Journal of Korean Medical Science
Vol. 10, No. 4, 287-293 August 1995

Reliability and Validity of the Cognitive Impairment Diagnosing Instrument (CIDI) in the Elderly

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The reliability and validity of the Cognitive Impairment Diagnosing Instrument (CIDI) were studied in 67 nursing home elderly subjects and 251 elderly psychiatric patients. Its possible highest score is 77 and covers 10 subscales: short-term memory, long-term memory, concentration / calculation, abstract thinking, judgement, memory registration, higher cortical functions, orientation in time, orientation in place and object naming. Test-retest correlations were between 0.827 and 0.990 for the subscale scores and 0.984 for the total score. Inter-tester kappas for each item ranged from 0.200 to 1.000 with a mean of 0.698. Concordance rates were between 50.0 and 100.0% with a mean of 87.2%. Cronbach's alphas for the items of the individual subscales ranged from 0.702 to 0.915. Inter-subscale and subscale-total correlations ranged from 0.503 to 0.820 with a mean of 0.684 and from 0.721 to 0.883, respectively. Cronbach's alpha of the subscales was 0.934. Sensitivity and specificity were 93.3% and 93.8% at the cut-off point of 57.0 / 57.5 for dementia. Subscale and total scores were significantly different between the demented and non-demented. The total CIDI score was significantly correlated with scores of the Blessed Dementia Rating Scale and the Korean version of the Mini-Mental State Examination.

Key Words : *Cognition, Dementia, Sensitivity, Specificity*

INTRODUCTION

The comprehensive assessment of cognitive function is essential for the diagnosis and precise delineation of the features of dementia. Brief mental status questionnaires are not adequate for this purpose. Although they employ objective tests, they only sample in a limited way a few spheres of cognitive function and are reliable in patients with moderate to severe impairment. Now we are recognizing that dementia is a heterogeneous condition in which a variety of deficits can occur. One sphere of cognitive function is more affected in a type of dementia while other cognitive deficits are more marked in different

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types of dementia. To be sensitive to this issue, a cognitive function test must sample a broad range of cognitive functions. Few schedules meet these requirements. The Mini-Mental State Examination (MMSE) appears to be the best brief objective test in current use (Folstein et al., 1975). One of the most frequently cited shortcomings of the MMSE is its lack of sensitivity to mild cognitive impairment and its failure to adequately discriminate patients with mild dementia from normal subjects (Tombaugh and McIntyre, 1992). And its content is highly verbal and very focused on orientation, lacking sufficient items to adequately measure other cognitive functions, for example, long-term memory and abstract thinking. These problems of the MMSE have pushed some researchers to modify its content (Mayeux et al., 1981 ; Teng et al., 1987 ; Galasko et al., 1990). Almost all problems inherent in the MMSE could occur in its Korean version(MMSEK)(Park and Kwon, 1990). A further requirement for a diagnostic tool for dementia is the reliable grading of severity. The Clinical Dementia Rating Scale (Hughes et al., 1982) and the Global Deterioration Scale (Reisberg et al., 1982) are notable. The Clinical Dementia Rating Scale is not easy to apply in clinical practice and it is imperative that all areas of cognitive function should be taken into account in order to arrive at a severity rating. The Global Deterioration Scale grades cognitive impairment along a seven-point scale, but the criteria weigh heavily on the severity of memory disorder.

The central objective to be described in this paper was to develop a semi-structured interview protocol, called Cognitive Impairment Diagnosing Instrument (CIDI), with an acceptable measure of reliability and validity for detection and assessment of cognitive dysfunction for use with the Korean elderly. It should overcome the limitations of the MMSEK and should not take much time to administer in the elderly possibly with severe cognitive impairment and little motivation. It has been also attempted to give an objective evaluation and a standardized recording of a broad range of cognitive functions. In Korea, there is no objective scale measuring a variety of spheres of cognitive function, comparable to the Mattis Dementia Rating Scale (Mattis, 1976) or Cambridge Cognitive Examination (Roth et al., 1986).

Almost all CIDI items are those which are frequently, even if unsystematically, asked by clinicians for evaluation of patients with mental disorders. They cover a variety of spheres of cognitive function which are needed for diagnosis of dementia. In its development we have attempted to make an instrument easily applicable to the Korean elderly. The CIDI is finally a semi-structured interview protocol for use with the elderly. It has been used in a prevalence study of dementia even though the form had not been the final one (Park et al., 1994). The MMSEK items are incorporated into the schedule, given the popularity of the MMSE in English-speaking populations and of the MMSEK in Korea. Thus, the CIDI provides a wider coverage of cognitive function than the MMSEK, as well as more information about most cognitive spheres. It comprises 10 subscales of cognitive function and the possible greatest scores are present in parentheses : short-term memory (13), long-term memory (9), orientation in time (5), orientation in place (5), memory registration (8), concentration/calculation (5), judgement (4), object naming (10), abstract thinking (7), and higher cortical functions (11). The items addressing higher cortical functions consist of agnosia, visuospatial dysfunction, apraxia and aphasia except object naming. The possible maximum total score is 77. Responses to the 68 items are scored on the pass-fail basis. Responses to two long-term memory and 7 abstract thinking items are scored 0 (incorrect), 0.5 (partially correct) or 1.0 (fully correct). The CIDI protocol is available on request from the authors.

MATERIALS AND METHODS

Two groups of people participated in this study. One group was 67 (26 men and 41 women) recruited from 90 elderly in a nursing home in Taegu. Twenty-three were not fully successful in the CIDI interview because of hearing difficulty in 8, speech disturbance in 5, refusal in 3, death in 3 and other in 4. Their ages ranged from 60 to 96 with a mean of 75.2 $\pm$ 7.7 (SD) years, and mean schooling was 3.4 $\pm$ 6.7 (SD) (range, 0—15) in years. Twenty-eight had definite cognitive impairment (scored less than 21), 17 had questionable cognitive impairment (scored from 21 to 24), and 22 had no cognitive impairment (scored greater than 24) based on the MMSEK criterion (Park et al., 1991). Severity of dementia was assessed in these subjects by their care-givers using the Blessed Dementia Rating Scale (BDRS) (Blessed et al., 1968). The relations of the CIDI score to severity of dementia and to the raw and corrected MMSEK scores were examined in them. The CIDI was readministered to 23

of these subjects for estimation of the test-retest reliability 25.5 ± 15.0 (SD) days later by the same examiner. Another 16 subjects had readministration of the CIDI by a different examiner for the inter-tester reliability 24.4 ± 4.5 (SD) days after the first examination. Pearson's correlation coefficients between scores of individual subscales, corrected subscale-total statistics and Cronbach's alpha were studied in the nursing home subjects for the evaluation of internal consistency. The corrected subscale-total statistics are Pearson's correlation coefficients between the score of the individual subscale and the total score subtracted by the score of the index subscale. For each subject the ratings of the two examiners were compared for all CIDI items and for its subscale. Two psychiatric residents administered the CIDI to all the nursing home subjects.

The diagnostic validity was studied in hospital patients. They were in- or out-patients aged 60 years or more at the Department of Psychiatry, Keimyung University Dongsan Hospital during the period between July 1991 and December 1993. Some of them were new-comers while others were in their follow-ups. They were in all 287. The CIDI was completed in 251 (104 men, 147 women) : 22 were lost to the interview, 6 refused, 5 gave incomplete data, 2 had total blindness, and 1 died before the interview. Two psychiatrists independently reviewed all the medical records and laboratory investigations of each patient and then made a diagnosis of either dementia or non-dementia according to the DSM-III-R criteria (American Psychiatric Association, 1987). Any documentation suggestive of diagnosis was kept away from the psychiatrists. Diagnosis of the subjects in whom it was disagreed on by the two psychiatrists was judged by the principal researcher. The three psychiatrists involved in making the diagnosis were blind to the CIDI or MMSEK data. The CIDI was administered to the hospital subjects by one psychiatrist.

Student's t-test was used in comparison of means between the two groups. For the inter-tester reliabilities, kappa was calculated for the response to each CIDI item. Concordance rate was also calculated because the kappa could not be calculated for some items. For the test-retest reliabilites, Pearson's correlation coefficient was computed between the two scores of each subscale and between the two total scores of the CIDI. Pearson's correlation between scores of each subscale, subscale-total statistics and Cronbach's alpha were calculated for the internal consistency. Means of subscale and total scores of the CIDI were compared between the demented and non-demented for diagnostic validity. Sensitivity and specificity and kappa were calculated at the most probable adequate cut-off score. Pearson's correlations of the total CIDI score to the BDRS score was evaluated for dementia severity. In comparison between the CIDI score and the MMSEK score, the raw and corrected MMSEK scores were compared with the total CIDI score which was subtracted by the raw MMSEK score. The MMSEK score is usually corrected in the non-educated elderly : 1 point is added to the orientation in time and the language function and 1 or 2 points to the concentration/calculation (Park et al., 1990).

RESULTS

The duration for completion of the CIDI ranged from 20 to 55 minutes with a mean of 31.6 ± 7.7 (SD) minutes in the 67 nursing home subjects and from 10 to 49 minutes with a mean of 23.9 ± 6.2 (SD) minutes in the hospital subjects. It took shorter for the subjects with either non-dementia or severe dementia while more time was needed for in-between subjects.

The inter-tester kappas ranged from 0.200 to 1.000, with a median of 0.709 and a mean of 0.698, except for the 6 items in which kappa could not be calculated. On the other hand, concordance rates were calculated for all items. They were between 50.0% and 100.0%, with a median of 87.5% and a

Table 1. Test-retest Pearson's correlation coefficients(r) of the Cognitive Impairment Diagnosing Instrument.

	r*
Short-term memory	.907
Long-term memory	.990
Concentration/calculation	.887
Abstract thinking	.890
Judgement	.827
Memory registration	.881
Higher cortical functions	.916
Orientation in time	.939
Orientation in place	.884
Object naming	.973
Total score	.984

*All correlations are statistically significant at $p<0.001$.

Table 2. Pearson's correlations between the Cognitive Impairment Diagnosing Instrument subscales in the 67 nursing home subjects.*

	01	02	03	04	05	06	07	08	09	10
01	-									
02	.762	-								
03	.663	.787	-							
04	.504	.652	.603	-						
05	.587	.654	.634	.557	-					
06	.503	.659	.811	.581	.515	-				
07	.749	.769	.754	.693	.781	.674	-			
08	.637	.720	.665	.803	.630	.674	.786	-		
09	.820	.725	.742	.680	.662	.614	.746	.787	-	
10	.696	.692	.693	.638	.599	.592	.748	.739	.813	-

01 : short-term memory, 02 : long-term memory, 03 : concentration/calculation, 04 : abstract thinking, 05 : judgement, 06 : memory registration, 07 : higher cortical functions, 08 : orientation in time, 09 : orientation in place, 10 : object naming.
*all correlation coefficients are statistically significant at $p<0.001$.

mean of 87.2%. The items with kappa less than 0.40 were 8 of 71 items (11.3%) in the inter-tester reliability. Concordance rates were between 50.0 and 100.0% for the items whose inter-tester kappa could not be computed. The great majority of items reached an acceptably high inter-tester reliabilities. The test-retest Pearson's correlations were from 0.827 to 0.990 for the subscale scores and 0.984 for the total scores. The correlations were very significant ($p<0.001$) (Table 1).

Table 2 presents the Pearson's correlations between the subscale scores in the nursing home subjects. They ranged from 0.503 to 0.820, with a mean of 0.684. Subscale-total statistics are shown in Table 3. All the corrected subscale-total correlations were acceptably high. Cronbach's alpha also was very high. Deletion of any subscale has little effect on the Cronbach s alpha. Using the Cronbach's alpha, the internal consistencies for the items of the individual CIDI subscales were acceptably high, from 0.702 for orientation in place to 0.915 for concentration/calculation (Table 4).

The diagnostic validity of the CIDI was studied in the 251 hospital psychiatric patients. Seventy-five were demented and 176 were non-demented. The mean age was 69.9 ± 7.2 (SD) in the demented subjects and 65.9 ± 4.8 (SD) in the non-demented ($t=5.20$, $p<0.001$). The years of schooling were similar in the two groups (the demented, 4.1 ± 4.6; the non-demented, 4.1 ± 4.8). There was no significant difference in sex distribution. All the subscale and total scores of the CIDI revealed great and highly significant differences between the demented and non-demented (Table 5). Examinations of the distribution of the total CIDI scores by diagnosis showed the optimal cut-off to be 57.0/57.5 for diagnosing dementia, based on the balance between sensitivity and

Table 3. Subscale-total statistics of the Cognitive Impairment Diagnosing Instrument in the 67 nursing home subjects.

	Corrected subscale-total correlation	Alpha if subscale deleted
Short-term memory	.763	.941
Long-term memory	.852	.922
Concentration/calculation	.737	.928
Abstract thinking	.883	.921
Judgement	.725	.933
Memory registration	.831	.925
Higher cortical functions	.838	.923
Orientation in time	.878	.925
Orientation in place	.816	.930
Object naming	.721	.928
	Cronbach's alpha=0.934	

Table 4. Cronbach's alpha (α) of the subscale items of the Cognitive Impairment Diagnosing Instrument.

	α
Short-term memory	.901
Long-term memory	.852
Concentration/calculation	.915
Abstract thinking	.865
Judgement	.717
Memory registration	.816
Higher cortical functions	.773
Orientation in time	.784
Orientation in place	.702
Object naming	.891

Table 5. Subscale and total scores of the Cognitive Impairment Diagnosing Instrument of the 75 demented and 176 non-demented subjects.*

	Demented (M ± SD)	Non-demented (M ± SD)
Short-term memory(13)**	1.67 ± 2.67	10.10 ± 2.06
Long-term memory(9)	4.87 ± 2.96	8.78 ± 0.58
Concentration/calculation(5)	1.36 ± 1.70	3.79 ± 1.57
Abstract thinking(7)	2.95 ± 2.10	5.81 ± 1.15
Judgement(4)	2.09 ± 1.46	3.75 ± 0.48
Memory registration(8)	5.17 ± 2.61	7.71 ± 0.50
Higher cortical function(11)	4.60 ± 3.30	9.28 ± 1.84
Orientation in time(5)	1.15 ± 1.17	4.18 ± 0.99
Orientation in place(5)	2.95 ± 1.87	4.84 ± 0.42
Object naming(10)	6.89 ± 3.59	9.77 ± 0.56
Total(77)	33.69 ± 18.84	67.98 ± 6.63

*all differences are significant at $p<0.001$.
**the possible maximum scores are in the parentheses.

specificity. This yielded 93.3% sensitivity and 93.8% specificity. Five (7%) of 75 cases with dementia were classified as non-demented by the CIDI, while, of the 176 non-demented patients, 11 (6%) were diagnosed by the CIDI as demented. The kappa was 0.851 between the DSM-III-R and CIDI diagnoses at this cut-off point.

Medical records of the 5 with CIDI non-dementia but DSM-III-R dementia were reviewed. Their total CIDI scores were 58 to 59, except one in whom the score was 68 and the diagnosis of dementia was based on memory impairment and personality change. One was a woman and 4 were men. Four had been to school for 5 to 14 years and one had not been to school. Medical records of the 11 DSM-III-R non-demented patients who were classified as demented by the CIDI were also reviewed. Their total CIDI scores were above 50.0 in 6 and between 44 and 49 in 5. One was a man and 10 were women. Ten had not been to school and one had been educated for 1 year. Major depression was diagnosed in 5, limited premorbid intelligence in 5, cerebral stroke in 2, and seizure disorder, Parkinson's disease, chronic schizophrenia, atypical psychosis, panic disorder and organic delusional disorder in 1, respectively. Some of them had comorbidity of mental disorders.

In the 67 nursing home subjects the total CIDI score correlated −0.601 ($p<0.001$) with the BDRS score, 0.918 ($p<0.001$) with the raw MMSEK score and 0.908 ($p<0.001$) with the corrected MMSEK score. The BDRS score correlated with the ten subscale scores of the CIDI with coefficients between −0.312 and −0.632 with statistical significances. Total CIDI scores of the subjects with the MMSEK score of 30 ranged from 74.5 to 77.0 while they were 0 in all the people with the MMSEK score of 0. People with questionable cognitive impairment by the MMSEK (score, 21~24) scored between 50 and 68.5.

DISCUSSION

The CIDI is a new semi-structured interview for the evaluation of cognitive function in the Korean elderly. It covers a variety of spheres of cognitive function on the clinical level and may be relevant for the purpose of identification and quantitative gradation of cognitive impairment in elderly people. It could also render cognitive status on a specific sphere of cognitive function. Therefore, it can detect both global and circumscribed impairments of cognitive function. All subscales and the great majority of the individual items of the CIDI have been found to have an acceptably high measure of inter-tester and test-retest reliabilities. The mean subscale scores were found to well differentiate between cases with and without dementia. The total CIDI score proved to have a high sensitivity and specificity in differentiation between the two conditions. Both the subscale and total scores were significantly correlated with the BDRS severity of dementia and the total CIDI score was highly correlated to the raw and corrected MMSEK scores.

The CIDI has some advantages over the MMSE or

MMSEK, even at the expense of test time. They are coverage of a broader sphere of cognitive function and lessening of ceiling effect. However, the bottom effect of the MMSEK was not shunned in the CIDI. The bottom effect is unavoidable because it results from the subjects with profound dementia. For the present the CIDI has proved itself of value in clinical diagnosis of dementia, quantification of cognitive function, and gradation of dementia severity. All of these findings were cross-sectional, based on hospital patients and nursing home subjects. Its further usefulness awaits longitudinal decline of the score in the long-term follow-ups of patients with mild to moderate dementia and may be also supported through comparison with clinician's diagnosis in community samples without hospital bias. Examination of cognitive change in the follow-up studies will be of particular importance for the development of valid criteria in the diagnosis of early dementia, pseudodementia and delirium.

Six percent of the 176 non-demented and 7% of the 75 demented were misclassified by the CIDI. It is well known that poor education, female sex, major depression, poor intelligence and chronic organic condition are risk factors contributing to misdiagnosing non-demented people as demented. Almost all psychometric tests suffer from difficulty in interpretation of test results on which education has some effects (Kittner et al., 1986). Patients with non-demented chronic organic conditions usually suffer from cognitive impairment even though not severe to meet the diagnosis of dementia. More likelihood for non-demented women to be misdiagnosed as demented may be related to their poor education through either school or social activities. On the contrary, 4 of 5 who were misclassified as non-demented by the CIDI had been relatively highly educated. Elderly depressives are likely to have cognitive impairment.

A few problems of this study should be addressed. The clinical diagnosis of dementia might not be fully independent of the CIDI score. Some CIDI items were probably asked in the clinical examinations by psychiatrists, even if not systematically, and the responses might be described in the medical records reviewed by the diagnosing psychiatrists. The frequency distributions in cells were not adequate for the calculation of kappa in 2 × 2 or 3 × 3 table for some items. For those items, however, the concordance rates were acceptably high. A hospital sample probably will have two differences from a community sample. First, a variety of mental disorders and almost all psychotropic drugs could impede cognitive function particularly in the elderly. When psychiatric patients were included in the comparison group, specificity has been lowered (Folstein et al., 1985 ; Davous et al., 1987). It might be the case in this study. Second, there is a possibility that few cases with mild or early dementia were included in the current estimation of the validity. These factors could influence kappa because it is influenced by the base rate of an index disease, sensitivity and specificity (Faraone and Tsuang, 1994). Community population is thought to have more cases with mild or early dementia and fewer cases with non-demented mental disorders. If the CIDI is used in a community, it may produce more or less different validities from this study.

The CIDI could be used for the assessment of cognitive function of the Korean elderly who live not only in Korea but also in other countries where only English-written tests of cognitive function are available.

ACKNOWLEDGEMENT

This study was conducted, in part, with the aid of a Keimyung University Bisa Research Grant-93. The authors would like to thank Norman L. Foster, MD, Department of Neurology, University of Michigan Medical Center, Ann Arbor, and Michigan Alzheimer's Disease Research Center for his meticulous review of the manuscript.

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