Measuring functional status of chronic coronary patients

Reliability, validity and responsiveness to clinical change of the reduced version of the Duke Activity Status Index (DASI)

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Aims Health-related quality of life assessment may be useful for understanding the variability in functioning of patients with a similar level of clinical impairment. We assessed the reliability, validity and responsiveness to clinical change of a reduced version of the Duke Activity Status Index (DASI) in chronic coronary patients.

Methods and results The reduced version of the DASI, a measure of self-reported functional capacity, was administered twice to two groups of patients: 46 stable coronary heart disease outpatients were tested and re-tested 2 weeks after their initial visit; and 44 patients undergoing elective angioplasty for angina pectoris were evaluated the day before and one month after the procedure. The Canadian Cardiovascular Society (CCS) functional grade was assessed in all patients, and a treadmill exercise test was performed sequentially (before and after the procedure) in angioplasty patients. Cronbach's alpha reliability coefficients for reduced DASI scores were high (between 0.81 and 0.89). Correlations of the reduced DASI scores with CCS grade and exercise test duration were moderately high (r = -0.51 and r = 0.45, respectively). Improvement after angioplasty as assessed by the reduced DASI scores was important (effect size = 0.75, P < 0.001).

Conclusion The reduced DASI is reliable, valid and responsive to clinical changes. Health-related quality of life measures may be useful in monitoring coronary patients.

Key Words: Health-related quality of life, functional capacity, chronic coronary patients, questionnaires, validity, reliability.

Introduction

In the last decade, assessment of the effectiveness of some cardiovascular therapies has frequently included the use of health-related quality of life instruments. Coronary artery bypass grafting, cardiac transplant, different antihypertensive therapies, and the comparison of outcomes after treatment of myocardial infarction by U.S. and Canadian clinicians have been evaluated by instruments that address functional capacity or health-related quality of life.

Health-related quality of life instruments should add to clinical assessment, and may be useful in understanding the substantial variability in functioning of patients with similar levels of clinical impairment.

Generic instruments are designed for a broad assessment of patients with different conditions, thus allowing for comparisons across patient groups. Several generic instruments have been shown to be valid and reliable, while specific instruments, more narrow in scope, focus on the impact of a specific disease. A recent study by Spertus et al., showed that the responsiveness to perceived clinical change in two groups of coronary artery disease patients was higher for the Seattle Angina Questionnaire, a disease-specific functional status measure, than for the SF-36, a generic measure of health. As the authors pointed out, although generic measures are useful for interpretation and comparison purposes, they are not a substitute for disease-specific instruments in the evaluation of clinical change. This is because specific measures usually cover functional capacity and symptoms, while most of the generic questionnaires cover more general concepts (i.e. health status). For all these reasons, specific instruments
may become more widely used in clinical research and practice.\(^\text{[9,10]}\)

Common functional measures used to assess functional grade in cardiovascular patients, such as the New York Heart Association (NYHA)\(^\text{[11]}\) and the Canadian Cardiovascular Society (CCS)\(^\text{[12]}\) classifications, have been criticized because of a lack of reliability and a low level of correlation with clinical tests (i.e., exercise tests).\(^\text{[13-15]}\) Therefore, it has been suggested that these functional classifications be supplemented by measures providing more accurate estimates of physical capability in cardiac patients.

The Duke Activity Status Index (DASI) is a self-administered questionnaire designed to measure functional capacity of cardiovascular patients, based on the patient’s ability to perform a set of common activities of daily living.\(^\text{[16,17]}\) The DASI has been used in large cross-sectional studies of coronary patients.\(^\text{[18]}\) Nevertheless, its ability to assess clinical changes and its correlation with changes in other measures have not been extensively evaluated. A reduced version of the scale was developed in the context of the SUPPORT study.\(^\text{[18]}\) Such an instrument might be appropriate as a simple and easy-to-administer measure of functional capacity to be used in clinical settings complementing the New York Heart Association or the CCS classifications. Short health status measures may be more easily introduced in clinical monitoring, provided they yield valid and reliable measurements.\(^\text{[19]}\)

The present study assessed the reliability, validity and responsiveness (or sensitivity) to clinical change of a reduced version of the DASI in two subgroups of chronic coronary patients with different patterns of disease change over time.

**Methods**

**The reduced DASI**

The DASI is a measure of functional capacity developed by Hlatky et al.\(^\text{[16]}\). It has been shown to be valid by a high correlation (r, ranging from 0.81 to 0.58) with peak oxygen uptake in 50 subjects undergoing graded exercise testing and to vary in a predictable way according to different clinical variables.\(^\text{[16]}\) The DASI has been used in several research projects evaluating the effectiveness of therapies for several heart diseases.\(^\text{[3,6]}\)

For the present study, a reduced version that had been produced for the SUPPORT study\(^\text{[20]}\) was used. The rationale for developing a reduced version was that it could be more suitable in studies where respondent burden needs to be minimal. Moreover, shorter instruments may facilitate the measurement of patient-based functional status in medical practice.\(^\text{[19]}\) This version was constructed to include information on all 12 items in the original DASI except for sexual function (original item 10), and for activities of daily living (original item 1). Also, for simplicity, the three items on yard work, moderate recreation and strenuous recreation were combined into a single item.\(^\text{[20]}\) To our knowledge, no information is available about the metric performance of the reduced DASI. Two of the authors in collaboration with the late Prof. M. Bergner, one of the original developers of the reduced DASI, adapted the index into Spanish.

In Table 1, the list of the activities included in the reduced DASI is shown, together with item weights used for the present analysis. Patients were asked to report on the degree of difficulty in performing the eight activities over a period of 2 weeks. Information about DASI item weights was kindly provided by researchers at Duke (C. Alzola), Harvard (F. Cook), and Johns Hopkins (A. Damiano) universities. A final score was calculated by multiplying each item weight by the value of: 3 ('Done without difficulty'), 2 ('Done with difficulty'), or 1 ('Not done because of health reasons'). Therefore, the higher the score, the better the function level. DASI scores range between 33 (highest function level) and 11.5 (lowest function level).

In the reduced DASI questionnaire, activities appear following a hierarchic order (the least demanding activity is asked first). A hierarchic 'skip pattern' was followed: patients responding 'Not done because of health reasons' in item 1 skipped items 2 to 4, and were asked about activities in item 5 (Table 1). If a patient reported that an activity was 'Not done because of reasons other than health', the skip pattern was not used and the next item was always asked. In the analysis, missing items were imputed with the response choice of the preceding item, assuming that the patient would have at least the same level of difficulty.

**Patient selection**

Two sets of coronary heart disease patients from the Hospital General Universitari Vall d’Hebron were included in the study from April 1991 to July 1992: a group of stable outpatients and a group of patients undergoing angioplasty. The first group (stable patients) was composed of patients considered to be stable by their cardiologist and who gave their informed consent to participate. These patients were selected for the study if: (a) they had definite coronary artery disease (past myocardial infarction or significant coronary stenoses) whether they had angina or not; (b) their clinical condition had remained unchanged over the last 3 months, as assessed by their cardiologist; and (c) they had been free from acute myocardial infarction and/or unstable angina in the previous 6 months. Patients were recruited after a routine medical visit. A research nurse assessed their functional status using CCS classification. Patients were also administered the reduced DASI during their initial visit. Two weeks later, they were re-administered the reduced DASI along with questions about change in their general health status and heart disease. A total of 46 stable patients completed the test and the re-test questionnaires.

Concurrently, a group of patients undergoing elective angioplasty for angina pectoris was recruited in
Table 1 Reduced DASI used in the study*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Degree of difficulty in the past 2 weeks for...</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Walking indoors</td>
<td>(if not done because of health reasons, skip to 5)</td>
<td>1</td>
</tr>
<tr>
<td>2. Walking a block or two</td>
<td>(if not done because of health reasons, skip to 5)</td>
<td>1</td>
</tr>
<tr>
<td>3. Climbing a flight of stairs</td>
<td>(if not done because of health reasons, skip to 5)</td>
<td>1</td>
</tr>
<tr>
<td>4. Running a short distance</td>
<td>(if not done because of health reasons, skip to 5)</td>
<td>1</td>
</tr>
<tr>
<td>5. Doing light housework</td>
<td>(if not done because of health reasons, finalize)</td>
<td>1.5</td>
</tr>
<tr>
<td>6. Doing moderate housework</td>
<td>(if not done because of health reasons, finalize)</td>
<td>1.5</td>
</tr>
<tr>
<td>7. Doing heavy housework</td>
<td>(if not done because of health reasons, finalize)</td>
<td>1.5</td>
</tr>
<tr>
<td>8. Doing moderate to vigorous exercise</td>
<td>(finalize)</td>
<td>2.5</td>
</tr>
</tbody>
</table>

*A final score was calculated by the summatory of giving each item a value of: 3 = 'Done without difficulty', 2 = 'Done with difficulty', and 1 = 'Not done because of health reasons'. If an activity was 'Not done because reasons other than health', the response for the previous activity was imputed in the analysis.

DASI = Duke Activity Status Index.

Table 2 Description of the two samples: patients undergoing angioplasty and stable patients

<table>
<thead>
<tr>
<th></th>
<th>Angioplasty patients (n=44)</th>
<th>Stable patients (n=46)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age, years (± SD)</td>
<td>55.5 (± 8.1)</td>
<td>61.2 (± 7.6)</td>
</tr>
<tr>
<td>Male sex, %</td>
<td>61.9</td>
<td>89.0</td>
</tr>
<tr>
<td>CCS classification, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>9.0</td>
<td>45.5</td>
</tr>
<tr>
<td>II</td>
<td>20.5</td>
<td>50.0</td>
</tr>
<tr>
<td>III</td>
<td>54.5</td>
<td>45.0</td>
</tr>
<tr>
<td>IV</td>
<td>15.9</td>
<td>0.0</td>
</tr>
<tr>
<td>Number of diseased vessels (≥ 75% stenosis), %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>52.3</td>
<td>NA</td>
</tr>
<tr>
<td>2</td>
<td>47.7</td>
<td>NA</td>
</tr>
<tr>
<td>3</td>
<td>0.0</td>
<td>NA</td>
</tr>
<tr>
<td>Mean duration of exercise test, seconds (± SD) [range]</td>
<td>360.1 (± 122.3) [155-575]</td>
<td>NA</td>
</tr>
</tbody>
</table>

CCS = Canadian Cardiovascular Society; NA = not available; SD = standard deviation.

Statistical procedures

Internal consistency was calculated using Cronbach’s alpha reliability coefficients. Mean test and re-test scores were compared using a t-test. Spearman correlation coefficients were used to assess the association among reduced DASI scores and categories of patients according to clinical information (functional and exercise test duration categories). Pearson’s correlation coefficients were calculated among continuous variables (reduced DASI scores and duration of exercise test in seconds).

The effect size, a statistic that transforms the score change into a standard unit of measurement which can be compared with score changes on other instruments, was calculated following the method outlined by Kazis et al. with the formula:

\[ \text{effect size} = \frac{\text{baseline mean} - \text{follow-up mean}}{\text{baseline SD}} \]

All P values were based on two-tailed tests, and the level of statistical significance was \( P < 0.05 \).

Results

Clinical characteristics of the two groups of patients studied are shown in Table 2. As expected, a higher
Table 3 Reduced DASI score by patient group

<table>
<thead>
<tr>
<th></th>
<th>Angioplasty patients (n=44)</th>
<th>Stable patients (n=46)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>24.7 (6.7)</td>
<td>27.8 (5.2)*</td>
</tr>
<tr>
<td>% 'Ceiling'†</td>
<td>26.2</td>
<td>34.8</td>
</tr>
<tr>
<td>% 'Floor'‡</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Internal Consistency (Cronbach's Alpha)</td>
<td>0.89</td>
<td>0.85</td>
</tr>
<tr>
<td><strong>Second administration</strong></td>
<td>(1 month after angioplasty)</td>
<td>(at 2 weeks)</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>29.7 (4.0)</td>
<td>29.1 (5.2)</td>
</tr>
<tr>
<td>% 'Ceiling'†</td>
<td>54.8</td>
<td>48.9</td>
</tr>
<tr>
<td>% 'Floor'‡</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Internal Consistency (Cronbach's Alpha)</td>
<td>0.86</td>
<td>0.81</td>
</tr>
</tbody>
</table>

*Difference between angioplasty and stable patients P<0.05; †% 'Ceiling' is the proportion of patients with the highest score (highest functional status); ‡% 'Floor' is the proportion of patients with the lowest possible score.

SD=Standard deviation.

Table 4 Mean differences between first and second assessment for patients undergoing coronary angioplasty and for stable patients

<table>
<thead>
<tr>
<th></th>
<th>Angioplasty patients (n=44)</th>
<th>Stable patients (n=46)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DASI score</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean difference (SD)</td>
<td>4.75 (5.3)</td>
<td>1.14 (4.32)</td>
</tr>
<tr>
<td>P value</td>
<td>&lt;0.001</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Effect size</td>
<td>0.75</td>
<td>0.22</td>
</tr>
<tr>
<td>Duration of exercise test (s)</td>
<td>45.9 (11.6-7)</td>
<td>NA</td>
</tr>
<tr>
<td>P value</td>
<td>0.01</td>
<td>NA</td>
</tr>
<tr>
<td>Effect size</td>
<td>0.40</td>
<td>NA</td>
</tr>
</tbody>
</table>

DASI=Duke Activity Status Index; NA=not available; SD=standard deviation.

proportion of angioplasty patients were in functional classes III and IV.

Mean DASI scores were higher for stable patients than for patients undergoing angioplasty (Table 3). Also, the percentage of patients obtaining the highest score ('ceiling effect') was higher among stable patients at baseline; in the re-test, more angioplasty patients reached the highest functional DASI score. Internal consistency Cronbach's alpha coefficients ranged between 0.81 and 0.89 (Table 3).

There were no statistically significant differences in DASI scores for stable patients in the 2-week re-test period. Conversely, changes before and after angioplasty were statistically significant (P<0.001) (Table 4). The effect size, that is, the standardized measure of change, was more than three times higher for angioplasty patients than for stable patients (0.75 and 0.22, respectively).

Spearman correlation coefficients between the DASI score and the CCS functional grade was −0.41 (P<0.01) before angioplasty and −0.51 after angioplasty (P<0.001) (Table 5). Correlation coefficients between the DASI scores and the duration of the exercise test in seconds were higher than those between the duration of exercise test and functional grade, both before and after angioplasty.

Figure 1 shows the distribution of DASI scores for patients undergoing angioplasty before (X axis) and 1 month after (Y axis) the procedure. Points above the diagonal represent patients improving their functional status, the distance to the diagonal reflecting the degree of improvement. Three patients showed smaller DASI scores after angioplasty, while 10 patients scored the highest score before and after the procedure.

**Discussion**

The results of the present study support the reliability and validity of the reduced DASI in patients with coronary artery disease representing two different points in the clinical spectrum of coronary syndromes: chronic stable patients and patients undergoing elective angioplasty for angina pectoris. In clinically stable patients, internal consistency was high and scores were reproducible. In both groups of patients, the level of correlation...
and in those patients undergoing coronary angioplasty. Given its brevity it should be tentatively considered for the assessment of functional status in coronary artery disease patients; * = 10 patients.

A recent study by Spertus et al. [8], suggested that specific health-related quality of life instruments may be of significant help in the routine evaluation of clinical change in stable patients with coronary artery disease and in those patients undergoing coronary angioplasty. Our results suggest that the reduced DASI may also help in achieving this aim. Our findings are in agreement with those of Spertus et al. [8]; in addition, the design of our study included correlations with common clinical measures such as the exercise test and clinical classification. On the basis of these results, the reduced DASI might be considered as a more valid and reliable instrument for the assessment of functional status in coronary patients attending a tertiary hospital than the CCS. Given its brevity it should be tentatively considered for the routine clinical evaluation of chronic coronary patients, if our results were further confirmed in wider populations.

The sizeable ceiling effect detected in our study among both stable patients and patients undergoing angioplasty deserves further discussion. An interpretation of the finding that 34.8% of stable patients and the 26.2% of patients undergoing angioplasty who achieved the highest level of functional capacity is that the reduced DASI is inadequate for patients with relatively good functional capacity. McHorney and Tarlov [22] have suggested that a ceiling effect higher than 15% may render a questionnaire inadequate for assessing individuals for clinical purposes, and thus the reduced DASI could not be responsive to a possible improvement in these patients. If this were the case, it would certainly reflect a weakness of the index, but this conclusion would require further testing. On the one hand, the stable group included patients with previous myocardial infarction and no angina: 45-5% of them were in CCS grade I. Thus, a high ceiling effect should not be particularly surprising in this patient subgroup. On the other hand, it may be that a considerable proportion of patients with angioplasty have the procedure indicated based on anatomical (angiography-driven) rather than functional status (patient-driven) considerations (e.g. 9% of angioplasty patients were in CCS grade I before the procedure). Differences between anatomically-based and patient-based clinical status have been reported [35], and that up to 17% of coronary angiographies may be clinically inappropriate [22]. All these explanations deserve further analysis before reaching a conclusion about the limitations of the reduced DASI as an adjunct measure for the evaluation of chronic coronary patients. It is possible that the original full DASI or other questionnaires assessing a wider range of strenuous activities could be more appropriate than the reduced DASI for monitoring mild coronary heart disease patients over time. On the other hand, the reduced DASI is a valid and reliable alternative when respondent burden needs to be limited. At any rate, results presented suggest the adequacy of using health status measures in coronary artery disease patients.

Second, in angioplasty patients, correlations between the reduced DASI and exercise testing were higher 1 month after the procedure than at baseline. Before angioplasty, reduced DASI scores (and also the CCS functional grade) may have been confounded by external restrictions placed on patients by physicians’ instructions. This is much less likely to have been the case after the procedure. It is likely that the performance of any measuring instrument based on the patients’ report of usual activities during a specific recall period depends on the extent to which these activities are modified by external factors such as doctors’ prescription or hospitalization. This problem is not unique to the reduced DASI and should be borne in mind in the use of instruments for the evaluation of coronary patients eligible for angioplasty. Our findings illustrate the possible limitations of assessing functional capacity in patients with coronary artery disease whose activities are limited by reasons other than symptoms. An important advantage of the assessment of functional capacity using the reduced DASI is that it is an estimation of the magnitude of change may be made. The effect size for DASI scores before and after angioplasty suggests that the clinical change may be moderate (0:5) or large (0:8) [31]. This effect is even higher than

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that observed for exercise testing, one of the most stand-
ardized clinical tests for evaluating coronary patients.

In summary, the reduced DASI has been shown to be
reliable, valid and responsive to clinical changes. Also,
the index seems feasible as a routine measure of func-
tional capacity in coronary patients attending ter-
tary hospitals. The latter deserves further research (e.g.
on the acceptability and administration burden) in dif-
ferent clinical settings on larger samples of patients,
before a recommendation for systematic use of such a
measure as a clinical evaluation of coronary artery
disease may be made. Nonetheless, the relative advan-
tage of reducing the number of items in the original
DASI should be counterbalanced against the possible
loss of responsiveness of the reduced DASI.

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