A COMPUTERIZED TESTING SYSTEM FOR SCREENING DEMENTIA IN COMMUNITY-BASED SETTINGS

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Abstract: We have developed a computerized testing system for screening dementia in community-based settings. The system was assembled with a touch-panel display and computer devices unified into one case. This made the hardware a very compact, light and easy to carry unit. Two test programs were implemented in the system, one for primary screening and the other for close examination. The primary screening program, which was intended to screen persons who are suspected of having dementia in community-based settings, consisted of 4 test tasks. The close examination program was designed to diagnose the dementia and was composed of 10 test tasks. Throughout the whole process, users were guided not only by text prompts but also by voice instructions. In the test process, the system presents questions by text, figures and/or voice. Then the system shows the choice icons on the computer display and requires the subject to touch the correct icon. By this method, even aged persons could easily operate the system. Results of the primary screening program yielded maximum sensitivity and specificity values of 96% and 86% for the total score, respectively. By applying this system to community-based settings, we have detected 55 persons as mild cognitive impairment (MCI) and 74 persons as suspicious of suffering from dementia out of 998 elderly residents.

1 INTRODUCTION

One of the most important issues in public health in Japan is the rapidly aging society. The number of aged persons over 65 years of age is now about twenty-six million which amounted to over 20% of all Japanese people in 2006. The Japanese rate of prevalence for dementia was reported to be 10% of all people over 65 years of age. This means that the number of persons with dementia is estimated to have reached more than two million in Japan. It is important to detect the early stages of dementia because intervention programs are more effective when useful cognitive function can still be preserved (Buschke et al., 1999), (Barker, et al., 2005). Moreover, at the present time some medication can improve symptoms and functioning and may slow the progression of the basic disease process (Knopman DS, 2006). However, because most dementia patients visit the hospital after their symptoms have become worse, medication is too late in many cases (Bennet et al., 2006), (Ganguli et al., 2004).

Community-based screening is the usual way to detect persons with dementia in the early stage and is carried out in many places. In the case that the mass-screening is administered by human testers, several examiners are required and their treatment seems to be biased according to their experience or knowledge. Moreover, there seems to be a risk that the criteria could vary from tester to tester. The necessary requirements which a test method must fulfil in mass-screening are speed, objectiveness and unbiased results even if the examiner changes.

Using a computerized cognitive test system yields some useful features; for example, it can provide quick, objective and precise results based on the same standards as more involved tests (Letz et al., 1996). For the screening of community-dwelling elderly people with dementia, we have developed a computerized testing system in which two test

programs are executed, one for primary screening and the other for close examination. In this paper, we present a description of the system and application of the system in community-based settings.

2 DESCRIPTION OF THE COMPUTERIZED SYSTEM

The system was assembled with a touch-panel display and computer devices unified into one case. This made the hardware a very compact (450W x 300L x 38D mm), light (2Kg) and easy to carry unit (Fig.1). The program was developed with Microsoft Visual Basic 6.0 and run under the Windows 2000 operating system. The system was designed for use by the elderly. We adopted a touch panel display as an input device so that aged people could operate it easily by touching the icon shown on the display without using a keyboard or mouse. Throughout the whole process, users were guided not only by text prompts but also by voice instructions.

Figure1: Exterior view of the system.

3 DESCRIPTION OF THE TEST PROGRAM

In the test process, the system presents questions by text, figures and/or voice. Then the system shows the choice icons on the computer display and requires the subject to touch the correct icon. The system determines if the selection is "true" or "false" according to the icon touched.

The primary screening program was made with reference to the Hasegawa dementia rating scale (Katho et al., 1991) and consisted of 4 test tasks, the procedures usually being completed altogether within 5 minutes. This program was intended to screen persons who are suspected of having dementia in community-based settings. The total number of points on this test is 15.

Each test tasks is as follows:
  (1) Three word memory test
  (2) Temporal orientation test
  (3) Three-dimensional visual-spatial perception test
  (4) Delayed recall test

The close examination program was designed to diagnose dementia and was made in reference to the Alzheimer's Disease Assessment Scale (ADAS-Cog), (Doraiswamy et al., 1997). Although, the original ADAS-Cog was composed of 40 test items, it was difficult to computerize all the items because they were created based on dialogical observation. Therefore, we selected items which were highly significant and easy modifiable to computerization, and assembled these into 10 computerized test tasks. The close examination program is usually administered within 30 minutes. In this procedure, a perfect score is 0 which increases according to the number and value of false answers. The score reaches 107 when all answers are incorrect. The test tasks for the close examination are as follows:
  (1) Word recall
  (2) Comprehension of spoken language
  (3) Orientation
  (4) Figure recognition
  (5) Object recognition(6) Following a command
  (7) Finger name recognition
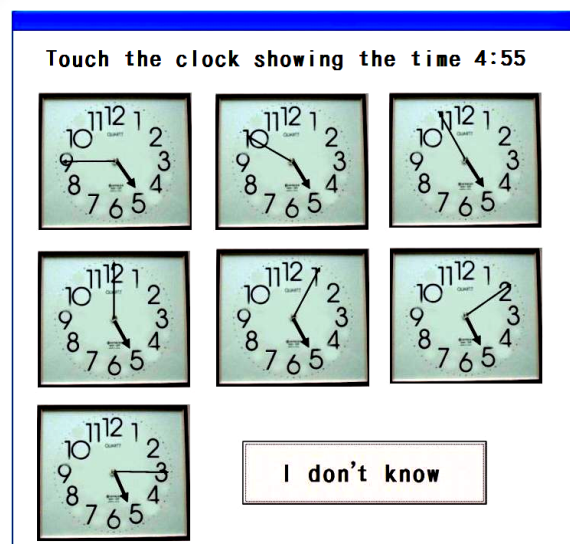 (8) Money calculation

Figure 2: A sample computer display which assesses clock timer recognition.

Table 1: The demographic characteristics of samples and results of individual test tasks out of dementia group and control groups.

	Dementia	Control	t-value
Sample size	72	102	
Age (years)	80.0±5.1	77.1±5.8	
Sex M/F	12/60	37/65	
Three word memory test	2.57±0.55	2.99±0.01	5.6[*]
Temporal orientation test	2.56±1.76	3.87±0.11	9.5[*]
Three-dimensional visual-spatial perception test	0.82±0.15	0.92±0.07	2.1[*]
Delayed recall test	3.64±4.09	5.92±0.15	11.1[*]
Total score	9.87±8.53	14.1±0.53	14.0[*]

* $p < 0.05$

(9) Accuracy of the order of a process
(10) Clock time recognition (non-digital)

Figure 2 shows a sample computer display which assesses "Clock time recognition".

4 SUBJECTS AND METHODS

Outpatients in the Memory Disorder and Dementia clinics at Tottori University Hospital participated. They received neuropsychological tests as well as neuroimaging examinations among other medical checks. Diagnosis of dementia was made according to criteria from Diagnostic and Statistical Manual of Mental Disorders (3rd ed., revised) (DSM-III-R), (American Psychiatric Association, 1987). Finally, seventy-two patients were diagnosed with dementia. We recruited community-dwelling elderly residents aged over 65 as control subjects. The control group was comprised of one hundred and two subjects with no neurological or psychiatric pathology. All subjects gave informed consent. By use of these subjects, we determined the cut-off point for the primary screening program which helped differentiate the dementia group from the healthy control group.

5 RESULTS

5.1 Results of the Primary Screening Program

Results of the primary screening program showed that the dementia group performed worse than the control group on each of the 4 tasks. The unpaired Student's t-test revealed that there was a significant difference between the two groups for each individual test and for the total score (Table1). The sensitivity and specificity parameters and cut-off points for the "Delayed recall test" and the "Temporal orientation test", and the total score, which revealed a high t-value, comparing the dementia group with the control group, is calculated by use of Receiver Operating Characteristic Analysis. Finally, the analysis yielded maximum sensitivity and specificity values of 96% and 86% for the total score, respectively, with a cut-off point of 13.

5.2 Result of the Screening Procedure

Nine hundred ninety-eight elderly residents aged over 65 underwent the screening. The screening process was done using the system as follows: first, we screened any person whose primary test score was 13 or less as hi-risk; then, we introduced those hi-risk participants into the close examination test. We regarded a person whose score on the close examination to be 14 or more as suspicious of suffering from dementia and recommended them to have a medical examination. Also, we regarded any person whose score on the close examination to be from 7 to 13 as mild cognitive impairment (MCI).

Two hundred ninety-five people were screened as hi-risk based on the primary test. Subsequently, they were introduced into close examination and 151 of them took the examination. Finally, we detected 55 persons as MCI and 74 persons as suspicious of suffering from dementia, respectively. The suspected 74 persons were recommended to receive a medical examination. Out of the 74 persons, 48 had received a medical examination by the time this paper was

written. Final diagnosis by medical specialists was as follows: 41 were diagnosed with Alzheimer's, 2 with vascular dementia and 5 with other diseases.

6 DISCUSSIONS

Community-based screening is a useful way to detect persons with dementia in their early stages. Several different tests were developed for the purpose of screening dementia. The Mini-Mental State Examination (MMSE) and the Hasegawa dementia scale, which are basically based on face-to-face interviews, are widely used to differentiate between normal aged people and cases of dementia in Japan. However, these tests were originally designed to diagnose dementia, and are not suitable for community-based settings because they take too long and are too cumbersome to administer(David and Jeffrey, 1999). A useful screening battery for dementia needs to be brief, simple and accurate. In this study, the primary screening program revealed that overall sensitivity and specificity for screening dementia was 96% and 86%, respectively, which were equivalent to other studies (Mendiondo et al., 2003), (Shulman, 2000), (Solomon et al., 1998). When we develop a computer system whose main target users are elderly persons, the system should be easy to operate even by a person with slight mentally debilitating disorders or without any type of experience with a computer. Adopting a touch panel display as an input device with the help of text prompts and audio instructions could present an easy user-computer interface and almost all of the subjects could understand how to interact with the system and completed the tasks by themselves. In the actual screening procedure, we detected 55 persons with MCI and 74 persons as suspected of suffering with dementia out of 998 elderly residents. We believe that this computerized screening system is useful for community-based settings and contributes toward the early detection of persons with dementia.

REFERENCES

Buschke H, Kuslansky G, Katz M, et al. Screening for dementia with the Memory Impairment Screen. Neurology 1999; 52: 231-238.

Barker WW, Luis C, Harwood D, et al. The effect of a memory screening program on the early diagnosis of Alzheimer disease. Alzheimer Dis Assoc Disord. 2005; 19: 1-7.

Knopman DS. Current treatment of mild cognitive impairment and Alzheimer's disease. Curr Neurol Neurosci Rep 2006; 6: 365-371.

Bennett DA, Schneider JA, Arvanitakis Z, et al. Neuropathology of older persons without cognitive impairment from two community-based studies. Neurology 2006; 66: 1837-1844.

Ganguli M, Rodriguez E, Mulsant B, et al. Detection and management of cognitive impairment in primary care: The Steel valley Senior survey. J Am Geriatr Soc 2004; 52: 1668-1675.

Letz R, Green RC, Woodard JL. Development of a computer-based battery designed to screen adults for neuropsychological impairment. Neurotoxicol Teratol 1996; 18(4): 365-370.

Katho S, Shimogaki H, Onodera A, et al. Development of the revised version of Hasegawa's Dementia Scale, Ronen Seishin Igaku Zasshi 1991; 2: 1339-1347. (in Japanese)

Doraiswamy PM, Bieber F, Kaiser L, Krishnan KR, et al. The Alzheimer's Disease Assessment Scale: patterns and predictors of baseline cognitive performance in multicenter Alzheimer's disease trials. Neurology. 1997;48(6):1511-1517.

American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 3rd ed, revised. Washington, DC: American Psychiatric Association; 1987.

David RD, Jeffrey LC. Evaluating dementia screening tests. Neurology 1999; 52: 224-227.

Mendiondo MS, Ashford JW, Kryscio RJ, Schmitt FA. Designing a Brief Alzheimer Screen (BAS). J Alzheimers Dis 2003; 5: 391-398.

Shulman KI. Clock-drawing: is it the ideal cognitive screening test? Int J Geriatr Psychiatry 2000; 15: 548-561.

Solomon PR, Hirschoff A, Kelly B, et al. A 7 minute neurocognitive screening battery highly sensitive to Alzheimer's disease. Arch Neurol 1998; 55: 349-355.