Validity of Direct Assessment of Functional Status as a tool for measuring Alzheimer’s disease severity

Orazio Zanetti, Giovanni B. Frisoni, Luca Rozzini, Angelo Bianchetti, Marco Trabucchi

Alzheimer Unit, IRCCS, ‘S. Giovanni di Dio’, ‘S. Cuore-Fatebenefratelli’ Institute, Via Pilastroni 4, 25123, Brescia, Italy
\textsuperscript{1}Geriatric Research Group, Brescia, Italy

Address correspondence to O. Zanetti. Fax: (+39) 30 348255; E-mail: ozanetti@mastercci.unibs.it

Abstract

Objective: to assess the validity of the Direct Assessment of Functional Status (DAFS) performance-based functional scale for the staging of dementia severity by comparing it with established clinical, functional and cognitive scales.

Patients and methods: 93 consecutive Alzheimer’s disease patients underwent DAFS. Socio-demographic variables, cognitive status (Mini-Mental State Examination; MMSE), global disease severity (Clinical Dementia Rating; CDR), disease duration, physical performance (Physical Performance Test, PPT) and functional status (as reported by the primary caregiver) were also recorded and basic (B) and instrumental (I) activities of daily living (ADL) assessed.

Results: a significant correlation was found between DAFS and MMSE (Pearson’s $r = 0.60$; $P < 0.01$), PPT ($r = 0.54$; $P < 0.01$) and CDR (Spearman correlation coefficient: $-0.48$; $P < 0.01$). A mild, significant correlation was found between DAFS score and daily function as reported by the primary caregiver ($r = -0.30$ for BADL and $r = -0.27$ for IADL). On multiple regression analysis, only MMSE and PPT were independently associated with the DAFS score, explaining 56% of DAFS total variance. ADL scales did not independently contribute to DAFS variance. A multivariate regression model of the association of DAFS with CDR showed that the association was significant even after adjustment for MMSE and PPT, suggesting that DAFS scores provide additional information on dementia severity.

Conclusion: DAFS is a valid tool for the assessment of dementia severity, capturing cognitive and physical aspects of disability.

Keywords: activities of daily living, dementia, functional assessment

Introduction

Functional impairment occurs in Alzheimer’s disease and other dementing illnesses: diagnostic criteria for Alzheimer’s disease include impairment in social, occupational and everyday functional abilities [1, 2]. According to the American Psychiatric Association Diagnostic and Statistical Manual of Mental Disorders, 4th edition, a diagnosis of dementia cannot be made without functional impairment, and the National Institute of Neurological and Communicative Disorders and Stroke–Alzheimer’s Disease and Related Disorders Association (NINCDS-ADRDA) workgroup has identified the assessment of objective functional capacities as being important in the diagnosis of dementia. Assessment of functional status is important for staging and monitoring progression in dementia and for the evaluation of the efficacy of therapies [3]. Staging disease severity may help in estimating the need for support for families. Staging is needed at a population level to plan institutional care, services and health policy. However, there is no consensus on the best way to assess functional status in Alzheimer’s disease.

The most common measures of functional abilities in demented patients are activities of daily living (ADL) scales [3-6], measures such as the Blessed dementia rating Scale [7] and those in the CAMDEX schedule [8, 9] which rely on the reports of family members. The performance of basic ADL (BADL) and instrumental ADL (IADL) functions are usually assessed by a close informant since demented patients are often incapable of making accurate self-reports [8, 10]. The carer judgement may be a reliable guide [8] but some have found marked disagreement between
the assessments of family members, patients and nursing staff [11, 12].

Patients tend to rate their own function higher than nurses, whereas family members tend to rate it lower [11]. Family members' and nursing staff's perceptions frequently disagree [12]. Caregivers' reports might be influenced as much by their own psychological problems [13-15]. Therefore, assessments that rely on caregivers may give a biased estimate of the patients' abilities [4, 11, 16].

Disadvantages of self-reported [4, 17, 18] or proxy-reported measures might be overcome by using performance-based measures. These were designed to be less influenced by poor cognitive function, culture, language and education and therefore more valid and objective than self-reported measures [10, 19, 20]. They have been specifically developed to assess functioning in Alzheimer's disease and other dementias [21-23]. Compared with self-report measures, performance-based assessment is more time consuming, requires space, equipment and a trained examiner and may not reflect adaptation to everyday life [17, 24].

Not all investigators have found performance measures to be superior [24, 25]. Several studies have shown discrepancies or poor relationships between self-report and performance-based measures of functioning [26-31].

In patients without severe cognitive impairment, underestimation (lower self-reported than performance-based levels of ADL) occurs in depressed subjects or those with low perceptions of physical competence [29]. Self-report and performance-based assessments are complementary: they do not measure the same things [31].

We have assessed the validity of the Direct Assessment of Functional Status (DAFS) [22] by comparing it with other established clinical, functional and cognitive scales for staging dementia severity (concurrent validity) and by evaluating the additional information provided by DAFS for the assessment of dementia severity.

Methods

Patients

We recruited 93 consecutive patients with probable Alzheimer's disease (NINCDS-ADRDA criteria) [1] attending the Alzheimer's Disease Research and Care Unit, Brescia, Italy between December 1994 and May 1995. Of these, 17 (18.3 %) were men. The diagnosis of Alzheimer's disease was based on a history of progressive deterioration in mental, social or occupational functioning, memory loss, impaired judgement, language dysfunction, personality change and deficits in visuo-spatial, reasoning or calculating abilities. Dementing conditions other than Alzheimer's disease were excluded on the basis of history, neurological examination and standard investigations (electroencephalogram, computed tomography or magnetic resonance imaging scan, chest X-ray, blood analysis and urinalysis).

Patients underwent a multidimensional assessment of cognitive, physical and social health. Demographic variables included gender, age, education. Cognitive status was assessed with the Mini-Mental State Examination (MMSE) [32]. For dementia assessments, we used the Clinical Dementia Rating Scale (CDR) [33], which is based on combined ratings of psychic, social and assessments made by a clinician, where 0 = normal, 0.5 = questionable dementia, 1 = mild, 2 = moderate, 3 = severe dementia.

Physical function was assessed by the Physical Performance Test (PPT) [34]. This is more sensitive to functional impairment than the established BADL and IADL measures [19]. The range is from 0 to 28, higher scores indicating better performance. Cognitive symptom duration was obtained from caregivers who were asked about the onset.

Assessment of functional status

For the indirect assessment of functional status, six BADL and eight IADL items, were assessed using the Katz index [5] and the scale of Lawton and Brody [6]. Dependency was defined as the inability to carry out ADLs without regular help from another person. Information was collected from the primary caregiver. For direct assessment, we used an Italian version of the DAFS [22, 35]. This is a performance-based measure for evaluating a broad spectrum of behaviours within seven functional domains (Table 1).

The Italian version was a faithful reproduction of the original, with the exception of two original items ("writing a check" and "balancing a checkbook") which were omitted since they are not relevant to the Italian elderly population. Transportation was not considered in the analysis, as most of our patients had never driven a car.

The maximum score of the Italian version of DAFS is 86, higher scores indicating better performance. The DAFS instrument was administered in a living room and a bathroom typical of those of an Italian house.

The mean time required for the DAFS application (evaluated in 10 patients) is 41 ± 5.67 min. The validation of the Italian version of the DAFS showed high intra-class correlation coefficient (0.85) and inter-rater reliability (0.99), evaluated in 10 patients.

Statistical analysis

Statistical analysis was performed by SPSS statistical software [36]. The relationships between variables were assessed with Pearson's and Spearman's r as appropriate. Independent predictivity of clinical and functional variables on DAFS performance were
assessed with multiple linear regression. Differences of cognitive and functional performance across levels of dementia severity were assessed with ANOVA. The critical P value for statistical significance was set at $P = 0.05$.

**Results**

Table 2 shows the clinical and demographic characteristics. Most patients (92.5%) were in the mild to moderate stage of the disease [53 (57%) had a CDR score of 1 and 33 (35.5%) had a CDR score of 2]. Due to poor comprehension, apraxia, agnosia and severe memory impairment, behavioural disturbances or refusal to perform the tasks, most patients with severe Alzheimer's disease (CDR 3) found it difficult to complete the assessment. Results are therefore only included for the seven patients who were collaborative during the DAFS.

Figure 1 shows the score distribution of the reported (BADL and IADL) and performance-based (DAFS) assessments. Most patients had lost no ($n = 50; 53.8\%$) or only one ($n = 11; 11.8\%$) BADL function; 19 (20.4%) had lost two functions. Forty-two patients (45.3%) had lost 6–8 IADL functions. DAFS scores were distributed along a wider spectrum. The mean DAFS score was close to the middle of the theoretical range. Significant correlations were found between DAFS and cognitive function (MMSE) and functional status as measured by BADL, IADL and PPT (Table 3). A significant association was also found between DAFS and global dementia severity (CDR). There was no association with age and education. Less than 10% of the total variance of DAFS was common to BADL and IADL ratings, while 36% was common to MMSE. Independent predictors of DAFS scores were identified by multiple linear regression analysis.

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Table 4 shows that MMSE and PPT are the only

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**Table 1. Direct Assessment of Functional Status domains**

<table>
<thead>
<tr>
<th>Orientation (time and date)</th>
<th>Maximum score: 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>The patient is shown four different times (0300 h, 0800 h, 1030 h and 1215 h) using a large model of a clock and is asked to tell the time. The patient is also asked to state the date, the day, the month and the year. Two points are scored for each correct item</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication abilities</th>
<th>Maximum score: 14</th>
</tr>
</thead>
<tbody>
<tr>
<td>The patient is invited to dial the operator, dial from a list of telephone numbers, dial from oral presentation and dial from written presentation. The patient is scored on picking up the receiver, dialling, hanging up and operating the telephone in the correct sequence. The patient is also invited to fold a letter in half, put it in an envelope, seal the envelope, put on a stamp, address it (from a presented stimulus card) and add a return address (the patient’s own current address, without a postal code). Each task is scored individually and one point is given for each correct response</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Financial skills</th>
<th>Maximum score: 13</th>
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<tbody>
<tr>
<td>The patient is invited to identify four different coins and three notes and to count four amounts of money (one point for each correct answer); later, after the shopping skills item, the patient is invited to make change (score: 2 points if correct)</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Shopping skills</th>
<th>Maximum score: 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before the preparation of the letter, the rater instructs the patients that in 10 min she/he will be going to a grocery store to select six items: orange juice, spaghetti, cherry jam, tuna fish, rice and tomatoes. After 1 min to recall as many grocery items as possible (maximum score: 6), the patient is taken to a simulated grocery store to pick out the items from a total of 25 (maximum score: 6). The rater then gives the patient a written grocery list (milk, crackers, eggs and laundry detergent) and asks them to select the four items and to hand them to the examiner</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transport (optional scale)</th>
<th>Maximum score: 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>The rater asks the patient to identify a driver's correct response to 13 road signals (one point is given for each correct response)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dressing/grooming skills</th>
<th>Maximum score: 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>The patient is taken to a bathroom and asked to take the cap off a tube of toothpaste, put toothpaste on a toothbrush, turn on the tap, brush teeth, dampen washcloth, put soap on washcloth, wash the face and turn off the tap. The patient is invited to use a hairbrush, put on a coat, button a coat (three buttons), fasten a zip and tie shoelaces</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feeding abilities</th>
<th>Maximum score: 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>The patient, sitting at a table, shows how she/he would cut a steak, take a bite of it, eat soup and pour water into a glass and drink it</td>
<td></td>
</tr>
</tbody>
</table>
Discussion

We have investigated the concurrent validity of DAFS with respect to established measures of mental, physical and functional status in a group of patients with Alzheimer's disease. DAFS scores are well distributed across different levels of disease severity from mild to severe with no ceiling or floor effect. Our results confirm [22, 37] moderate to good correlation of DAFS with clinical, functional and cognitive scales used for staging disease severity in demented patients.

Consistent with past research [38–43], our results indicate that cognitive functioning greatly contributes to functional performance. Cognitive function as measured by MMSE explained 36% of DAFS variance. The introduction of the multiple linear regression model of physical performance as measured by PPT increases the explained variance to 56%. Thus, cognition and physical performance both independently contribute to performance in ADL tasks. The subjects independent predictors, accounting for over 50% of DAFS variance, while BADL and IADL did not independently contribute to DAFS variance. Age was not entered in the model as an independent predictor. A second model was built to include MMSE, PPT and age. Again, age was not associated with DAFS ($B = -0.06; 95\% \text{CI} -0.35$ to 0.23; $P=0.654$), while MMSE and PPT retained high significance ($P<0.005$ for both variables). We then addressed whether DAFS provides additional information on functional and cognitive scales that contribute to its variance. CDR, an indicator of global dementia severity compounding functional and cognitive information, was chosen as a means of dividing the sample into three groups.

MMSE, PPT and DAFS showed increasing impairment with increasing level of global disease severity (Table 5). This was also true for BADL and IADL, the former changing from 0.5 (SD 0.8) through 1.3 (SD 1.3) to 3.0 (SD 1.8) and the latter from 3.6 (SD 2.3) through 6.5 (SD 1.6) to 6.4 (SD 3.0) functions lost across groups of CDR = 1, CDR = 2 and CDR = 3. The crude difference of DAFS score between the most severely impaired (CDR = 3) and those less impaired CDR groups is 13.1 points (95\% CI = 1.86–24.28; $P<0.024$) for CDR = 2 and 25.2 points (95\% CI = 14.37–36.03; $P<0.000$) for CDR = 1 (Table 5). Table 6 shows that the differences remained significant for group CDR = 1 and CDR = 2 even after adjusting for MMSE and PPT, indicating that DAFS captures information on global dementia severity in addition to that provided by MMSE and PPT. As expected, PPT ($B = 1.37; 95\% \text{CI} = 0.90–1.84; P<0.000$) and MMSE ($B = 1.40; 95\% \text{CI} = 0.82–1.98; P<0.000$) retained significance while age ($B = -0.03; 95\% \text{CI} = -0.32–0.26; P=0.82$) was not significant.
Table 2. Clinical and demographic characteristics of 93 subjects with Alzheimer's disease

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Observed</th>
<th>Theoretical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>75.6</td>
<td>7.7</td>
<td>54–92</td>
<td>-</td>
</tr>
<tr>
<td>Education (years)</td>
<td>6.9</td>
<td>4.0</td>
<td>2–18</td>
<td>-</td>
</tr>
<tr>
<td>Disease duration (months)</td>
<td>47.1</td>
<td>33.3</td>
<td>2–240</td>
<td>-</td>
</tr>
<tr>
<td>Basic ADL(^a)</td>
<td>1.0</td>
<td>1.3</td>
<td>0–5</td>
<td>0–6</td>
</tr>
<tr>
<td>Instrumental ADL(^a)</td>
<td>4.8</td>
<td>2.5</td>
<td>0–8</td>
<td>0–8</td>
</tr>
<tr>
<td>Direct Assessment of Functional Status</td>
<td>52.3</td>
<td>15.7</td>
<td>4–80</td>
<td>0–86</td>
</tr>
<tr>
<td>Mini-Mental Status Examination</td>
<td>16.2</td>
<td>5.0</td>
<td>4–27</td>
<td>0–30</td>
</tr>
<tr>
<td>Physical Performance Test</td>
<td>19.6</td>
<td>4.7</td>
<td>7–27</td>
<td>0–28</td>
</tr>
<tr>
<td>Number of diseases(^b)</td>
<td>1.6</td>
<td>1.7</td>
<td>0–6</td>
<td>-</td>
</tr>
</tbody>
</table>

\(^a\)Lost function.
\(^b\)Excluding Alzheimer's disease.
ADL, activities of daily living.

Table 3. Correlations of Direct Assessment of Functional Status scores with functional and clinical characteristics in 93 subjects with Alzheimer's disease

<table>
<thead>
<tr>
<th>Score</th>
<th>Age</th>
<th>Education</th>
<th>Disease duration</th>
<th>Mini-Mental Status Examination</th>
<th>Basic Activities of Daily Living(^c)</th>
<th>Instrumental Activities of Daily Living(^c)</th>
<th>Physical Performance Test</th>
<th>Clinical dementia rating(^d)</th>
<th>Number of diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score</td>
<td>0.01</td>
<td>0.18</td>
<td>-0.13</td>
<td>-0.30(^b)</td>
<td>-0.27(^a)</td>
<td>0.54(^b)</td>
<td>-0.48(^b)</td>
<td>-0.09</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)P < 0.05; \(^b\)P < 0.01 (two-tailed significance).
\(^c\)Lost function
\(^d\)Values represent Pearson's r and \(^c\)Spearman correlation coefficient.

Table 4. Independent predictors of Direct Assessment of Functional Status score

<table>
<thead>
<tr>
<th>Score</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B(^a)</td>
<td>95% CI</td>
<td>P</td>
</tr>
<tr>
<td>Score</td>
<td>1.73</td>
<td>1.30–2.16</td>
<td>&lt; 0.005</td>
</tr>
<tr>
<td>Score</td>
<td>1.39</td>
<td>0.92–1.86</td>
<td>&lt; 0.005</td>
</tr>
</tbody>
</table>

Adjusted \(R^2 = 0.56\).

Variables were selected with a stepwise selection method in a multiple linear regression model. Age and basic and instrumental activities of daily living variables did not reach the criterion (F to enter 3.84; F to remove 2.71) to enter the model.

\(^a\)Unstandardized regression coefficient, i.e. the change of Direct Assessment of Functional Status score for a one unit change of Mini-Mental Status Examination and Physical Performance Test.

with Alzheimer's disease in our study had a slightly higher (19.6 ± 4.7) mean PPT score than was observed in a large sample of 549 community-dwelling elderly patients (PPT = 18.1 ± 7.7) whose MMSE mean value was 25.5 ± 4.6 [19]. Moreover, when the PPT scores of 437 community-dwelling elderly people, 87 patients with mild to moderate Alzheimer's disease and 280 patients admitted to a geriatric evaluation and rehabilitation unit were compared, the scores of the subjects with Alzheimer's disease were similar to those of the general population and higher than those of the patients admitted to the rehabilitation unit. The latter group had more physical disease, demonstrating the PPT's independence from cognitive function [44].

The relationship between cognition and function varies also with overall level of cognitive severity. Reed et al. [39] found that cognitive scores explained the variance in ADL and IADL scores, but only for patients with severe cognitive impairment; in the less demented patients the MMSE and ADL were independent of each other. In contrast, Teunisse et al. [45] using the CAMCOG [9] found a good correlation with ADL scale: cognitive decline accounted for 50% of the variance in functional disability. The inconsistent results of previous studies reflect the different characteristics of the
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Table 5. Association of Direct Assessment of Functional Status (DAFS), cognitive and functional scales with dementia severity according to the Clinical Dementia Rating (CDR) scale

<table>
<thead>
<tr>
<th>CDR</th>
<th>n</th>
<th>MMSE Mean (and standard deviation)</th>
<th>PPT</th>
<th>DAFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>53</td>
<td>18.9 (3.7)</td>
<td>20.8 (4.5)</td>
<td>58.5 (11.2)</td>
</tr>
<tr>
<td>2</td>
<td>33</td>
<td>13.4 (3.8)</td>
<td>17.9 (4.9)</td>
<td>46.4 (17.1)</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>8.0 (2.9)</td>
<td>18.8 (3.5)</td>
<td>33.3 (13.9)</td>
</tr>
</tbody>
</table>

*Significance on one-way ANOVA.

MMSE, Mini-Mental State Examination; PPT, Physical Performance Test.

populations studied and the varying degrees of dementia.

Although DAFS contains items related to BADL and IADL, ADLs did not independently contribute to DAFS variance. These data confirm the poor association between self-report and performance-based measures of functioning [26–31]. Recently Stern et al. showed that dependence level (which assesses a patient's needs and hence care requirement) and the Blessed dementia rating scale self-care factor were correlated. However, in a multiple linear regression analysis with MMSE as dependent variable, both contributed to much of the variance [34]. Socio-demographic variables, cognitive functioning [10], affective functioning and personality characteristics may all reduce the concordance between self-report and performance-based measures [29].

These results confirm that direct (DAFS) and indirect (reported ADLs) assessment of functional status, while interdependent, are complementary as they record different aspects of daily functions [26, 46].

DAFS provides additional information on global dementia severity. This additional information could be related to mood [42, 47], behavioural disturbances [4], hearing or visual impairment [29] and lack of motivation [24]. Freels et al. [48] found that two psychiatric problems, behavioural disorders (e.g. screaming, wandering, catastrophic reactions, aggressiveness) and apathy were associated with ADL impairment independent of age, sex, race and cognitive impairment measured with MMSE.

A major limitation of performance measures is that they do not reflect adaptations made to the person's everyday situation [24]; performance tests represent only a 'simulation' or isolated instance of given behaviour and may not reflect how the person normally carries out the activity.

Many subjects with severe Alzheimer's disease find it difficult to complete the entire DAFS assessment. For these reasons DAFS may be more appropriate for the assessment of mild and mild to moderately demented patients.

DAFS might provide objective and quantitative measures for longitudinal studies, for the evaluation of the rehabilitative or pharmacological therapies. It could be incorporated in ward assessments and may be particularly useful when a surrogate is not available.

**Key points**

- Reported and performance-based assessments of daily function in dementia measure different aspects of patient's performance and can be viewed as complementary.
- The Direct Assessment of Functional Status performance-based scale captures cognitive and physical aspects of disability.
- This scale is sensitive to dementia severity and provides additional information when compared with established cognitive and physical assessment tools.
- It may be of use in the evaluation of disease progression and the efficacy of therapeutic interventions, as well as in ward assessment and when an informant is not available.

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**References**


Functional abilities in dementia


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