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The Dementia Severity Rating Scale Predicts Clinical Dementia Rating Sum of Boxes Scores

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Keywords

Dementia Severity Rating Scale; Clinical Dementia Rating Scale Sum of Boxes; Alzheimer's disease; Mild Cognitive Impairment

1. Introduction

Functional assessment is an indispensable component of dementia evaluations. Functional evaluations are necessary to differentiate normal aging from mild cognitive impairment (MCI) and MCI from Alzheimer's disease (AD), and to track AD progression. While cognitive test performance is an equally important part of this process, functional measures have higher ecological validity, may be better at determining change from previous, higher levels of ability, and are less sensitive to the effects of education and premorbid intelligence [1].

The Clinical Dementia Rating Scale (CDR), a commonly used dementia staging instrument, employs a semi-structured interview format to collect detailed information from an informant regarding the patient's ability to function in various domains. The CDR offers a global characterization of everyday functions that may be affected by neurodegenerative disease [2]. The value of global characterizations has been questioned, however, especially during the assessment of MCI[3]. The wider range of scores provided by the CDR sum of

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boxes (CDR-SB) score may enable a more refined analysis of subtle changes associated with very mild disease or between stages in later AD [4, 5],

The CDR is the most well known, well studied dementia staging instrument [6]. The scale, however, is not without limitations. Primary concerns include a lengthy rater certification process, approximately 30-minute administration time, and clinical judgment required during administration and scoring [2]. The Dementia Severity Rating Scale (DSRS) is a brief informant-rated, multiple-choice questionnaire made up of 12-items that measure functional abilities and parallel CDR content [7]. The DSRS requires minimal staff training to administer, takes five minutes to complete, and can be completed via mail, Internet, or phone. Similar to the CDR-SB, the DSRS incorporates a broad range of scores, making this instrument useful for quantifying all levels of functional impairment, and permitting the detection of fine increments of change over time [8]. Reliability and validation studies have shown that the DSRS has high reliability, as well as a constant linear rate of change throughout the entire course of AD. The original version demonstrated high concurrent validity with the CDR and the Mini Mental State Examination [7, 8]. To improve its utility, however, further analysis of the association between the DSRS and the CDR is required. With this in mind, the goal of the present study was to examine the ability of the DSRS to predict scores on the CDR-SB.

2. Methods

A retrospective analysis was performed on data collected from 952 patients from the Penn Memory Center, the clinical core of the University of Pennsylvania's Alzheimer's Disease Center. Subjects (N = 952) had diagnoses of probable or possible AD (64%, n = 612), non-AD Dementia (10%, n = 97), MCI (14%, n = 133), or were healthy older adults (12%, n = 110). Participants were 61% female and predominantly non-Hispanic whites (80%). Demographic and clinical variables are presented in Table 1. Participants were randomly assigned in halves to a training sample (n = 476) or a validation sample (n = 476); the clinical and demographic characteristics of each of these sub-samples were consistent with the whole study population.

On the basis of all available data, a consensus diagnosis was established using standardized clinical criteria for AD, MCI, or other neurological or psychiatric conditions presenting with cognitive impairment. As part of each evaluation, a knowledgeable informant (usually a spouse or adult child) was asked to complete the DSRS. The instrument is described in detail in the original publication [7] and is available upon request from the Penn Memory Center http://www.pennadc.org/contact. The total score is derived from the sum of scores in 12 functional areas, and ranges from zero (i.e., no impairment,) to 54, extreme impairment[8]. The CDR was administered according to established criteria [2]. The information collected during the CDR parallels that which is gathered on the DSRS and DSRS scores were available to the clinician completing the CDR.

3. Results

Linear regression analysis was performed with SAS Software (v 9.1, SAS Institute, Cary, NC) to determine the strength of association between the scales and the formula for

predicting CDR-SB. We first performed the linear regression in the training sample, using the DSRS total score to predict CDR-SB. This analysis yielded an R-squared value of 0.8, indicating that 80% of the variance in scores on the CDR-SB was explained by scores on the DSRS. The regression equation to determine a predicted CDR-SB score was *Predicted CDR-SB = -0.068 + 0.39(DSRS total score)*. Thus, the CDR-SB score increases at a linear rate of 0.39 with each 1 point increase in the DSRS score.

The regression equation from the training sample was subsequently applied in the independent validation sample to examine the robustness of the prediction equation obtained from the training sample. In the validation sample, the mean CDR-SB score = 6.28 ± 5.2 [Range = 0 - 18]. The *predicted* CDR-SB based on DSRS total scores in the same sample had a mean CDR-SB of 6.29 ± 4.6 [Range = 0 – 20.5]. The Pearson correlation between DSRS-*predicted* CDR-SB and the observed CDR-SB was $r = 0.90$.

We conducted a secondary analysis to confirm the relationship when the range was restricted to participants (n=300) with no to very mild dementia (CDR-SB of 0-2.5). Again, a strong linear relationship was observed in a training sample (n=150) that yielded an R-squared value of 0.5. In the validation sample (n=150), the mean CDR-SB score = 0.96±0.9 [Range=0–2.5] and the *predicted* CDR-SB score based on DSRS total scores had a mean of 1.02±0.7 [Range=0.3–4.5]. The Pearson correlation between the DSRS-*predicted* CDR-SB and the observed CDR-SB was $r = 0.59$.

4. Discussion

The results of the linear regressions indicate that scores on the DSRS strongly predict scores on the CDR-SB across a wide range of functional abilities. High Pearson correlations between DSRS-predicted and observed CDR-SB scores lend further support to this result and confirm that DSRS total scores can be used to predict CDR-SB scores in clinical research settings. This finding has implications for situations where a CDR-SB score is desirable but impractical due to cost or examiner or participant burden. The DSRS joins other brief instruments that predict CDR scores or functional impairment through shortened structured interview formats, providing valuable alternatives to the full CDR [9].

We also see value in using the DSRS at more frequent intervals than would be possible with the CDR during the course of clinical care or a research protocol. This has the potential to allow for smoothing of data points in order to better characterize change over time, whether it be rate of decline or stability/gain as a result of an intervention. For instance, we have used DSRS total scores of 0-11 as a screening boundary for identifying participants with no or very mild impairment. DSRS total scores in that range predict CDR-SB scores of 0 to 4.2, scores that may be interpreted as normal to very mild dementia and are consistent with CDR global scores of 0 to 0.5. Moreover, recent results from our center indicate that use of the DSRS in conjunction with cognitive testing improved diagnostic accuracy beyond that found with cognitive or functional instruments alone and that a DSRS cut score of 10 was optimal for distinguishing the transition from MCI to AD [10].

A methodological caveat of this study is that DSRS scores and questionnaires were available to our clinical staff at the time the CDR interview was conducted. As such, our DSRS and

CDR scores cannot be considered independent functional metrics. This characteristic may limit the applicability of our results to similar clinical research settings. In addition, although the instructions for the DSRS request that the person completing the form, note his or her relationship to the patient and extent of weekly contact, the flexibility of administration of the DSRS (i.e., by mail, phone, web, or in-person) also reduces clinician oversight, standardization, and thus introduces a potential bias that may reduce utility in some settings.

We contend that clinical scientists invested in accurately predicting CDR ratings consistent with MCI or AD and subsequently confirming the predicted CDR score will find our results helpful. The investigator may use the DSRS as a technique for enriching samples in larger epidemiological settings where administration of the CDR to all participants may be impractical and as a technique for smoothing functional ratings in longitudinal designs. In addition, use of both measures serves as a validity check; because the DSRS was designed to mirror the CDR, the items on each measure should elicit similar answers and, if this is not the case, a caution may be raised as to the quality of the informant and/or subject responses.

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Table 1

Clinical and demographic characteristics (M ± SD) of the full sample (N = 952).

	AD (n=612)	Non-AD Dementia (n=97)	MCI (n=133)	Controls (n=110)
Age	76.9 ± 8.3	70.1 ± 9.8	74.5 ± 8.6	75.5 ± 9.2
Sex (% female)	64%	46%	56%	65%
Race (% white)	78%	93%	82%	77%
Education	13.5 ± 3.5	13.8 ± 3.5	14.7 ± 3.2	16.4 ± 3.0
MMSE	17.4 ± 7.4	17.4 ± 9.0	26.4 ± 2.8	29.2 ± 1.3
DSRS	19.8 ± 10.5	22.9 ± 12.9	7.2 ± 5.3	1.2 ± 2.1
CDR-SB	8.1 ± 4.6	8.7 ± 5.5	1.8 ± 1.5	0.2 ± 0.4