Longitudinal Validity of a Mild Cognitive Impairment Screen: The CANS-MCI Study

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Abstract

Background: Early identification of the mild cognitive impairments that progress to AD would reduce the rate of disease progression and delay placements in nursing homes. Unfortunately, MCI often goes undetected. The CANS-MCI is a computerized screening measure designed for efficient usability in clinicians' offices to help determine the need for full diagnostic dementia evaluations.

Objective: To determine the effectiveness of CANS-MCI scoring algorithms for detecting MCI, using the criterion standards of full, longitudinal neuropsychological evaluations and diagnostic correlates in a primary care setting.

Methods: 410 elderly community-dwelling volunteers enrolled in a 3-year longitudinal NIA-funded study. Logistic regression and ROC curve analyses were run on a sub-sample of study participants who received baseline and 1-year follow-up full neuropsychological evaluations (N= 74). Follow-up analyses are presented here along with longitudinal data on 28 self-referred patients in a primary care office.

Conclusions: Based on the criterion standard categorization (normal vs. mildly impaired) on 3 factors (Memory, Executive Function, Fluency) we generated scoring algorithms using logistic regression that best fit the data for baseline and 1-year follow-up scores. We created two separate algorithms based on level of education (<= 12 yrs. and 13+ yrs.). These correctly classified 85% of participants with a high school degree or less (Chi-square = 11.74) and 80% of those with at least some college (Chi-square = 31.41). ROC curve analyses on the two educational levels revealed that cut-points lead to sensitivities/specificities of .93/.83 (<=12 yrs) and .84/.74 (13+ yrs). Areas under the curve were high (.917 for <= 12 yrs education and .888 for 13+ yrs). These findings indicate that the CANS-MCI is an effective screen for the need to perform full neuropsychological evaluations.
A clinical sample (N=73) followed with the CANS-MCI for at least one year in geriatric family medicine offices confirmed this finding with respect to diagnostic and treatment correlates. Only 28 cases were available with truly separate diagnostic determinations. Almost all patients with eventual diagnoses were detected as in need of closer examination on their first CANS-MCI test report. Multiple screenings over time are recommended for highest predictive validity.

The CANS-MCI

The Computer-Administered Neuropsychological Screen for Mild Cognitive Impairment is a self-administered instrument that measures multiple cognitive domains and has the ability to measure changes over time. Development of the CANS-MCI tests was based upon findings of previous neuropsychological research findings about the most predictive test dimensions. The CANS-MCI appeared to offer a way of enhancing perceptions of control over testing and avoiding the activation of interpersonal defenses.

Introduction

Instruments focused upon MCI measurement would provide useful screening information for decisions concerning full diagnostic evaluations for AD. Previous studies found that tests sampling different cognitive domains, when combined, significantly enhance the predictive validity of a test battery because of variations in the initial cognitive deficits associated with AD. Brief automated neuropsychological tests may be the preliminary step most suited to determining the need for evaluations, which require costly neuropsychological or neuroimaging techniques.

The CANS-MCI is self-administered in controlled settings and provides screening information about the need for full diagnostic evaluations for dementia. The internal consistency, test-retest reliability, self-administration usability, and concurrent neuropsychological test validity were previously established. Exploratory and confirmatory factor analyses previously demonstrated 3 clear factors: Memory, Executive Functioning and Fluency. The present study examines the effectiveness of factor-based 1-year follow-up scoring algorithms as predictors of full neuropsychological evaluation categorization and clinical diagnoses.

Subjects

A total of 410 community-dwelling elderly people were recruited through senior centers & retirement homes in Washington State for a 3-year longitudinal NIA-funded study. 74 of these study participants received full neuropsychological evaluations and returned for 1-year follow-up evaluations. 73 community-dwelling elderly patients self-referred to a geriatric primary care physician in New Jersey were followed for a minimum of 1 year. The usability of the CANS-MCI by elderly subjects was previously confirmed using the following criteria: test-retest reliability, acceptability, ease of administration, and completion of all tests entirely by self-administration.

Statistical Analyses

To determine the ability of the CANS-MCI to accurately screen for mild cognitive impairment (MCI) we compared scores on the CANS-MCI with the results of an independent professional neuropsychological examination. We used logistic regression models to predict the dichotomous outcomes of MCI vs. normal cognitive functioning (as determined by the neuropsychological exam). Because education can affect scores on measures of cognitive impairment, we separated our sample into individuals with a high school degree or less (N=20)and those with schooling beyond high school (N=54). Gender and age were included in the model. We performed receiver operating characteristic (ROC) analyses to calculate the sensitivity (the proportion of persons who have MCI that are defined as having MCI) and specificity (proportion of persons who have normal cognitive functioning that are defined as having normal functioning) of the CANS-MCI.

Few clinical cases followed for at least a year with the CANS-MCI have independent MMSE or diagnostic evaluations. However, the predictive trends for the CANS-MCI justifies inclusion in long-term studies of disease progression. A current study of concomitant full neuropsychological, imaging, and autopsy data is being undertaken.

Results

The regression model statistics for the 1-year follow-up evaluations were strong but limited by small sample size. The algorithms correctly classified 85% of participants with a high school degree or less (Chi-square = 11.7; Nagelkerke pseudo-R2 =.63) and 80% of those with at least some college (Chi-square = 31.4; Nagelkerke pseudo-R^2 =.59) indicating a good fit of the data to the model (Table 2). The CANS-MCI has good levels of sensitivity and specificity in classifying those with an education up to a high school degree (Tables 1 and 2). The optimum sensitivity and specificity for those with 13+ years of education is lower but still excellent. The ROC curve analyses for longitudinal change (Table 2) on the two educational levels revealed that cut-points lead to sensitivities/specificities of .93/.83 (<=12 yrs) and .84/.74 (13+ yrs). Areas under the curve were high (.917 for <= 12 yrs education and .888 for 13+ yrs). This indicates that progression toward Alzheimer's among MCI-categorized individuals is not certain, even among those so categorized by full neuropsychological evaluation. Of the 10 patients who acquired a diagnosis of MCI or AD from other neuropsychological or imaging tests (mean follow-up: 17 months), 9 always had a CANS-MCI probability of .6 or greater and all 10 eventually had a probability of .6 or greater. Of the 18 patients who never acquired a separate diagnosis (mean follow-up: 21 months), 16 always had a CANS-MCI probability of .5 or less and 17 eventually had a probability of .5 or less.

Table 1: Logistic Regression – FIRST Full Neuropsychological evaluation and ROC Curve Analyses

Education	χ^2	Nagelkerke R^2	Predicted Classification % Correct	Area Under the Curve	% Sensitivity	% Specificity
Less Than 13 Years	35.4	1.0	100	1.0	100	100
13 or More Years	50.3	.79	84.2	.96	100	84.8

Table 2: Logistic Regression – ONE YEAR LONGITUDINAL evaluation and ROC Curve Analyses

Education	χ^2	Nagelkerke R^2	Predicted % Correct Classification	Area Under the Curve	% Sensitivity	% Specificity
< 13 Years	11.7	.63	85.0	.917	92.9	83.3
>= 13 Years	31.4	.59	79.6	.888	83.9	73.9

Table 3: Clinical cases with separate imaging or neuropsychological diagnoses

MCI Probability (CANS-MCI)	MCI Diagnosis	NO MCI diagnosis
Consistent Warning	90 %	0 %
Consistent Normal	0 %	89 %
Eventual Warning	100 %	5 %
Eventual Normal	0 %	95 %

Conclusions

As effective treatments for AD emerge, it becomes important to identify people who have the earliest signs of the cognitive impairments most likely to become AD. These findings indicate the CANS-MCI is a valid screening measure to determine if a person needs to be assessed for cognitive impairment. The preliminary evaluation of longitudinal differences between normal and impaired cognitive ability groups, as determined by full neuropsychological evaluations, indicates a high degree of prediction by the CANS-MCI. The rigorous standard created by the use of a community sample (instead of a clinical sample) and by a difficult group discrimination (between MCI, rather than diagnosed AD, and normal) affects sensitivity.

Clinical follow-ups give strong indication that the CANS-MCI, when used longitudinally, detects all cases that eventually acquire MCI or AD diagnoses. Further investigation into longitudinal validity with large clinical samples, full neuropsychological evaluations, imaging and autopsy data is in progress.

The CANS-MCI is a computer administered and scored touch screen battery that ascertains whether more expensive evaluations for early cognitive impairment are warranted. The CANS-MCI generates graphical reports of scalable, reliable, and valid longitudinal findings so clinical decisions can be made that consider cognitive reserve capacity.

DISCLOSURE: Funded by Screen, Inc. All authors are presently or previously associated with Screen, Inc, the commercial owner and distributor of the CANS-MCI.