Journal of Gerontology: MEDICAL SCIENCES
1995, Vol. 50A, No. 2, M128–M133



# Validation of the Minimum Data Set Cognitive Performance Scale: Agreement with the Mini-Mental State Examination

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***Background.*** Almost all nursing homes in the United States are required by the 1987 Omnibus Budget Reconciliation Act to assess each resident's functional, medical, psychosocial, and cognitive status using a standard instrument known as the Minimum Data Set (MDS). We report a validation study to show that the MDS Cognitive Performance Scale (CPS), a cognitive measure generated from 5 MDS items (comatose status, decision making, short-term memory, making self understood, and eating) can be used to detect cognitive impairment as defined by the Mini-Mental State Examination (MMSE).

***Methods.*** Two hundred subjects were randomly recruited from 8 nursing home facilities in North Carolina. Two medical students administered the MMSE, while a geriatric research nurse was responsible for collecting MDS cognitive items, which included the 5 items required for generating CPS scores. Cognitive impairment was defined by MMSE scores adjusted for education. Agreement between the CPS and the MMSE in identifying cognitively impaired subjects was then evaluated.

***Results.*** The CPS showed substantial agreement with the MMSE in the identification of cognitive impairment; the sensitivity was .94 (95% confidence interval [CI]: .90, .98), the specificity was .94 (95% CI: .87, .96), and the diagnostic accuracy as measured by the area under the receiver operating characteristics (ROC) curve was .96 (95% CI: .88, 1.0).

***Conclusions.*** The MDS Cognitive Performance Scale, when performed by a trained research nurse using recommended protocols, provides a valid measure of cognitive status in nursing home residents.

CHRONIC, progressive, cognitive impairment in the form of dementia, particularly dementia of the Alzheimer's type, is a major problem in nursing homes across the United States, affecting over 50% of nursing home residents (1–5). This number is expected to increase, due to the rapid aging of the population and concomitant demand for long-term care (6–8). Consequently, assessment of resident cognitive functioning, particularly cognitive impairment, is an important consideration in the provision of care for the nursing home population. Until recently, however, nursing facilities maintained only limited information on resident functional status, including cognition (9,10), and the information available varied across facilities. This situation has now changed, due to a Congressional mandate in the Omnibus Budget Reconciliation Act of 1987 (OBRA '87) (11), which requires all Medicare and Medicaid certified nursing homes in the United States to complete a standardized assessment of each resident's functional, medical, psychosocial and cognitive status (10,12).

This standardized assessment system is known as the Resident Assessment Instrument (RAI) with its care assessment component known as the Minimum Data Set (MDS). The structure of the MDS calls for clinical professionals (e.g., nurses, social workers, therapists) to directly observe and assess resident performance over all shifts during a specified time period (12). Additional data on resident performance are obtained from the medical record and from direct-care staff. These data are then used to develop an appropriate plan of care for each resident. MDS assessments are part of the residents' permanent medical record and are required at admission, every 3 months following admission, and on any significant change in the residents' status.

The MDS provides a common terminology of resident assessment across facilities and includes 7 direct measures of cognition: short and long-term memory, recall or orientation items (season, location of room, staff names/faces, orientation to nursing home), and decision-making ability. A number of indirect measures of cognition are also included: comatose status, communication skills (making self understood, ability to understand others), 8 measures of activities of daily living (ADL) performance (bed mobility, transfer, locomotion, dressing, eating, toilet use, personal hygiene, bathing), problem behavior (wandering, verbal and physical abuse, socially inappropriate behavior), and level of continence.

Although numerous cognitive assessment instruments are available, they are generally unfeasible for use in nursing home populations due to their: (a) excessive length, (b) need

for highly skilled personnel for administration, and (c) excessive administration costs. Hence, even though skepticism has surrounded the issue of whether MDS data should be used for research purposes (13), both research and practice in nursing homes would benefit if MDS data could somehow be used to generate simple, standardized, and valid cognitive assessments. In response to this need, the MDS Cognitive Performance Scale (CPS) was recently developed (14). The CPS combines selected MDS cognitive items within a hierarchical 7-category rating scale, ranging from no cognitive impairment to very severe impairment. Modeling of the CPS was based on two standard cognitive assessment instruments — the Mini-Mental State Examination (MMSE) (15), and the Test for Severe Impairment (TSI) (16).

Once an instrument has been developed, its scientific quality is quantified through validation. Accordingly, this study evaluated the validity of the CPS against the MMSE (15), a popular clinical measure of cognitive functioning. Validation was carried out in a random sample of 200 residents recruited from 8 nursing home facilities in North Carolina. The MMSE was considered the "gold standard" for identifying cognitively impaired subjects. Presence or absence of cognitive impairment in each subject was defined by the MMSE cut point recommended by Folstein et al. (15) and adjusted for education level (17–20). Agreement between the CPS and the MMSE in classifying cognitively impaired and cognitively intact subjects was then evaluated.

## METHODS

*Subjects.* — Two hundred study subjects were randomly recruited from 8 licensed nursing home facilities in North Carolina. The 8 nursing homes represented a sample of convenience, in that each facility was within a 1-hour driving distance from Chapel Hill. Facilities that were entirely rehabilitation and Veterans Administration homes were excluded. Since the measurement of cognitive impairment as a result of dementia was the main outcome of interest, facilities with Alzheimer's Special Care Units (SCUs) were oversampled. Of the 8 study facilities, 4 had SCUs. All SCU residents were asked to participate. Non-SCU subjects were selected from patient rosters using a random numbers table. Subjects were excluded if: (a) they did not have a good working command of the English language; (b) were seriously ill; or (c) were due to be discharged shortly. Anticipating a 40 to 50% nonresponse rate, a total of 526 subjects and their responsible parties were initially approached and asked for their participation in order to recruit a final sample of 200 nursing home residents.

*Instruments.* — Instruments used in this study for the assessment of cognitive functioning were the MDS Cognitive Performance Scale (CPS) (14) and the MMSE (15). The CPS combines 5 selected MDS cognitive items (comatose status, short-term memory, ability to make decisions, making self understood, and eating performance) within a single, hierarchical cognitive rating scale creating 7 categories of cognitive impairment. The categories range from 0 (no impairment) to 6 (very severe impairment) and assign nursing home residents into easy-to-translate cognitive categories. Reported interrater reliabilities for short-term memory, ability to make decisions, making self understood, and eating performance were .81, .88, .77, and .94, respectively (21). Additional MDS items that were considered to be related to cognitive impairment were also collected. These included: long-term memory, orientation/recall items, additional ADL items (toileting, dressing, locomotion, personal hygiene, bathing), incontinence, disruptive behavior, medication use, and restraints.

The MMSE is a brief general purpose cognitive screening instrument consisting of 22 questions and requiring approximately 10–15 minutes to administer. The questions test a subject's orientation to time and place, attention and concentration, language, constructional ability, and immediate and delayed recall. Scores range from 0 (worst) to 30 (perfect). An MMSE score of 23 has traditionally been recommended by Folstein (15) as the cut point to identify cognitive impairment. However, this cut point has been found to misclassify individuals with low education as cognitively impaired (18,22–25), and an MMSE cut point of 17 or less has been suggested for subjects with a grade 8 education or less (17,19). The MMSE is considered a reliable and valid test for the identification of cognitively impaired persons in long-term care facilities (26–30), even though it is susceptible to ceiling and floor effects (31,32). The brevity and ease of administration of the MMSE make it a very popular cognitive assessment instrument among investigators and clinicians working in elderly populations.

*Data collection.* — Following subject recruitment and receipt of written informed consent by each responsible party and/or family member, on-site data collection was performed from May 11 to August 15, 1992. Each resident was assessed once on the MMSE. The study team, consisting of two medical students, a geriatric research nurse, and an epidemiologist were stationed at each facility for a period of 7–10 days. This allowed resident assessments to be carried out at times that were convenient for both the subject and the care staff. The medical students were responsible for the administration of the MMSE. Independent of the medical students, the geriatric research nurse was responsible for collecting the selected MDS cognitive items, which included the 5 items required for generating CPS scores. MDS items were collected by chart review and direct observation of the subject. Although each study subject had a completed MDS on his/her chart, we were not sure of the accuracy of these records and chose to collect MDS data following the guidelines published in the MDS protocol (12). In addition, it was necessary that MMSE and MDS assessments occurred during the same time period so that cognitive functioning scores on the CPS and cognitive functioning scores on the MMSE could be compared at the same point in time. A comparison of MDS items collected for this study by the geriatric research nurse with the original MDS items in each subject's chart would have given valuable information for MDS interrater reliability; however, it was outside the protocol and budget of this study and was not undertaken.

Assessors were blind with respect to diagnosis of dementia, unless the subject was a resident in an SCU. Data were entered and analyzed using numeric identifiers only. The

MMSE was administered twice by different assessors on a random 15% ($n$ = 30) of the study population. The interrater reliability of the MMSE as measured by the intraclass correlation coefficient was .71 (95% confidence interval [CI]: .39, 1.0). Overall quality of the data was further ensured by comprehensive training sessions for the assessors prior to data collection, detailed manuals for coding and interviewing, access to a telephone "hot-line" to contact MMSE and MDS experts regarding any problems, and random data auditing on site by the epidemiologist.

Basic demographic information was also collected on nonresponders to evaluate possible selection bias. A nonresponse was defined as: (a) a subject who refused to participate regardless of responsible party permission; (b) a subject who could not participate because the responsible party refused their participation; and (c) no response received to the mailing asking for proxy informed consent from the responsible party. Demographic variables included age, gender, race, occupation, and education. Of the 526 eligible subjects, a total of 326 (62%) were excluded — 229 (43.5%) because of nonresponse for informed consent from responsible parties, 15 (3%) because the responsible party refused to grant consent, 14 (3%) study subjects refused to be interviewed, and lastly 18 (3.4%) eligible subjects who had not yet been interviewed were excluded after the required sample size of 200 was reached. Demographic data were collected on 276 (85%) of the 326 nonrespondents. Medical charts were no longer available for 50 (15%) of the nonrespondents due to hospitalization, discharge, or transfer of the resident. Nonrespondents were not significantly different from the final sample with respect to age, education, gender, and marital status. The nonrespondent group had fewer White subjects than the respondent group, but this was significant only at the $p < .05$ level.

*Data analysis.* — Epi Info (33) was used for all data entry and was contracted to a professional data firm who verified data entry accuracy. SAS software (SAS Institute, Cary, NC) was used for all data analyses. Distributions of: (a) the five MDS-CPS items, (b) CPS scores, and (c) mean MMSE scores across CPS categories were calculated. Correlation between the CPS and the MMSE was examined by the Spearman correlation coefficient. Subjects were then classified into two groups: (a) cognitively intact, or (b) cognitively impaired based on the crude and education-adjusted MMSE cut points. For crude measurement, subjects with an MMSE score of 23 or less were classified as cognitively impaired. Adjusting for education, subjects with an MMSE score of 23 or less and an education level greater than grade 8 and subjects with an MMSE score of 17 or less and an education level of grade 8 or less were classified as cognitively impaired. The CPS cut point for cognitive impairment was a score of 2 or more. On the basis of these cut points, the sensitivity and specificity of the CPS in identifying cognitively impaired subjects as defined by the MMSE were calculated. Receiver operating characteristic (ROC) curves and the area under the ROC curves were calculated to graphically illustrate the relationship between sensitivity and specificity of the CPS and to evaluate the probability of the CPS in correctly identifying cognitively impaired and cognitively intact subjects (34). The level of agreement between the CPS and the MMSE was expressed statistically with kappa coefficients of concordance (35,36). Lastly, positive predictive values and negative predictive values were calculated (37).

## RESULTS

Of the 200 study participants 56 were men (28%) and 144 were women (72%). One-hundred and seventy-two (86%) were White and 28 (14%) were from other races. Forty-nine subjects (25%) were SCU residents. The mean age was 80.5 years (standard deviation [$SD$] = 10.92). Mean overall MMSE and CPS scores were 12.7 ($SD$ = 9.47) and 2.99 ($SD$ = 1.9), respectively. The majority of the subjects were widowed (63%), and the mean education level was 10.84 ($SD$ = 3.57) years.

Distributions for the 5 MDS-CPS items are shown in Table 1. No one was considered comatose. Approximately 75% of the subjects had short-term memory impairment, 29% were severely impaired on decision making, 16% could not make themselves understood, and 16% were totally dependent on staff for eating. Looking at CPS distributions, 53 (26.5%) were cognitively intact (CPS levels 0–1), 89 (44.5%) mild to moderately impaired (CPS levels 2–4), and 58 (29%) were severe to very severely impaired (CPS levels 5–6). For SCU residents ($n$ = 49), no one was cognitively intact, 25 (51%) were mild to moderately impaired, and 24 (49%) were severe to very severely impaired. Table 2 shows the distribution of mean MMSE scores, crude and stratified on high and low education across each CPS level. Average MMSE scores appeared to drop in a stepped fashion across the seven CPS levels. Level 0 (intact) had a mean crude MMSE score of 24.2 ($SD$ = 3.45), while level 6 (very severe impairment) had a mean score of 1.64 ($SD$ = 3.53).

Table 1. Percent Distribution of MDS Items Used to Generate CPS Scores ($N$ = 200)

| MDS Item | Percent |
|---|---|
| Comatose | 0.0 |
| Memory Impairment | |
| Short-term memory (1 = yes) | 75.5 |
| Short-term memory (0 = no) | 24.5 |
| Decision Making | |
| Independent (0) | 19.0 |
| Modified independence (1) | 22.0 |
| Moderately impaired (2) | 30.0 |
| Severely impaired (3) | 29.0 |
| Making Self Understood | |
| Always understood (0) | 47.0 |
| Usually understood (1) | 19.5 |
| Sometimes understood (2) | 17.0 |
| Never/rarely understood (3) | 16.5 |
| Eating Performance | |
| Independent(0) | 57.5 |
| Supervision (1) | 15.5 |
| Limited assistance (2) | 3.0 |
| Extensive assistance (3) | 7.5 |
| Total dependence (4) | 16.5 |

Table 2. Distribution of Mean MMSE Scores and Standard Deviations (*SD*) Across CPS Levels (*N* = 200)

| CPS Level | Crude | High Education (> grade 8) | Low Education (< grade 9) | Morris et al.* |
|---|---|---|---|---|
| *n* = 27 0 | 24.2 (3.5) | 25.3 (2.9) | 21.6 (3.4) | 24.9 (5.1) |
| *n* = 26 1 | 23.4 (4.8) | 24.2 (4.8) | 20.8 (4.4) | 21.9 (5.7) |
| *n* = 26 2 | 17.1 (5.1) | 18.3 (6.3) | 15.8 (3.2) | 19.2 (5.6) |
| *n* = 46 3 | 12.7 (5.3) | 13.5 (5.6) | 10.8 (3.9) | 15.4 (8.0) |
| *n* = 17 4 | 5.8 (5.9) | 5.3 (5.8) | 7.7 (6.6) | 6.9 (6.9) |
| *n* = 33 5 | 3.4 (3.9) | 3.7 (4.4) | 2.8 (2.5) | 5.1 (5.3) |
| *n* = 25 6 | 1.6 (3.5) | 1.7 (4.0) | 1.5 (2.4) | 0.4 (0.9) |
| | *N* = 200 | *n* = 138 | *n* = 62 | *N* = 272 |

*Morris JN, Fries BE, Mehr DR, et al. MDS Cognitive Performance Scale, see reference (14).

Table 3. Measures of Sensitivity, Specificity, and Reproducibility (Standard Error) of the Cognitive Performance Scale (CPS) Stratified on Education Level (*N* = 200)

| Cognitive Impairment | Sensitivity (*SE*) | Specificity (*SE*) | Kappa (*SE*) |
|---|---|---|---|
| High Education (*n* = 138) (MMSE≤23, CPS>1)* | 0.90 (0.03) | 0.95 (0.04) | 0.85 (0.07) |
| Low Education (*n* = 62) (MMSE≤17, CPS>1)† | 0.94 (0.03) | 0.85 (0.10) | 0.76 (0.12) |

*Cut points for identification of cognitive impairment in subjects with more than grade 8 education.

†Cut points for identification of cognitive impairment in subjects with grade 8 or less education.

Estimates from this study's sample and the Morris sample (14) which developed the CPS were also comparable. Correlation between the MMSE and the CPS, as measured by the Spearman correlation coefficient, was $r = -.863$ ($p < .001$).

*Sensitivity and specificity.* — Mean MMSE scores for high and low education groups at CPS level = 1 (intact cognition) were 24.18 (*SD* = 4.80) and 20.83 (*SD* = 4.44), respectively. Mean MMSE scores for high and low education groups at CPS level = 2 (impaired cognition) were 18.31 (*SD* = 6.3) and 15.83 (*SD* = 3.23), respectively. These estimates support the lower MMSE cut point of ≤17 rather than ≤23 in subjects with grade 8 or less education. Hence, cognitive impairment was defined by an MMSE cut point of ≤23 for subjects with an education level of more than grade 8 and an MMSE cut point of ≤17 for subjects with an education level of grade 8 or less. A CPS cut point of 2 or more was used to define cognitive impairment. Sensitivity and specificity measures for the CPS (stratified on education level) are shown in Table 3 and were above .80. Overall, adjusting for education level, sensitivity and specificity measures for the CPS compared with the MMSE were both .94.

*Kappa coefficients of reproducibility.* — In addition to sensitivity and specificity, kappa coefficients for the reproducibility of the CPS are shown in Table 3. Kappa measures correct for chance agreement that would be expected to occur if the classification of cognitive impairment between the MMSE and CPS were totally unrelated. For instance, if the CPS measurement of cognitive impairment agrees with the MMSE measurement of cognitive impairment only at the chance level, reproducibility will be zero. If the CPS agrees perfectly with the MMSE, reproducibility is equal to one.

Two measures of reproducibility were calculated in this study, Cohen's kappa (k) and the "reproducibility coefficient" ($k_D$) which estimates the intraclass coefficient (38). Cohen's k generates the most accurate estimates of agreement when the prevalence of a positive diagnosis (i.e., cognitive impairment) is about 50% (34). The "reproducibility coefficient" ($k_D$), another form of kappa, adjusts for varying prevalence and was reported if more conservative than Cohen's k (39). Reproducibility was k = .85 (95% CI: .72, .98) and k = .76 (95% CI: .53, .99) for high and low education respectively. Adjusting for education level, agreement between the CPS and MMSE was k = .82 (95% CI: .68, .96).

*The area under the ROC curve.* — A receiver operating characteristic (ROC) curve was calculated to evaluate the diagnostic accuracy of the CPS in correctly identifying cognitively impaired from cognitively intact subjects as defined by the MMSE. The curve was constructed by plotting the proportion of true positives (sensitivity) vs the proportion of false positives (1-specificity) for six cut-off values of the CPS (cognitive impairment = CPS > 0, CPS > 1, CPS > 2, CPS > 3, CPS > 4, CPS > 5). Figure 1 is the corresponding ROC curve, adjusted for education. The area under the ROC curve was .96 (95% CI: .88, 1.0), including excellent diagnostic accuracy of the CPS for the identification of cognitively impaired subjects.

*Positive and negative predictive values.* — The positive predictive value (PPV) and the negative predictive value (NPV) of the CPS were calculated. The PPV was .97 (95% CI: .93, 1.0) and the NPV was .80 (95% CI: .69, .91). Prevalence of a positive diagnosis (impaired = yes) and negative diagnosis (impaired = no) was 76% and 24%, respectively.

## DISCUSSION

In this population of nursing home residents, the Cognitive Performance Scale (CPS) validly discriminated between cognitively impaired and cognitively intact subjects as defined by the Mini-Mental State Examination (MMSE). The CPS uses available cognitive data routinely collected on nursing home residents in the Minimum Data Set (MDS), so additional professional or highly skilled staff time is not needed to compute the CPS. Administrative costs are minimal, since the MDS cognitive items are readily abstracted from the residents' medical files. Because of these characteristics, the CPS overcomes many of the characteristics of other cognitive assessment instruments that limit their use in the nursing home population, such as excessive length, requiring skilled staff for administration, and high adminis-

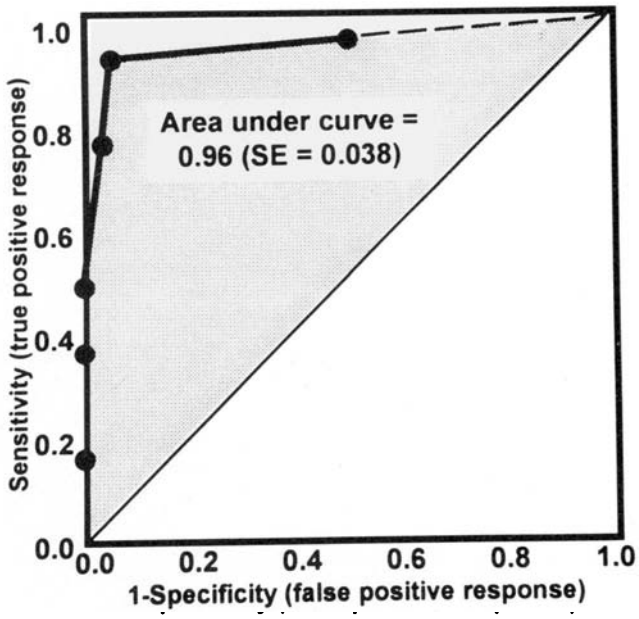


Figure 1. Receiver operating characteristics (ROC) curve of the diagnostic accuracy of the Cognitive Performance Scale (CPS) in identifying cognitively impaired and cognitively intact subjects adjusted for education level ($N$ = 200), where $SE$ = standard error. The curve was constructed by plotting the proportion of true positives against the proportion of false positives for six cut-off values of the CPS (cognitive impairment = CPS > 0, CPS > 1, CPS > 2, CPS > 3, CPS > 4, and CPS > 5.

trative costs. Interpretation of the 7-level CPS score is straightforward, ranging from level 0 (no cognitive impairment) to level 6 (very severe impairment) with the presence or absence of cognitive impairment defined as a CPS level of 2 or more. Hence, the CPS has a variety of potential uses, including identification of cognitively impaired nursing home residents, generation of more accurate estimates of the prevalence of cognitive impairment, service and care planning, and longitudinal tracking of cognition for research purposes.

Our findings rest on the assumption that MDS data are collected and scored in accordance with the recommended protocols. Consequently, we reiterate that MDS data used in this study were carefully collected by a trained research nurse according to the recommended protocols described in the official MDS manual, and were independent of MDS recordings made by indigenous nursing home staff. In the real world, however, MDS data may not always be collected following the recommended protocols, and this study could not indicate how sensitive the CPS might be to such variation. Although the 5 MDS cognitive items that are used to generate the CPS scores (comatose status, short-term memory, decision making, making self understood, and eating performance) all reported high inter-rater reliabilities in pilot testing of the MDS, the possibility of non-uniform data collection across facilities remains a concern. As a result, methods of ensuring uniform collection of MDS data across nursing home facilities should continue to be a priority before the CPS can validly be used to assess cognitive impairment from existing nursing home records.

These results were obtained using MDS scores gathered by a research nurse who had been trained to follow the MDS protocol. The subjects were gathered using a stratified sampling method which, while it did result in an even distribution of subjects across the range of cognition (Table 2), does not represent a random sample of nursing home patients. Therefore, these findings require replication with other nursing home populations and with MDS data gathered during routine nursing home care.

Finally, we remind the reader that MDS data are a new information resource that presents a feasible means toward assessing the quality of care delivered to the nursing home resident. This is of particular importance given the scarce health resources in long-term care, and a growing demand that resources should be spent in a way that maximizes the health that can be obtained from them. The wide applicability of the MDS suggests the potential of MDS data to help answer issues of nursing home resident care, staffing requirements, regulation, reimbursement, and quality. The validation of the CPS is an initial step toward reducing the skepticism that has surrounded the question of whether MDS data should be used for research purposes (13). However, this demonstration of the sensitivity and specificity of MDS data gathered by research staff requires replication using data collected by nursing home staff during routine care. Thus, this study is the first of what we hope will be many validation studies of MDS items, including not only cognitive items but also other MDS domains such as mood, well-being, and behaviors.

ACKNOWLEDGMENTS

This research was supported by grant U-01-AG10313-01 from the National Institute on Aging.

The authors would like to acknowledge the support of Drs. Bert Kaplan and James Allen, who assisted in the review of this research, and to Dianne Mattingly and Laura McCarter, who assisted in data collection.

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*Received September 1, 1993*
*Accepted May 6, 1994*