and healthy life. The common risk factors for accelerated cognitive decline include diabetes mellitus, hypertension, stroke, smoking, physical inactivity, high LDL cholesterol and obesity (3,4).

Diabetes mellitus seems to be one of the most important risk factor for various morbidities including cognitive dysfunction, especially among the elderly, considering the alarming rate at which the population of diabetics is increasing. The global population of diabetics is expected to rise from 171 million persons in 2000 to 366 million in 2030. (5). Longitudinal studies report a 1.5 – 2 fold increased risk of dementia in individuals with diabetes compared to those without (6).

There has been a steady increase in the incidence and prevalence of diabetes mellitus in India (10, 11) along with the increase in the percentage of elderly population. Considering that there will be a large population of elderly affected with diabetes

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mellitus and of a longer duration in the coming years, it can be well expected that there will be significant cognitive impairment in that group, both as a result of aging and deleterious effect diabetes mellitus on cognitive functions. Hence there is an urgent need to identify a screening test which can be used easily, without much specialized training by all healthcare professionals so that the cognitive dysfunction in diabetics can be diagnosed early and easily and appropriate preventive/curative measures can be initiated to improve the quality of life of patients and thus reduce the cost of treating late complications of cognitive deficits.

The Mini Mental State examination (MMSE) test, The Blessed Dementia Scale (BLS-D) and Wechsler Memory Scale are some of the tests that have been used to assess cognitive functions. All these tests, though suitable, have some limitations, especially if it is to be used by general health care professionals as an easy screening test (12). Keeping this objective in mind, we used the simple '7 Minute Screen' test (13, 14) to evaluate the cognitive functions in elderly adults, both healthy subjects and diabetic patients to evaluate the utility of this test. This test was specifically chosen due to the following advantages – it can be rapidly administered by even allied health professionals in a primary care setting and requires minimal training and no clinical judgment, it surveys multiple cognitive areas and can reliably distinguish between Alzheimer's Disease (AD) and cognitive deficits associated with the normal aging process and most importantly, it is time saving and cost effective. At the same time this test is proven to be almost as sensitive and specific as the Wechsler's scale and MMSE both of which require competent professional training for administration of the tests (13).

Methods

We used the neurocognitive screening instrument named the 7 Minute Screen (14) which consisted of a battery of four tests, each focusing on an area of cognition compromised in MCI – Orientation, memory, visuospatial ability and expressive language.

Subjects

The study was conducted in 10 elderly male subjects, 60 years or older. All subjects signed an informed written consent form. The control group had 5 healthy subjects whereas the study group had 5 patients of type 2 diabetes mellitus of more than 10 years' duration. The inclusion and exclusion criteria were as follows.

Study group

All subjects in the study group were of type-2 diabetes mellitus for the past 10 years or more. All were on treatment but the extent of control of blood glucose levels was not the same in all. There were no signs and symptoms of any complication like neuropathy, retinopathy or nephropathy in any of them. There was no previous history of hypertension or hypercholesterolaemia in any of the subjects.

Control group

The control group consisted of individuals with no history of diabetes, hypertension or hypercholesterolaemia with no previous trauma to head. They were non-smokers with a moderate body build. (underweight and obese individuals were excluded)

Study instrument

As described above the 7 Minute Screen was used and subjects were evaluated in the four areas, orientation, memory, visuospatial ability and expressive language. The procedure of the test was explained in simple and clear terms and after obtaining their consent the test battery was administered in four parts as follows.

Benton Temporal Orientation Test (BTOT) – The examiner asks the subject relevant questions to assess his/her ability to identify the month, date, year, day of the week, and time of day. Unlike other mental status tests that have orientation as a component, the BTOT uses a graduated scoring system that reflects the degree of error, the maximum error score being 113. The examiner awards 5 points for each month off (maximum—30), 1 for each date off (maximum—15), 10 points for each year off (maximum—60), 1 point for each day off (maximum—3) and 1 point for each 30 minutes off (maximum—5). If subject does not respond or says "I don't know" then he is encouraged to guess and if he does not guess then he is awarded the maximum score. Thus a higher score indicates greater cognitive derangement.

Enhanced Cued Recall Test – A test in which the subject is asked to recall 16 items presented pictorially on four individual cards initially displayed to him along with semantic cues that best describe the objects. When the patient cannot recall any of the items, the examiner provides

appropriate cues for reminding the items. This test distinguishes between AD and the memory deficits associated with the normal aging process, because normal elderly patients benefit more from reminder cues than do patients with AD. The score for this test is the total number of items remembered in both the uncued and cued recall, with a maximum score of 16 and lower scores being suggestive of cognitive impairment.

Clock drawing test – This tests the visuospatial ability of the subject. He is asked to draw a handless clock showing all the numbers on it and then draw clock hands set at 20 minutes before 4. The maximum score of 7 represents normal cognition and with lower scores the cognitive impairment will be greater. A full score of 1 point is given in each case if

- Only numbers 1-12 are present (Arabic or Roman numerals)
- Numbers in correct order
- Numbers in correct position
- 2 hands present
- Hour number is properly indicated
- Minute target number indicated
- Hands in correct proportion

Verbal fluency test – The examiner asks the patient to name as many members of the category "animals" as possible over a 1-minute period. The score is the total number of appropriate items named. The maximum score is 45 and lower scores point towards compromised fluency.

The combined scores obtained for all the four component tests for each individual subject were further analysed by feeding onto an online/offline calculator devised by Solomon et al (14). The calculator directly generated the subject's probability of developing Alzheimer's disease in the future as either LOW or HIGH.

The unpaired t-test was used to compare the performance of control and diabetic subjects in each of the 4 tests and also the probability of developing dementia obtained as either LOW or HIGH. Numerical data of the 4 tests were used as such and for the probability of developing dementia, a score of 0 was assigned to LOW and a score of 1 was assigned to HIGH. A value of $p \leq 0.05$ was considered significant.

The ethics approval was obtained from the Institutional Ethics Committee through the Student Research Forum of Kasturba Medical College, Manipal, Karnataka, India.

Results

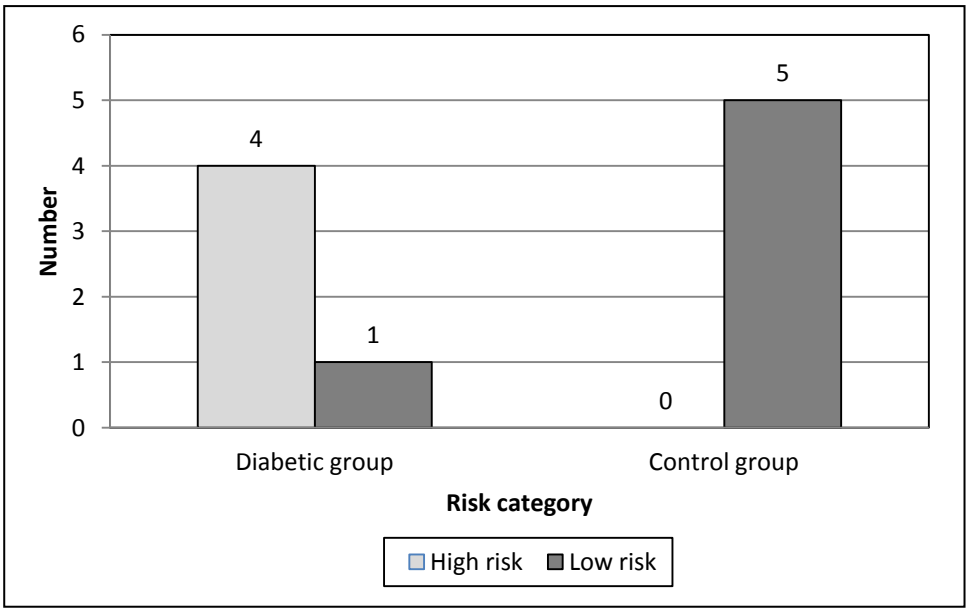
The mean age of the control group was 68±7.99 (mean ± SD) years whereas the diabetics were of 63.6±5.6 years with the mean duration of diabetes being 17.6±7.1 years. The groups were not significantly different in age. The values (Mean ± SD) of the four different aspects of cognitive functions as tested by the method used are compared in Table 1.

As can be inferred from the table, the diabetic patients' performance on orientation was very poor compared with the controls, which was statistically significant. Their ability to draw the clock was also relatively poor compared to controls, though it was not statistically significant. In the other two parameters, the two groups were not significantly different. On further analysis of the probability rating expressed by the 7 minute test online calculator after feeding the test values, it was found that 4 out of 5 diabetics were at high risk of developing dementia compared to 0 out of 5 in healthy volunteers. This difference was statistically significant with a 'p' value of 0.00395. This is shown in Figure 1.

Table 1: Comparison between cognitive functions of diabetic vs. control group

	Orientation	Recall	Clock	Naming
Control group	0 ± 0	15.2 ± 0.83	6 ± 0.70	16 ± 3.93
Diabetic group	3.2 ± 2.94	12 ± 6.36	4.2 ± 2.28	13.4 ± 3.64
p value	0.041466	0.297314	0.130311	0.310228

Figure 1: The number of subjects at risk of dementia in the two groups



A significant reduction in orientation was seen in chronic diabetics of the age group of 60 years or more with a higher risk of developing dementia, compared to the control group. However a conclusive opinion couldn't be formed regarding the other three cognitive functions tested.

Discussion and Conclusions

In this study an attempt has been made to find a clinically useful, easily administrable, reliable and cost effective test to identify cognitive impairment by using The 7 minute screening test, and also to further identify any statistical correlation between MCI and type-2 diabetes mellitus as a part of an ongoing effort to identify specific areas where interventions might preserve cognitive health, especially since full blown dementia, which deranges lives of numerous aged persons round the globe is found to be almost non-curable till date. The target population selected were Indians above the age of 60 years since not much has been done to shed light on the prevalence of diabetes induced accelerated cognitive impairment in a country having the dubious reputation of being the diabetes capital of the world.

The study showed that there is a significant impairment of at least some elements of cognitive functions in patients with more than 10 years of diabetes mellitus. The risk of developing dementia was also found to be higher in diabetics compared to healthy age-matched controls.

The test used for this study was administered by second year medical students who did not require any specialized training. In all subjects, the time required to complete the test was less than 10 minutes and none of the study subjects in both the groups had any difficulty in understanding the test procedure.

Uncontrolled or poorly controlled diabetes has a high risk of developing dementia. But even with normal blood glucose levels as a result of good control, some individuals show accelerated cognitive deficits. Thus asymptomatic cases of MCI can be identified if this test is done routinely for screening as this test has the benefits of simplicity, affordability and convenience without compromising its sensitivity and specificity (13).

It can be used as a follow-up tool to check for improvements or deteriorations in cognitive functions of diabetic patients as well as a research tool to demonstrate the effects of interventions like exercises, lifestyle changes, or even drugs aimed at improving cognition as a treatment or at least as a control of the causative factors.

There are limitations in this study. Duration of diabetes may be important in the pathophysiology of cognitive impairment, but in this study the duration of diabetes was not taken into analytic considerations. The extent of control measures taken and the knowledge about diabetes were different in different subjects, which may play a

role but was not specified in this study. A conclusive opinion couldn't be formed regarding the effect of diabetes on the cognitive functions tested other than orientation, probably due to the limited sample size. A more extensive study including both the sexes would help to answer all these questions which are unanswered in this study.

Finally, the use of the seven minute test to identify diabetic cognitive impairment in the aged population is highly promising. Nevertheless the present study is inadequate to draw any definitive conclusion or provide any tangible suggestion in this respect. Hence further research into this field is highly desirable.

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