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The Bedford Alzheimer Nursing Severity Scale for the Severely Demented: Validation Study

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Summary: We evaluated the floor effect and convergent, discriminant, and known-group validity of the Bedford Alzheimer Nursing Severity scale (BANS-s), a rating scale comprising cognitive and functional items recently developed for grading severe dementia. Ninety-nine demented patients (81 females and 18 males aged 55-100 years) in two nursing homes were assessed with the BANS-s, established cognitive and functional scales [Mini Mental State Examination, the extended version of the Clinical Dementia Rating (CDR), Katz's basic activities of daily living, Tinetti balance and gait, and Crichton scales], a behavioral scale (UCLA Neuropsychiatric Inventory), and indicators of malnutrition (Prognostic Nutritional Index). A relevant proportion (40%) of patients scored close to the floor of all scales except BANS-s and CDR, which showed a more uniform distribution of scores throughout the possible range. Convergent validity of BANS-s with the other cognitive and functional scales was good, with Pearson's r ranging from 0.62 to 0.79. Discriminant validity analysis of BANS-s versus the UCLA Neuropsychiatric Inventory showed that the two scales measure different domains (Pearson's $r = 0.36$). To test known-group validity, all patients were divided into two groups of different dementia severity as defined by the Prognostic Nutritional Index. BANS-s and CDR were the scales with the best ability to discriminate malnourished from nonmalnourished patients. As a further validity test, the 37 patients reaching the floor on other cognitive and functional scales were divided into two subgroups of different dementia severity as defined by the Tinetti scale. BANS-s but not CDR was able to differentiate the two groups. **Key Words:** Bedford Alzheimer Nursing Severity scale—Validation—Rating scales—Severe dementia.

The increasing prevalence of elders with advanced dementia and the need for decision making, resource planning, and allocation in nursing home facilities have prompted interest in the measurement of clinical changes in late-stage dementia. The majority of the measures of cognitive and functional performance in the demented have been developed to detect changes of cognition and function occurring early in the course of the dementing disorder (Katz et al., 1970; Folstein et al., 1975; Tinetti

et al., 1986; Heyman et al., 1987; Cole, 1989). Such instruments are useless in the evaluation of the most advanced stages of dementia, when patients score at the floor of the scales. Recently, the Bedford Alzheimer Nursing Severity scale (BANS-s) for advanced dementia was developed (Volicer et al., 1994) to evaluate not only cognitive abilities (speech, eye contact) and basic activities of daily living (dressing, eating, ambulating) but also pathological symptoms (sleep-wake cycle disturbances, muscle rigidity). This instrument proved useful in the prediction of mortality (Volicer et al., 1993), and the score correlated with the extent of neuropathological change in the brain (Volicer et al., 1994). The aim of this study was to give further support to the validity of the scale by assessing its (1) floor effect, i.e., ability to provide evenly distributed scores at the end of the

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scale indicating greatest severity; (2) concurrent validity, i.e., ability to measure a common dimension, in relation to some commonly used scales evaluating severity of dementia; (3) discriminant validity, i.e., ability to measure a different dimension, in relation to a scale assessing behavioral symptoms; and (4) known-group validity, i.e., ability to discriminate individuals of acknowledged different levels of the measured dimension, in patients with different levels of dementia severity.

METHODS

The study was carried out between January 1 and April 30, 1995, in two nursing homes (Giroldi Forcella in Pontevico, and Pia Opera S. Angela Merici in Desenzano del Garda, Brescia, Italy). Patients were admitted to the nursing homes primarily because of loss of ability in the basic activities of daily living or because of the appearance of behavioral symptoms; patients remained resident the homes until their demise. Subjects in this study were all of the demented patients in the charge of the two facilities during the study period. Alzheimer disease (AD) patients met NINCDS-ADRDA criteria for probable AD (McKhann et al., 1984), vascular dementia patients met NINDS-AIREN criteria for probable ($n = 21$) or possible ($n = 7$) vascular dementia (Román et al., 1993), and mixed dementia patients met both NINCDS-ADRDA criteria for possible AD and NINDS-AIREN criteria for AD with associated cerebrovascular disease (Román et al., 1993). Diagnoses in each center were performed by one of the authors (G.B.F.) and supported by a modified version of the Hachinski ischemic score (Hachinski et al., 1974; Rosen et al., 1980). Multidimensional evaluation, including information on demographics (age, sex, education), cognitive status, functional abilities, and physical health, was performed using a standard protocol by four geriatricians previously trained by one of us (G.B.F.). Dementia severity was assessed with the following cognitive and functional scales:

- Mini Mental State Examination (MMSE) (Folstein et al., 1975).
- The extended version of the Clinical Dementia Rating scale (CDR) (Heyman et al., 1987), which measures overall dementia severity and comprises the original five levels (0 = absence of disease, 0.5 = questionable dementia, 1 = mild dementia, 2 = moderate dementia, 3 = severe dementia) plus level 4 (severe aphasia with maintained mobility) and level 5 (bedridden and dependent in eating).
- Katz's basic activities of daily living (Katz et al., 1970), which is assessed with direct observation of behavior

- by health workers and evaluates dependence in bathing, dressing, grooming, continence, mobility, and eating.
- Tinetti scale (Tinetti et al., 1986), a performance-based instrument whose score ranges from 0 (maximum impairment) to 28 (best performance) and addresses balance and gait. Balance is evaluated while sitting, arising from and sitting on a chair, in the standing position, with eyes closed, while turning, when nudged on the sternum, and when turning the neck while standing. Gait is evaluated as initiation of gait, step height, length, symmetry, and continuity, path deviation, trunk stability, and turning while walking. Good performance is defined as score greater than 18, whereas scores of 18 or lower indicate risk of fall.
- An abbreviated version of the Crichton scale (Cole, 1989) comprising only the five self-sufficiency items (eating, dressing, walking, continence, grooming) and providing a score ranging from 0 (no impairment) to 20 (severe impairment).
- BANS-s (Volicer et al., 1994), comprising seven items evaluating functional (ambulating, eating, dressing) and cognitive (speech, eye contact) abilities and pathological symptoms (muscle rigidity, sleep-wake cycle disturbances). Scores range from 7 (best performance) to 28 (poorest performance). Twenty patients were randomly selected among those evaluated by one rater to assess interrater and test-retest reliability. BANS-s was completed by a second rater on the same day as the first (baseline) assessment, and by the first rater 15–20 days after the baseline assessment. Interrater and test-retest evaluation of BANS-s showed good reliability (intraclass correlation coefficients of 0.89 and 0.96, respectively).

Behavioral disturbances were assessed with the UCLA Neuropsychiatric Inventory (Cummings et al., 1994), which measures frequency and severity of delusions, hallucinations, agitation, depression, anxiety, euphoria, apathy, disinhibition, irritability, and motor activity. The score for each symptom is determined as the product of frequency times severity; scores range from 0 (no behavioral disturbances) to 120 (highest degree of behavioral disturbances).

Nutritional status was evaluated by the Prognostic Nutritional Index (PNI) (Buzby et al., 1980), a measure compounding information from a number of nutritional indicators and computed as: $PNI = 150 - 16.6 \times (\text{serum albumin in g/dl}) - 0.2 \times (\text{serum transferrin in mg/dl}) - 0.78 \times (\text{triceps skin fold in mm}) - 5 \times (\text{anergy on tine test})$. Anergy was evaluated by the tine test with intradermal injection of a purified protein derivative according to Rosenthal (1961); reactions were classified

as absent, erythematous, or nodular nonconfluent. PNI scores of 35–40, 41–45, and ≥ 46 are believed to indicate mild, moderate, and severe malnutrition. The study was approved by the local ethics committee. Interrater and test–retest reliability were assessed with an intraclass correlation coefficient (Ebel, 1951). Convergent and discriminant validity of BANS-s with the other scales were assessed by computing Pearson's correlation coefficient (r). Differences between groups were assessed with a Mann–Whitney U -test for both continuous and categorical variables.

RESULTS

Ninety-nine patients were recruited in the two centers (47 and 52 residents at the Girolodi Forcella and Pia Opera S. Angela Merici nursing homes, respectively). Patients were not different across centers for demographic factors and cognitive and functional scales ($p > 0.30$ on t -test). Sixty-eight individuals were diagnosed as having AD, 28 had vascular dementia, and 3 had AD with cerebrovascular disease.

Table 1 shows sociodemographic, cognitive, functional, and clinical features of the patients. They were very old, had a low educational level, and were mainly females. Dementia severity as measured by MMSE and CDR indicated severe impairment. On average, about one basic activity of daily living as measured by Katz's scale was retained. The Tinetti scale indicated an overall poor mobility level. The Crichton and BANS-s scores were around the middle to low range for the scales. The PNI scores indicated borderline to moderate malnutrition. The AD and vascular dementia patients had simi-

lar cognitive status (MMSE and CDR: $p > 0.10$ on Mann–Whitney U -test), but the latter were more impaired in function (Katz index and Crichton scale: $p < 0.005$) and gait (Tinetti scale: $p < 0.005$) and had poorer somatic health and nutritional status (number of diseases and IPN: $p < 0.04$). Intergroup comparisons were not carried out for the three patients with AD with cerebrovascular disease because of the small size of this group.

Table 2 shows good association among cognitive and functional scales assessing severity of dementia. In particular, BANS-s showed very good correlations with the other dementia severity scales (Pearson's r ranging from 0.62 to 0.79). Furthermore, BANS-s results were inversely associated with UCLA Neuropsychiatric Inventory ratings, indicating that more severely demented patients had a lower degree of behavioral disturbances. Age was poorly associated with the dementia severity scales.

To compare dementia severity scales with each other directly, the values were (1) polarized, so that low scores indicated poor and high scores indicated good performance for all scales, and (2) standardized as a percentage of the maximum theoretical score, so that the minimum score was 0 and the maximum score was 100 for each scale. Figure 1 shows comparisons of score distributions for all of the dementia severity scales. BANS-s and CDR were the scales with the widest distribution in the sample; the other scales attained a relatively early floor effect. Zero and five patients reached the floor on the BANS-s (scores of 27 and 28) and CDR (score of 5), respectively. The Crichton scale had the next widest distribution, with 37 patients scoring at the floor (scores of 19 and 20). Even greater proportions of patients

TABLE 1. Clinical and demographic features of 99 institutionalized demented patients divided according to diagnosis

	AD ($n = 66$)	VD ($n = 28$)	AD with CVD ($n = 5$)	Possible range	Observed range
Age (years)	82.3 (8.6)	85.5 (4.7)	79.8 (8.7)	—	55–100
Gender (% females)	86	71	80	—	—
Education (years)	4.7 (1.8)	4.4 (1.2)	6.2 (3.8)	0+	2–13
Mini Mental State Examination	5.0 (6.7)	4.7 (6.3)	6.0 (8.2)	0–30	0–23
Clinical Dementia Rating	3.0 (0.7)	3.2 (0.9)	2.6 (0.5)	0–5	1–5
Hachinski ischemic score (modified by Rosen)	2.6 (2.5)	7.9 (1.4)	1.0 (0.8)	0–12	0–10
Katz index (functions spared)	1.4 (1.2)	0.6 (1.1)	1.4 (1.3)	0–6	0–5
Tinetti scale	11.9 (9.8)	4.6 (7.3)	10.0 (12.8)	0–28	0–28
Crichton scale	14.5 (5.0)	17.4 (4.1)	12.6 (5.4)	0–20	0–20
BANS-s	17.1 (4.7)	18.7 (4.2)	14.8 (4.5)	7–28	8–26
UCLA Neuropsychiatric Inventory ^a	17.3 (15.9)	11.6 (12.3)	10.5 (14.8)	0–120	0–54
Prognostic Nutritional Index	33.7 (16.7)	40.6 (12.6)	42.9 (8.2)	0+	4.7–74.5
Pressure sores (%)	27	18	20	—	—
No. of diseases (excluding dementia)	3.8 (2.9)	5.0 (2.4)	4.8 (2.5)	0+	0–11
No. of drugs	2.9 (1.9)	3.7 (2.0)	4.0 (2.7)	0+	0–8

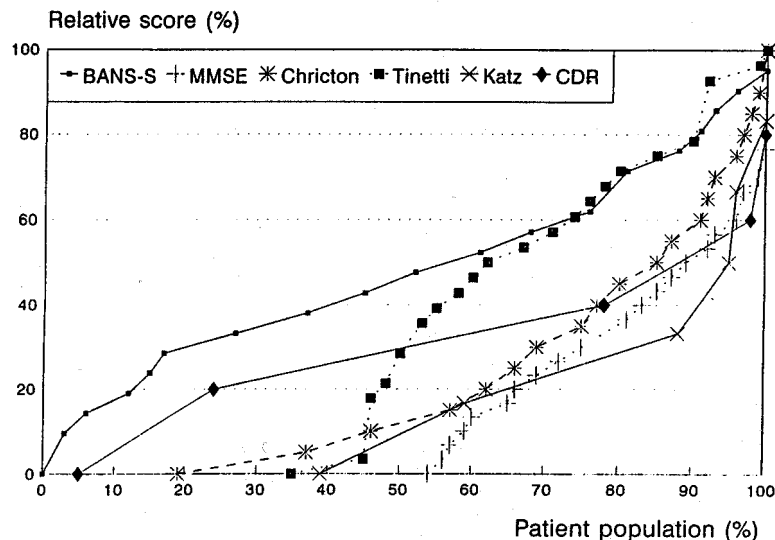
Values represent mean (SD) or percentage. AD, Alzheimer disease; VD, vascular dementia; CVD, cerebrovascular disease; BANS-s, Bedford Alzheimer Nursing Severity scale.

^aThe UCLA Neuropsychiatric Inventory was administered to 40 AD, 15 VD, and 1 AD with CVD patients.

TABLE 2. Correlations among age, dementia severity, and scores on functional and behavioral scales in 99 institutionalized demented patients

	MMSE	CDR	Tinetti	Crichton	BANS-s	UCLA
Age	0.11 NS	-0.06 NS	-0.20*	0.24*	0.07 NS	-0.34***
MMSE	—	-0.69***	0.39***	-0.63***	-0.67***	0.19 NS
CDR	—	—	-0.41***	0.65***	0.62***	-0.02 NS
Tinetti	—	—	—	-0.68***	-0.68***	0.37**
Crichton	—	—	—	—	0.79***	-0.29*
BANS-s	—	—	—	—	—	-0.36**

Values represent Pearson's *r*. MMSE, Mini Mental State Examination; CDR, Clinical Dementia Rating; BANS-s, Bedford Alzheimer Nursing Severity scale; UCLA, UCLA Neuropsychiatric Inventory. **p* < 0.05; ***p* < 0.01; ****p* < 0.001; NS, not significant.

**FIG. 1.** Cumulative distribution of scores on dementia severity and functional scales.

reached the floor of Tinetti, Katz, and MMSE scales. None of the patients reached the ceiling of the BANS-s (score of 7).

Malnutrition is often associated with the late stages of dementia (Sandman et al., 1987; Wolf Klein et al., 1992; Wolf Klein and Silverstone, 1994; Frisoni et al., 1995). Therefore, the ability of the BANS-s and the other scales to discriminate between different levels of dementia severity was assessed by dividing our sample according to nutritional level; 46 patients with a PNI of 35 or higher were considered malnourished. Figure 2 shows that malnourished patients were detected as more impaired by all scales. However, the dispersion of values was lower for the BANS-s and CDR scale in both subgroups, as indicated by lower standard deviations. This is reflected by greater statistical significance of the differences between group means. Moreover, the figure highlights the fact that the scores of the majority of scales were close to the floor, whereas the BANS-s and CDR were the scales whose mean values were farther

from the floor for both subgroups.

BANS-s was then compared to the CDR (the only scale with a similarly wide distribution of values) for ability to discriminate between different levels of dementia severity in those very seriously impaired patients for whom the other scales were no longer discriminative. These patients were chosen on the basis of the scale with the lowest floor effect next to BANS-s and CDR, i.e., the Crichton scale.

The 37 patients scoring at the floor of the Crichton scale (scores of 19 and 20) were selected. These patients were very old (mean age: 86.0 ± 6.1 years), performed poorly on the MMSE (1.9 ± 4.3), had poor functions (Katz index: 0.03 ± 0.1 spared functions), and were very impaired in mobility (Tinetti scale: 1.9 ± 4.2), and had poor somatic health status (IPN: 41.3 ± 13.7 ; number of diseases: 4.2 ± 2.6 ; number of drugs: 2.9 ± 1.6). To assess known-group validity, this group had to be divided into two subgroups of different degrees of dementia severity according to a clinically valid criterion. To avoid circular reasoning, the criterion had to be included in

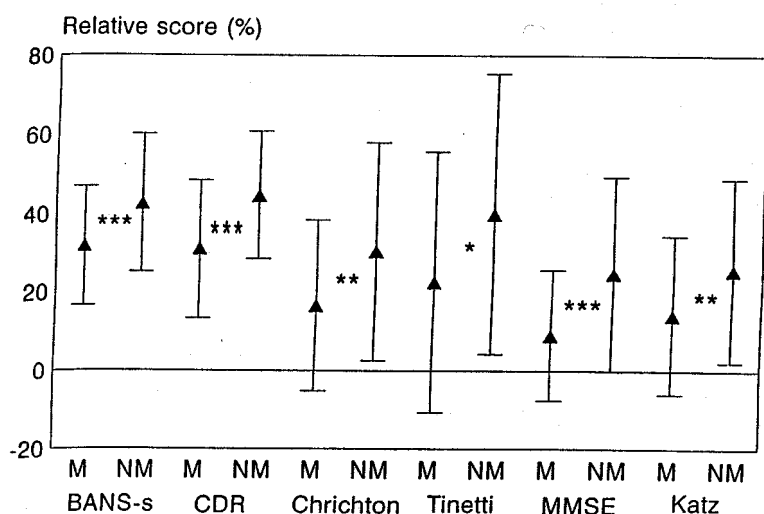


FIG. 2. Distribution of scores on dementia severity and functional scales by nutritional level. Graphic shows mean \pm 1 SD in malnourished (M) and nonmalnourished (NM) patients. Malnutrition was defined as a Prognostic Nutritional Index of >35 . * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

both the BANS-s and CDR scales or in neither of them. Furthermore, the criterion needed to split the groups into numerically comparable subgroups. The only criterion that met these needs was the ability of patients to keep the trunk upright when in the sitting position (operationally defined as having a Tinetti score of 1 or greater). This criterion divided the group into two subgroups of 10 (able) and 26 (unable) patients. Table 3 indicates that the two subgroups were different only in mean BANS-s score; the mean CDR values were similar. The two subgroups were both at the floor and not different for the other dementia severity scales (MMSE, Katz index, Tinetti and Chrichton scales). A nonsignificant difference of mean PNI values was present (42.6 ± 14.3 vs. 37.2 ± 12.6 in those with Tinetti scores of 0 vs. ≥ 1), indicating marginally poorer nutritional status in those patients unable to keep the trunk upright.

DISCUSSION

In the present study, we demonstrated that the BANS-s is a valid instrument for evaluation of late-stage dementia in that (1) its scores are evenly distributed in the stage

where most other scales have reached the floor, (2) it measures a dimension that is common to other valid scales for dementia assessment, i.e., dementia severity, (3) it does not measure dimensions not associated with dementia severity, i.e., behavioral symptoms, and (4) it discriminates groups of patients with different dementia severity even when all other scales are insensitive.

Although a large number of scales are available for the evaluation of cognitive and functional performance of the demented, their sensitivity is limited to the relatively early stages of the dementing process. Thus, patients in the late stages of the disease are usually considered profoundly and uniformly impaired. The inability to measure changes in the severely demented has led to the hypothesis that in this phase the progression of dementia might halt, giving rise to a plateau in the course of the disease (Yesavage and Brooks, 1991). This view has so far hindered effective evaluation and management of severely demented patients and rational allocation of resources.

As a first step in the demonstration of the validity of the BANS-s in the late stages of dementia, we showed an even score distribution across all the ranges of severity of our patient sample. None of the patients scored at the floor of the BANS-s; among the other scales tested, only the CDR showed a similar distribution. A relevant proportion (37%) of patients scored at the floor of the Chrichton scale, and greater proportions scored at the floor of the MMSE and other scales. Because it is likely that our sample is representative of the general nursing home population (Kane et al., 1994), it follows that a relevant proportion of nursing home demented elders cannot be evaluated by most of the commonly employed

TABLE 3. BANS-s and CDR scores for 36 patients scoring at the floor of the Chrichton scale

	Patients with Tinetti score of 0 (n = 26)	Patients with Tinetti score of ≥ 1 (n = 10)	p
BANS-s	22.2 (3.0)	18.9 (2.4)	0.004
CDR	3.5 (0.7)	3.7 (0.6)	NS

Values represent mean (SD). Significance of differences (p) determined by Mann-Whitney U-test. BANS-s, Bedford Alzheimer Nursing Severity scale; CDR, Clinical Dementia Rating; NS, not significant.

instruments. Furthermore, it should be emphasized that none of the patients scored at the highest level of the BANS-s, suggesting that it might be applicable also in the assessment of the earlier stages of dementia. This might be useful when comparing demented patients of a very wide range of dementia severity.

The BANS-s was associated with all the other cognitive and functional instruments, suggesting that it measures a common underlying dimension. In contrast, it was inversely associated with severity of behavioral disturbances. In fact, it is known that most behavioral disturbances decrease with increasing severity of dementia (Cummings and Benson, 1991).

The BANS-s was able to discriminate different levels of severity in the whole patient sample at least as well as the other cognitive and functional instruments. Malnutrition, as indicated by high PNI scores, was chosen to define two subgroups of different severity for a number of reasons. First, malnutrition is frequently, though not invariably, associated with the relatively later stages of dementia (Sandman et al., 1987; Wolf Klein et al., 1992; Wolf Klein and Silverstone, 1994; Frisoni et al., 1995) and can therefore be considered an indicator of dementia severity. Second, the clinical signs and symptoms of classical medicine are not applicable to the severely demented patient (Kane et al., 1994) and thus fail to provide useful hallmarks of disease progression and disease severity. Lastly, malnutrition is an indicator external to all the evaluated scales, in that nutritional parameters do not pertain to any item of the other scales. For this reason, scales can be compared through levels of malnutrition without generating a recursive conceptual pathway.

The inability to keep the trunk upright was chosen as the indicator of dementia severity for those patients who were at the floor of most scales other than the BANS-s and CDR scale. In these patients, we were not able to identify malnutrition as an indicator of dementia severity, which may be due to the fact that most such patients had reached a relevant level of malnutrition. This possibility is supported by the observation that the mean PNI values in those able and those unable to keep the trunk upright, though indicating poorer nutritional status in the latter, were above the commonly accepted threshold of 35 in both subgroups. Mobility is implicitly or explicitly part of both scales (BANS-s and CDR) compared for the two subgroups, thus, once again, conceptual recursivity in the comparison was avoided. BANS-s was the only instrument capable of differentiating patients able from those unable to keep the trunk upright, proving superior to all other available scales.

Some notes of caution should be stressed in the interpretation of these results.

Patients were recruited from two different institutions, raising the possibility of different admission criteria and evaluation methods. However, age, education, and scores on cognitive and functional scales were not different between the two centers. Furthermore, training of all raters and diagnostic and assessment consultation for both centers were consistently provided by one of the authors, thus minimizing possible discrepancies.

With this study we have expanded the evidence for the validity of the BANS-s. At variance with Volicer et al.'s original study on relatively young male AD patients (Volicer et al., 1994), in this study we tested the scale in a sample of very old demented with a female preponderance. In addition, not only AD patients but also patients suffering from cerebrovascular disease were included. The results indicate that the BANS-s may be useful also for this patient population, although the pattern of cognitive and functional impairment is different from that of AD patients (Cummings and Benson, 1991). Further studies are needed to assess whether the BANS-s is applicable to other dementias and whether it is superior to other scales aimed at evaluating relatively less impaired (Severe Impairment Battery; Panisset et al., 1994) or more impaired (Glasgow Coma Scale; Benesch et al., 1993) demented patients.

In conclusion, the BANS-s has shown reliability and validity features that make it a promising instrument for the evaluation of the severely demented patient.

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