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Clinical validity of the Chinese version of Mattis Dementia Rating Scale in differentiating dementia of Alzheimer's type in Hong Kong

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Abstract

The present study aimed to examine the clinical validity and applicability of the Chinese version of Mattis Dementia Rating Scale (CDRS) for elderly Chinese individuals. The scale was found to have good reliability with internal consistency ranging from 0.7 to 0.9. Its significant correlation with the Chinese version of Mini-Mental State Examination (CMMSE) suggested satisfactory construct validity of the scale. The discriminant validity of the CDRS in differentiating Alzheimer's disease (AD) patients and Normal Control (NC) elderly was also supported by the Receiver Operating Characteristics (ROC) analysis. Several cut-off points were presented for different clinical or research applications, and formulas to adjust for the age and educational level of the CDRS total score were provided. The Initiation/Perseveration and Memory subscales were suggested to be an abbreviated version of the CDRS for a quick screening. The present results also showed the association between the impairment of the CDRS performance and the progress of the AD. (*JINS*, 2003, *9*, 45–55.)

Keywords: Neuropsychology, Cognition, Geriatric

INTRODUCTION

Mental status examinations are assessment tools developed for documenting the presence and severity of cognitive impairment, tracking the progression of dementia over time, and assessing the effects of potential therapeutic agents on cognitive functioning in the demented patients (Salmon et al., 1990). The Mini-Mental State Examination (MMSE: Folstein et al., 1975), Blessed-Roth Information-Memory-Concentration Test (IMCT: Blessed et al., 1968) and the Mattis Dementia Rating Scale (DRS: Mattis, 1976, 1988) are examples of standardized mental status examinations. Similar to many other cognitive assessment tools, the mental status examinations are mainly developed in the United States and other western countries. Cross-cultural comparison of performances in the instruments is often needed before generalizing and adapting them to people with different cultures, such as Spanish (Jacobs et al., 1997) and Japanese (Fuld et al., 1988).

In a study on dementia done in Shanghai, two mental status examinations, the MMSE and IMCT, were being translated and applied as screening tools and for assessing the cognitive impairment of elderly Chinese individuals (Hill et al., 1993; Jin et al., 1989; Katzman et al., 1988; Salmon et al., 1989a, 1995). Despite the cultural differences noted in both IMCT and MMSE (Jin et al., 1989; Katzman et al., 1988), the results suggested that both the Chinese MMSE and IMCT were effective in detecting cognitive impairment for the elderly population in Shanghai (Salmon et al., 1995). Similar findings were demonstrated in Hong Kong (Chiu et al., 1994) in which the Chinese version of MMSE (CMMSE) had an internal consistency of .86 and a test-retest reliability of .78 to discriminate normal and demented elderly. The sensitivity and specificity, with a score of 19 as the cut-off point, were 97.5% and 97.3%, respectively (Chiu et al., 1994). These findings supported the use of CMMSE as a reliable and valid instrument to assess cognitive impairment of elderly Chinese individuals in different cohorts.

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Though the IMCT and MMSE are shown to be useful in screening for cognitive impairment in elderly Chinese individuals, the brevity of the tests limits their ability in providing detailed assessment of different cognitive abilities. In addition, it has shown that the MMSE and IMCT are not particularly sensitive to detect cognitive impairment of patients in the early stage of the disease and in the very severely demented patients who generally suffer from the floor effects (Salmon et al., 1990). Therefore, the Mattis Dementia Rating Scale (DRS), which samples a comprehensive range of cognitive functioning, may be considered as an alternative to these two scales to detect and characterize cognitive impairment (Salmon et al., 1990; Shay et al., 1991). The DRS is one of the standardized mental status examinations that is widely used in the United States (Lucas et al., 1998; Salmon et al., 1990; Woodard et al., 1996). The test is found to have impressive reliability, with a test-retest reliability of .97 (Mattis, 1988), split-half reliability of .90 (Gardner et al., 1981) and internal consistency ranging from .75 to .95 (Vitaliano et al., 1984). Studies also indicated that the DRS had adequate content validity (Smith et al., 1994; Vitaliano et al., 1984), convergent validity (Vitaliano et al., 1984), discriminant validity (Green et al., 1995; Hofer et al., 1996), and predictive utility (Hochberg et al., 1989; Smith et al., 1994; Troster et al., 1994).

Besides providing a global measure of various cognitive domains, the total DRS score is found to be a clinically valid measure for staging the impairment of demented patients (Salmon et al., 1990; Shay et al., 1991). The pattern of scores in the DRS is shown to be able to differentiate controls from mildly demented patients and distinguish mildly from moderately demented Alzheimer's disease (AD) patients (Hochberg et al., 1989). In addition, the pattern of the DRS scores can also show the qualitative difference in the cognitive profiles of different types of dementia (Connor et al., 1998; Paolo et al., 1995; Paulsen et al., 1995; Salmon et al., 1989b). For instance, the DRS is found to be useful in differentiating AD patients from patients with Parkinson's disease (Paolo et al., 1995), Huntington's disease (Paulsen et al., 1995; Salmon et al., 1989b), Lewy Body Variant of AD (Connor et al., 1998), and Progressive supranuclear palsy (Rosser & Hodges, 1994).

A number of sociodemographic factors, such as age and education, are found to have significant impact on the DRS performance (Chan et al., 2001; Freidl et al., 1996, 1997; Lucas et al., 1999; Paolo et al., 1995). In view of these influences, several studies presenting normative data for the DRS have developed scaled scores for the DRS total and subscale scores that are adjusted for the demographic variables. For instance, in the studies by Lucas et al. (1998), Schmidt et al. (1994), and Marcopulos et al. (1997), normative data for the elderly with specific age and education level are presented. In some other studies, regression analysis is employed to derive equations to adjust for the effects of age and education on the DRS scores (Lucas et al., 1998; Monsch et al., 1995). The use of age- and education-adjusted norms are found to increase the discriminatory power of the assessment tool, so as to avoid over-diagnosis and lower the expenses on unnecessary treatment and placement services (Gorp et al., 1999; Kittner et al., 1986; Marcopulos et al., 1997; Schmidt et al., 1994; Vanderploeg et al., 1997).

The usefulness and applicability of the scale in Chinese population are limited by the lack of appropriate cohort study (Chan et al., 2001). To adapt and apply the DRS to elderly Chinese individuals, the current study was performed to examine the clinical utility of a Chinese version of the DRS (CDRS) by using a sample of Chinese-speaking normal elderly and patients with a presumptive diagnosis of AD. AD is a leading cause of dementia among elderly individuals both in western countries as well as Hong Kong society (Chiu et al., 1998; Liu et al., 1998). The present study examined the psychometric properties of the CDRS, including the internal consistency, construct and discriminant validity. In view of the effects of age and education on the DRS score, the present study also aimed to investigate an adequate adjustment of the cutoff point on the CDRS, which was significant during assessing the cognitive abilities of elderly individuals and detecting dementia in a Chinese population. Moreover, the CDRS subscale profiles (i.e., the characteristics in the patterns of cognitive performance) of the AD patients classified according to the severity of their impairment were also studied.

METHODS

Research Participants

There were 83 elderly Chinese individuals (14 men, 69 women) who participated in the study as normal control (NC). They were volunteers recruited from various community recreational centers for elderly individuals located in various districts in Hong Kong. All reported no history of cognitive impairment, substance abuse, neurological or psychiatric disorder, or head injury. All elderly individuals were living and functioning independently in the community and were able to travel to the recreational center and participate in its activities without assistance. They were permanent residents of Hong Kong. To reduce the probability that the normal elderly individuals might consist of individuals in the early-stage of dementia, the elderly individuals who obtained a score below 19 on the CMMSE (a suggested cut-off score) would be examined by a psychiatrist, who was one of the co-investigators in this project, for a detailed physical and neurological examinations to rule out the possibility of dementia.

Forty AD patients (11 men, 29 women) were voluntarily recruited from the Prince of Wales Hospital and Shatin Hospital. They either received in-patient service or attended outpatient clinic in the hospital. The diagnosis of AD was made by the senior psychiatrists of the Prince of Wales Hospital, based on the diagnostic criteria in the Diagnostic and Statistical Manual of Mental Disorders–Fourth Edition

(DSM-IV; American Psychiatric Association, 1994). To rule out alternative etiologies of dementia, all patients received medical (e.g., blood tests, serum tests, urinalysis, routine electrocardiogram, and electroencephalogram) and comprehensive neurological examinations. The Global Deterioration Scale (GDS) and Functional Assessment Staging Dementia (FAST) were routinely conducted to determine the level of dementia for each patient.

The age, years of education as well as the score of the CMMSE and the CDRS total score of the two groups were shown in Table 1.

The education level varied greatly in both of the samples. Whereas the NC participants had 4 elderly individuals with tertiary level (more than 13 years of education), 16 individuals with secondary level (7–12 years of education), 36 with elementary level (1–6 years of education), and 27 with no formal education, the AD sample included 5 elderly individuals with tertiary level, 3 with secondary level, 12 with elementary level, and 15 with no formal education. Due to the civil wars in the 1990s, most of the elderly Chinese individuals do not receive much education and many are illiterate. According to some published data (Chan et al., 2001, Hill et al., 1992) and the present findings, the average years of education for the elderly Chinese individuals is about 5 years, which is significantly less than that of the western counterparts. The mean years of education for the NC participants and the AD participants had no significant difference ($t(121) = -.137$, $p > .05$). Although the mean age of the NC participants and the AD patients was significantly different ($t(121) = -3.31$, $p < .05$), the mean difference was only 4 years. The two groups of participants had significant difference between their performance on both the CMMSE ($t(121) = 12.35$, $p < .01$) and the CDRS total score ($t(121) = 10.67$, $p < .01$).

Materials

Chinese version of the Mattis Dementia Rating Scale (CDRS)

The CDRS consists of 36 tasks, which tap a range of cognitive competence. There are five subscales: Attention, Initiation/Perseveration, Construction, Conceptualization, and Memory, providing information on specific abilities. The maximum possible scores for the Attention, Initiation/Perseveration, Construction, Conceptualization, and Memory subscales are 37, 37, 6, 39, and 25, respectively.

The CDRS was developed by directly translating most of the scales' items from English. A second translator reviewed the initial direct translation and discrepancies were discussed and approved by a third translator. Modifications necessary to culturally adapt the DRS were suggested by a bilingual neuropsychologist, who was very familiar with the test and with psychometric test development. Changes were reviewed by the translation team for linguistic accuracy. Finally, pilot data demonstrating the effectiveness of the translation and modifications were obtained from five undergraduate students.

Most of the test items could be directly translated, some items, however, required adaptation. Specifically, the letter "A" was substituted by "7" in the counting task of the Attention subscale because most of the elderly individuals in Hong Kong are not familiar with the English alphabet. There was also a change in the wording of the "Differences" part in the Conceptualization subscale. Due to the difference between the pronunciation of Cantonese and English, the word "cat" was changed to "face" and "train" was changed to "ship." For the "Sentence initiation" part of the same subscale, in view of the generally less education level of elderly individuals in the Chinese population, the subjects were requested to make up any complete sentence, instead of a sentence with the words "man" and "car." Moreover, in the Memory subscale, the questions in the "Orientation" part were changed to suit the societal background in Hong Kong. For example, the participants were asked to recall the name of the present chief executive of the Hong Kong Special Administrative Region, instead of president of the United States. A recent study to compare the performance of elderly Chinese individuals on the CDRS with that of elderly American individuals on the English version of the DRS suggested that the Chinese version is comparable with that of the English one (Chan et al., 2001).

The Cantonese version of Mini-Mental State Examination (CMMSE)

The Cantonese version of Mini-Mental State Examination (CMMSE) that is translated and adapted by Chiu et al. (1994)

Table 1. Means and standard deviations of age, years of education, scores in the Chinese version of Mini Mental Status Examination and Dementia Rating Scales for patients with Alzheimer's disease (AD) and normal control (NC)

	AD ($N = 40$)		NC ($N = 83$)	
	Mean	*SD*	Mean	*SD*
Age	76.30	7.26	72.07	6.31
Education	4.10	5.32	3.98	4.38
Mini Mental Status Examination score	16.63	6.35	26.57	2.57
Dementia Rating Scale total score	88.88	29.42	127.73	10.82

was administered to all the participants. It is a brief screening test consisting of a variety of items to assess orientation to time and place, attention/concentration, language, constructional ability, immediate and delayed recall. The maximum total score is 30.

Global Deterioration Scale (GDS) and Functional Assessment Staging of Dementia (FAST)

Among the AD patients in the present sample, the severity level of dementia of 32 patients (10 males and 22 females) was assessed with the Global Deterioration Scale (GDS: Reisberg et al., 1988) or the Functional Assessment Staging of Dementia (FAST: Reisberg, 1988). The GDS contains seven stages for assessing cognitive and functional abilities in normal aging, age-associated memory impairment, and primary degenerative dementia. In the FAST, stages 6 and 7 of the GDS are divided into substages on the basis of the patients' ability to perform activities of daily living and other basic functions within these stages. The 16 stages of the FAST are enumerated so as to be concordant with the corresponding stages in the GDS and are helpful in assessing residual cognitive capacities in those who suffer from severe dementia (Cohen-Mansfield et al., 1996).

Procedures

In order to ensure proper test administration, each participant was tested individually in a quiet room by a trained examiner who was blind to the purpose of the examination. The assessment took place in the community recreational center for the NC elderly individuals and in the hospital for the AD participants. The CDRS was administered following the procedures of Mattis (1988), except that all the items were administered. Written informed consent was obtained from all the participants prior to the test session or from the caregivers of the patients. Since the tests administered in the present study were paper and pencil tasks that did not involve injection of or exposure to hazardous material, resulting in any harm to the body, consents from the caretakers for those demented patients was considered to be adequate and sufficient. Given that there were some subjects with no formal education, the subjects' abilities to read Arabic number and the words in the memory subscale were examined. All subjects knew the number "7" which is used in the Attention subtest. For the illiterate subjects who could not read the words in the Memory subtests, their scores on the Memory subscales were prorated with the other subtests in the domain. All subjects were able to comprehend the testing instructions and to follow the procedure.

RESULTS

Statistical Analyses

The discriminative capability of the Chinese version of the DRS was examined by the receiver operating characteristic (ROC) analysis. Subjects' performances in different tests were assessed and compared along their full range of cutoff points (Jagger & Clarke, 1992; Ritchie & Fuhrer, 1992; Swets et al., 1979), and the measure of the area under the ROC curve (AUC) is a quantitative indicator of the information content of a test. An AUC probability of 0.50 indicates that a test lacks information content (i.e., failing to discriminate the patients from the normal controls), and its ROC curve lies on the line of no information. A perfect test with 100% discrimination between the two groups has an AUC probability of 1.00 and its ROC curve follows the left and upper boundary of the graph (Murphy et al., 1987). By comparing the AUCs, the overall discriminability of different tests can be compared (Ritchie & Fuhrer, 1992).

Reliability and Validity

The internal consistency of the Chinese version of the DRS was measured by using the Cronbach's alpha. The scale provides a measure of global cognitive functioning and the items are considered to be reliable in measuring this general characteristic if the scale is internally consistent (Kaplan & Saccuzzo, 1993). The results showed that the alpha values ranged from 0.7 to 0.9 (AD = 0.909, NC = 0.701, Overall = 0.893), indicating good reliability for the CDRS on both AD and NC groups.

To assess the validity of the CDRS, Pearson's correlation coefficients between the CMMSE and the CDRS scores were computed and shown in Table 2. The CMMSE was chosen to test the construct validity given that it is the only validated test for dementia in Hong Kong. All the CDRS scores were significantly correlated with the CMMSE score, providing evidence for supporting the construct validity of the CDRS as an assessment tool of cognitive functioning for elderly individuals in Hong Kong.

Relationship and Adjustment with Age and Level of Education

To understand the effects of age and education level on participants' performance, multiple regression analyses of the CDRS total and subscale scores onto age and education were

Table 2. Pearson's Correlation Coefficients between the CMMSE and the CDRS scores

	AD ($N = 40$)	NC ($N = 83$)	Overall ($N = 123$)
CDRS Total	0.711**	0.615**	0.848**
Attention	0.574**	0.363**	0.594**
Initiation/Perseveration	0.590**	0.459**	0.802**
Construction	0.578**	0.442**	0.623**
Conceptualization	0.598**	0.441**	0.697**
Memory	0.727**	0.514**	0.859**

Note. $^{*}p < .05$, $^{**}p < .01$

done for the NC participants. Except the Construction subscale, the total and other subscale scores were significantly affected by the educational level and/or age of the participants. The results suggested that the older and less educated elderly individuals generally tended to obtain lower scores in the CDRS than the younger and more educated participants.

The significant effects of the two variables on the CDRS scores justified the adjustment for the age and level of education of the scores. The subscales and total scores were adjusted if they (i.e., age and education level) were correlated with the CDRS scores at or below a *p*-value of .05. Considering the residual scores of the regression lines as the adjusted scores, the raw scores were adjusted by adding the product of the participants' demographic data (i.e., level of education and/or age) and the coefficients of the respective variables in the regression lines. As a result, the raw CDRS scores were transformed to age- and education-adjusted scores with the following five equations:

$$\text{Adjusted CDRS} - \text{total score} = \text{raw CDRS} - \text{total score} + 0.421\,(\text{age}) - 1.091(\text{education}) \quad (1)$$

$$\text{Adjusted Attention score} = \text{raw Attention score} - 0.178\,(\text{education}) \quad (2)$$

$$\text{Adjusted Initiation/Perseveration score} = \text{raw Initiation/Perseveration score} + 0.191\,(\text{age}) \quad (3)$$

$$\text{Adjusted Conceptualization score} = \text{raw Conceptualization score} - 0.5\,(\text{education}) \quad (4)$$

$$\text{Adjusted Memory score} = \text{raw Memory score} + 0.137\,(\text{age}) - 0.171\,(\text{education}) \quad (5)$$

Overall Test Performance and Optimal Cutoff Points

Results of the ROC analyses for both the non-adjusted and adjusted CDRS scores, with the AUCs and standard errors for the CDRS subscales as well as the total CDRS scores, were reported on Table 3. None of the CDRS subscales or total scores (for both non-adjusted and adjusted) included the value 0.5 within their 95% confidence intervals, which suggested that the discriminating abilities of the CDRS subscale and total scores were statistically significant.

Given that all the CDRS scores provided significant information in the discrimination of the two groups of elderly individuals, the effects of adjustment for age and level of education on their discriminative abilities were investigated. By calculating the z-ratio to compare the AUCs, it was found that only the adjustment for the CDRS total score gave significant increase in the discriminating power. ROC curves for both the non-adjusted and adjusted CDRS total scores were presented on Figure 1a. The ROC curve of the adjusted CDRS total score was noted to be closer to the upper left boundary of the graph. No significant difference, however, was found between the AUCs, that is, discriminative capabilities, of the non-adjusted and adjusted scores for the five CDRS subscales.

To further assess the test performance of the CDRS, its ability in discriminating the two groups of elderly individuals was compared with that of the CMMSE. No significant difference was found when the AUC of the CMMSE (AUC = 0.918 ± 0.03) was compared with that of the CDRS ($z = .34$, $p > .05$) and the adjusted CDRS total scores ($z = 1.56$, $p > .05$). The result suggested that the total score of the CDRS had comparable discriminative power with the CMMSE in detecting AD patients of the local population. The sensitivity and specificity for various cutoff points of the adjusted total scores on the CDRS and non-adjusted total and subscales scores were presented on Table 4. In the

Table 3. Results of Receiver Operating Characteristics (ROC) analysis and Comparison for both the non-adjusted and adjusted CDRS scores, with Standard Error (S.E.) and 95% Confidence Interval (C.I.) for Area Under ROC Curve (AUC)

	Non-adjusted scores AUC ±SE (95% C.I.)	Adjusted scores AUC ±SE (95% C.I.)	Comparisons of AUC (*z* scores)
CDRS total	0.927 ± 0.026 (0.876 to 0.977)	0.959 ± 0.015 (0.929 to 0.989)	2.04*
Attention	0.651 ± 0.052 (0.549 to 0.752)	0.651 ± 0.055 (0.543 to 0.759)	0
Initiation/Perseveration	0.944 ± 0.024 (0.898 to 0.991)	0.935 ± 0.028 (0.881 to 0.990)	−0.61
Construction	0.695 ± 0.054 (0.588 to 0.801)	—	—
Conceptualization	0.782 ± 0.048 (0.687 to 0.876)	0.818 ± 0.041 (0.738 to 0.899)	1.52
Memory	0.918 ± 0.032 (0.855 to 0.981)	0.923 ± 0.034 (0.856 to 0.989)	0.27

Note. $*p < .05$, $** p < .01$

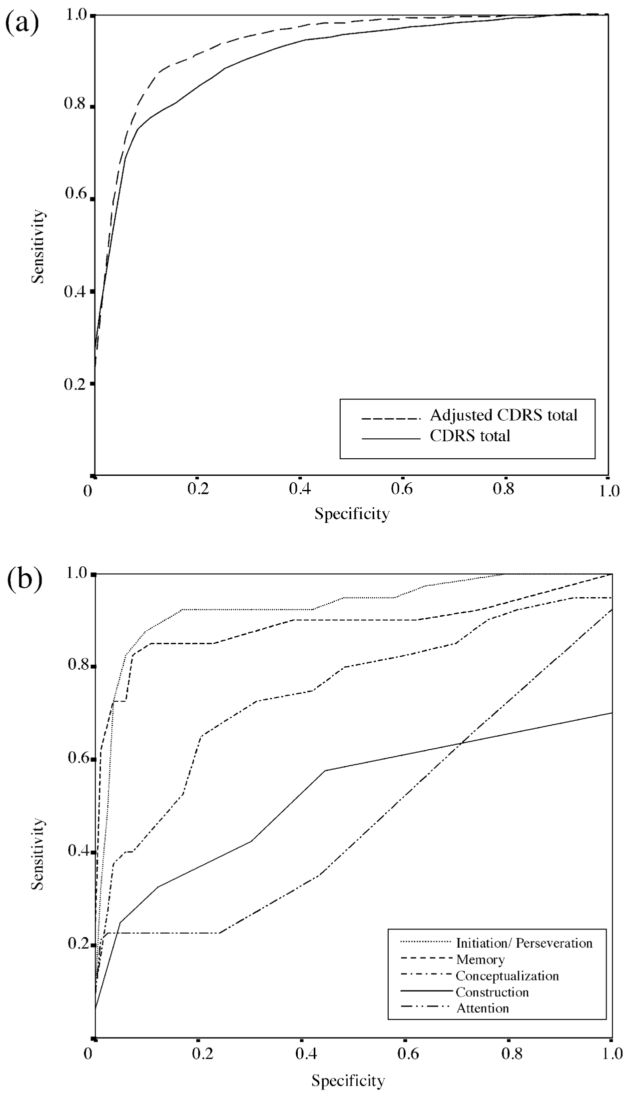

Fig. 1. (a) Receiver Operating Characteristics (ROC) curves of both the non-adjusted and adjusted CDRS total scores. (b) Receiver Operating Characteristics curves for the non-adjusted scores of the five subscales of the Chinese version of the DRS.

Table 4. Sensitivity and specificity at the cut-off points for the CDRS subscales and total scores

	Cut-off scores	Sensitivity (%)/ Specificity (%)
Adjusted CDRS Total	137	77.5%/94.0%
	140	82.5%/92.7%
	*141**	*85.0%/91.6%*
	144	87.5%/88.0%
	145	90.0%/86.8%
CDRS Total	109	70.0%/94.0%
(total = 144)	111	77.5%/92.8%
	*112**	*80.0%/91.6%*
	116	82.5%/84.3%
	121	87.5%/74.7%
Attention	27	20.0%/100 %
(total = 37)	*29**	*22.5%/98.8%*
	35	35.0%/56.6%
Initiation/Perseveration	24	75.0%/96.39%
(total = 37)	*26**	*85.0%/94.0%*
	28	92.5%/83.1%
Construction	2	25.0%/95.0%
(total = 6)	*3**	*33.0%/88.0%*
	4	43.0%/70.0%
Conceptualization	26	50.0%/88.0%
(total = 39)	*28/29**	*65.0%/79.5%*
	31	72.5%/68.7%
Memory	16	72.5%/96.4%
(total = 25)	*18**	*82.5%/92.7%*
	20	85.0%/77.1%

*Optimal cut-off scores

present study, the optimal cutoff scores were chosen such that the sum of the two measures reached a maximum. Specifically, the recommended cutoff scores for the total CDRS and adjusted total CDRS scores were 141 and 112, respectively.

Test Performance of the CDRS Subscales

Among the five CDRS subscales, differences in the discriminating ability were noted. ROC curves for the non-adjusted scores of the five subscales were shown on Figure 1b. Both qualitative and quantitative evaluation of the ROC curves suggested that Memory, Conceptualization and Initiation/Perseveration subscales performed relatively better than the other subscales in discriminating the two groups, since their curves were closer to the left and upper boundary of the graph and they had larger AUC values (> 0.7).

In order to further assess and compare the contribution of the five CDRS subscales in discriminating the AD patients and NC groups, logistic regression analysis was carried out. The result of the analysis on the non-adjusted scores revealed that only the scores of Initiation/Perseveration (*Wald* = 12.28, $p < .01$) and Memory (*Wald* = 11.72, $p < .01$) subscales were significant predictors in the differentiation between the AD and NC participants (model $\chi^2 = 106.9$, $p < .01$; overall correct classification rate = 92.68%).

Given that the Initiation/Perseveration and Memory scores contributed most in discriminating the AD patients from NC elderly individuals and the adjusted scores gave rise to an increase in classification rate, the adjusted scores for the two subscales were used in further logistic regression analysis. The resulting model had a χ^2 value of 104.1 ($p < .01$) and an overall correct classification rate of 91.9%. Since the adjusted scores were obtained by multiplying the coefficients of age and level of education to the two factors in the regression lines, after substituting the raw subscale scores back into the final regression equation, the following discriminative formula could be derived: $x = 19.91 - 0.25$ (Initiation/Perseveration) $- 0.37$ (Memory) $- 0.097$ (age) $+ 0.063$ (education). According to the definition of logit equations, when the value of x > 0, the probability of having disease was greater than 0.5. When the value of x < 0, the probability of having disease was less than 0.5. In our sample, there were 79 AD patients (out of 83, i.e., 95.18%) obtained a value of x above zero while 33 NC (out of 40, i.e., 82.5%) had a value of x below zero.

It was found that the severity level of the AD patients, as assessed with the GDS or FAST (Reisberg, 1986), was significantly correlated with the CDRS total score ($r = -0.474$, $p < .01$). The severity level of the AD patients was then classified into three groups according to their GDS or FAST staging. The GDS of mild ($n = 14$), moderate ($n = 15$), and severe ($n = 3$) groups were 3 to 4, 5, and 6 to 7, respectively. The CDRS total score was found to be significantly different among the three groups of AD patients ($F(2,31) = 3.976$, $p < .05$) and the CDRS total score dropped with the increase of dementia severity level. The means and standard deviations of the CDRS total score for the mild, moderate, and severe AD patients were 99.21 (*SD*: 24.35), 86.33 (*SD*: 28.7), and 50.33 (*SD*: 37.54), respectively. *Post hoc* analysis indicated that the CDRS total scores of participants with mild level of dementia were significantly different from those with mild and severe level of dementia ($t(15) = -2.90$, $p < .05$). Furthermore, the difference between the scores of the participants with moderate and severe level was marginally significant ($t(16) = -1.90$, $p < .10$). However, there was no significant difference between the CDRS total scores of the participants with mild and moderate level of dementia ($t(27) = 1.30$, $p > .10$). These results were consistent with those obtained from non-parametric analyses. The power for this comparison was calculated to be 0.26. It was estimated that 56 participants were needed in each group in order to obtain a power of 0.75.

In order to examine the difference in the CDRS pattern among the AD patients differing in severity, the Multivariate Analysis of Variance (MANOVA) and non-parametric analysis were done. The results from both analyses suggested that the differences in the performances between the groups were not statistically significant (*Wilks* $= .61$, $p > .05$). Despite the failure of reaching a statistically significant level, a general pattern of performances could be noted (Figure 2). The patient with mild or moderate level of dementia severity tended to have more subtle and selective impairments in their cognitive functioning, while the patients with severe level of dementia had obviously poorer performances for all the subscales.

DISCUSSION

The present results demonstrated the clinical applicability of the Chinese version of the DRS, such that it was a reliable and valid instrument for the screening and assessment of cognitive functions for elderly Chinese individuals. The optimal cut-off points recommended for all the scores of the CDRS in the present study were lower than those suggested by Mattis (1988). This may partly be explained by the difference in selection criteria of cut-off scores between the two studies. However, such difference is also largely accounted for by the generally poorer CDRS performance for the elderly Chinese individuals in our population. The present finding is consistent with that observed in Chan et al.'s study (2001), in which applying the scores recommended by Mattis (1988) will result in a considerable drop of the sensitivity of the test. The result suggested that clinicians should be cautious when applying norms and cutoff scores that are developed in the western population, which limits the discriminative power of the assessment tool. It also indicates the need of local normative data for a more adequate assessment and diagnosis when applying the translated tests in the local population.

The findings of significant effects of age and level of education on the CDRS performance are consistent with studies in other western countries (e.g., Caramelli et al., 1997; Katzman, 1993; Lucas et al., 1998; Marcopulos et al., 1997; Salmon et al., 1995; Vangel & Lichtenberg, 1995), as well as the study in Hong Kong (Chan et al., 2001). In view of such influences, regression is employed to adjust the effects of these two variables on the CDRS scores. Given that various studies suggest that adjustment with demographic variables can improve the discriminatory power of the assessment and diagnostic tools (Gorp et al., 1999; Kittner et al., 1986; Marcopulos et al., 1997; Schmidt et al., 1994; Vanderploeg et al., 1997), the effect of the adjustment for the scores of the CDRS on their discriminative capabilities was investigated with the ROC analysis. The result of comparison between the AUC values of the non-adjusted and adjusted scores indicated that the adjustment for the CDRS total score could significantly improve the discriminatory power. Moreover, it was noted that at cut-off points with the same level of sensitivity (or specificity), the corresponding specificity (or sensitivity) was greater for the adjusted than the non-adjusted CDRS total scores. Therefore, the adjustment for the CDRS total score is suggested to take the effects of age and level of education into account while interpreting the CDRS performances or when higher correct classification rate is desired.

Another major implication of the present study is that it suggested an abbreviated form for the CDRS. Within the five CDRS subscales, it was found that both the Initiation/Perseveration and Memory subscales contributed the most significance in the differentiation between the AD patients and the NC elderly individuals. These results may be attributed to the findings that elderly Chinese individuals performed poorer than their American counterparts in the Memory and Initiation subscales (Chan et al., 2001). Consistently, Monsch et al. (1995) also reported similar findings on the particular contribution of Memory and Initiation/Perseveration subscales, which they concluded as the best discriminative indexes for an abbreviated version. By applying the logistic regression analysis together with the equations used for adjustment of age and level of education, a discriminative formula that took the effects of the two variables into account could be derived. In the present study,

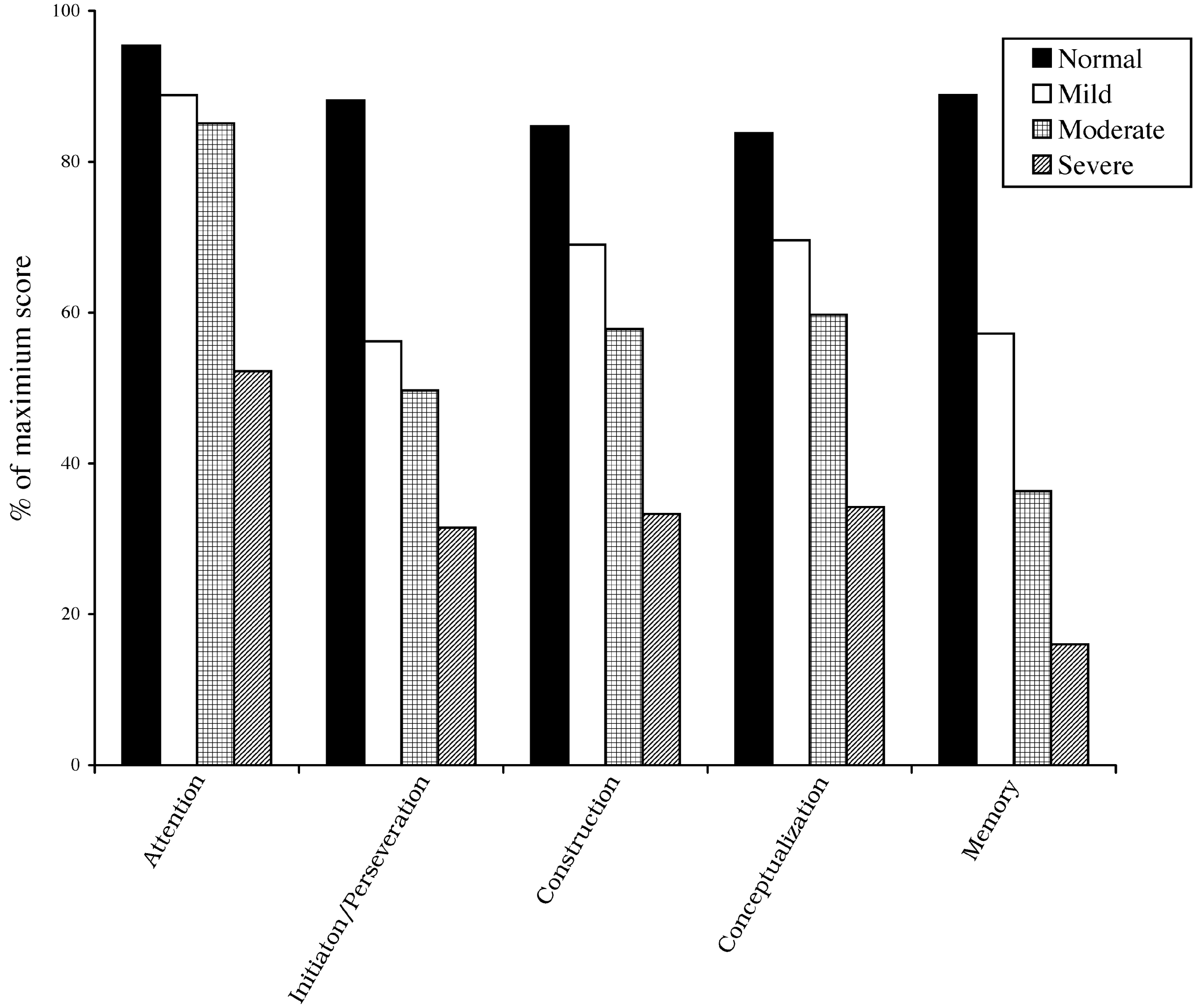

Fig. 2. Performance on the five subscales of the Chinese version of the DRS for the normal control (NC) and Alzheimer's disease (AD) patients with mild, moderate and severe levels of dementia.

the formula successfully helped in identifying 95.18% of the AD patients while it was able to correctly classify 82.5% of the NC elderly individuals. The abbreviated version appears to be a good alternative to the full version of CDRS as a screening tool, especially when the time for assessment is limited. However, with the use of shortened form, the comprehensive data on different aspects of cognitive functioning of the subjects will be lost.

Despite the failure to reach a statistically significant level in comparing the CDRS performance among different levels of dementia, a general pattern of the CDRS performance can be noted. The observed patterns are consistent with the cognitive characteristics and the pathological changes of the AD patients. First, the CDRS total score drops with an increase in the severity level of dementia, indicating a global deterioration of cognitive functions along with the progress of the disease. Moreover, the patients with severe level of dementia have obviously poorer performances in all the subscales, indicating their significant deficits in all the cognitive domains. The pattern is consistent with the overall course of the disease that runs consistently downhill to the extent that all functions are lost (Lezak, 1995). In spite of this, the deficit of cognitive functions for patients with mild or moderate level of severity appears to be more subtle and selective. Among the five cognitive domains, attention is minimally affected in the initial stage of the dementia, which is consistent with the past findings that AD patients may not display attentional deficits, particularly in the early stage (Martin, 1990: quoted by Lezak, 1995) and the alertness often remains unaffected for mildly to moderately demented patients (Nebes & Brady, 1993: quoted by Lezak, 1995). In addition, consistent with the notion that memory impairment is the most obvious early symptoms and prominent aspects of the disease (Banich, 1997; Lezak, 1995), the present sample demonstrated considerable deterioration of memory even in the early stage of the disease and the memory functioning appeared to deteriorate at the fastest rate with obvious differences noted along with the increase in the severity level of dementia. The deterioration in the verbal functions (e.g., the word finding ability) as well as the perseveration and intrusion problems are noted to be common among the AD patients (Cahn et al., 1997; Jacobs et al., 1995; Lezak, 1995). These deficits are observed in the CDRS performance in which even the patients with mild level of dementia demonstrate obvious impairment in the Initiation/Perseveration subscales.

The results of the present study support the clinical validity and applicability of the CDRS for the Chinese population in Hong Kong. Although the present study examined Cantonese-speakers, this version of CDRS can also be applied to Chinese individuals who speak other dialects, given that all the instructions are written in Chinese and can be read with Mandarin, Cantonese or other dialects. In addition, most of the items in the DRS, such as drawing figures, imitating gestures, generating items, are relatively insensitive to culture difference and can probably be applied to Chinese individuals living in different parts of the world. However, the item asking "Who is the president of the United States" in the US version of the DRS, and "Who is the chief executive of the Hong Kong Special Administration Region" may be the most culturally sensitive question. It is thus recommended that this item be changed into a more culturally appropriate question or prorate the subscale with other items. While a recent study showed that the CDRS has a similar sensitivity and specificity as the English version (Chan et al., 2001), the level of education is a significant factor contributing the different performance between the two groups of subjects. Thus, further studies to establish normative data of population in different parts of China are recommended to increase the sensitivity and validity of the test given that the level of education of the elderly are very different in the cities (e.g., Shanghai) and the countryside (e.g., Hunan).

The scale is found to have good reliability, as well as satisfactory construct and discriminant validity. The influence of age and level of education on the CDRS performance is found to be significant, which indicates the need to take into account the effects of these two variables when interpreting the CDRS scores. Adjustment of the CDRS total score for age and educational level are recommended. Moreover, an abbreviated version of the CDRS with a discriminative formula is suggested, which is helpful for quick screening with adequate classification rate. The present results also show the association between the impairment of the CDRS subscales performance and the progress of the AD. However, given the small sample size and difference in terms of age of the patients and normal subjects, it should be reminded that this study is considered as a preliminary study, instead of a well-established one. Therefore, further studies with a larger pool of elderly individuals and patients with various types of dementia are needed for cross-validation. The applicability of the discriminative formula, the possible influence of gender and education on the discriminative ability and examination of the clinical validity of the CDRS in the staging and differentiation of dementia should also be further studied.

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