Development and Validation of a Short Version of the Seattle Angina Questionnaire

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Background—Clinical trials and national performance measures increasingly mandate reporting patients’ perspectives of their health status: their symptoms, function, and quality of life. Although the Seattle Angina Questionnaire (SAQ) is a validated disease-specific health status instrument for coronary artery disease (CAD) with high test-retest reliability, predictive power, and responsiveness, its use in routine clinical practice has been limited, in part, by its length (19 items).

Methods and Results—Using data from 10,408 patients with CAD from 5 multicenter registries, we derived and validated a shortened version of the SAQ (SAQ-7) among patients presenting with stable CAD, undergoing percutaneous coronary intervention, and after acute myocardial infarction. We examined the psychometric properties of the SAQ-7 as compared with the full SAQ. Seven items from the Physical Limitation, Angina Frequency, and Quality of Life domains were identified for the SAQ-7, with high levels of concordance (0.88–1.00) with each original SAQ domain. The SAQ-7 demonstrated good construct validity (compared with Canadian Cardiovascular Society class for angina), with a correlation of 0.62 and 0.38 for patients with stable CAD and undergoing percutaneous coronary intervention, respectively. It was highly reproducible in patients with stable CAD (intraclass correlation, ≥0.78) and exhibited excellent responsiveness in patients after percutaneous coronary intervention (≥18 points in each SAQ domain). Finally, the SAQ-7 was predictive of 1-year mortality and readmission.

Conclusions—To increase the feasibility of measuring patient-reported outcomes in patients with CAD, we developed and validated a shortened 7-item SAQ instrument for use in clinical trials and routine care.

Key Words: coronary artery disease ■ health services research ■ health status

Accurately quantifying patients’ perspectives about the impact of their coronary artery disease (CAD) on their health status (ie, symptoms, function, and quality of life) has become increasingly important as an outcome in clinical trials, as well as in quality assessment and clinical care. The Seattle Angina Questionnaire (SAQ), a commonly used instrument for measuring health status in patients with CAD, has been frequently used as an outcome in clinical trials and has been endorsed as a performance measure for assessing the quality of CAD care. The use of the SAQ in quality assessment and clinical care, however, has been limited because of its length (19 questions) and the absence of a single summary score that facilitates an overall assessment of patients’ health status.

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Given the importance of being able to accurately and objectively assess patients’ health status and prognosis using a low-cost, noninvasive strategy, we sought to develop a shorter version of the SAQ that preserves the full instrument’s psychometric and prognostic properties. Shortening the SAQ directly addresses recently articulated challenges that hinder the routine use of patient-reported outcomes in clinical care. This report describes the development and validation of the SAQ-7 and its summary score, including its psychometric (validity, reliability, and responsiveness to change) and prognostic properties.

Methods

The SAQ

This SAQ quantifies 5 domains measuring the impact of angina on patients’ health status: Physical Limitation (9 items), Angina Stability (1 item), Angina Frequency (2 items), Treatment Satisfaction (4 items), and Quality of Life (3 items). Item responses are coded sequentially from worst to best status and range from 1 to 6 for Physical Limitation, Angina Stability, and Angina Frequency items; 1 to 5/6 for Treatment Satisfaction items; and 1 to 5 for Quality of Life items. Scores are generated for each domain and are scaled 0 to 100, with 0 denoting the worst and 100 the best possible status. The SAQ has been shown to be valid, reproducible, and sensitive to clinical change. Moreover, patients’ SAQ scores have been found to be independently prognostic of subsequent mortality, hospitalization, and resource use.

Data Sources

We used data from 5 longitudinal cohort studies of CAD patients for the development and validation of a shortened SAQ, all of which underwent institutional review board review and approval at each participating institution.

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WHAT IS KNOWN

- The Seattle Angina Questionnaire (SAQ) is a validated disease-specific instrument for assessing the health status of patients with coronary artery disease.
- Although the SAQ has been frequently used in clinical trials and registries, its use in routine clinical care has been limited by its length (19 questions) and the absence of a single summary score that facilitates an overall assessment of patients’ health status.

WHAT THE STUDY ADDS

- In this article, we derived and validated a 7-item shortened version of the SAQ (SAQ-7), as well as an overall summary score, to facilitate assessments of health status in patients with coronary artery disease. The SAQ-7 performed well in patients with stable coronary artery disease, undergoing percutaneous coronary intervention, and presenting with acute myocardial infarction.
- The SAQ-7 has the potential to improve clinical care by providing physicians an objective, efficient mechanism to follow the trajectory of their coronary artery disease patients’ health status.

In deriving the short SAQ, we restricted consideration to the 3 domains that directly measure patients' current health status: Physical Limitation, Angina Frequency, and Quality of Life. Within each of these domains, we examined how closely each item tracked with its respective score. An explicit goal of this analysis was to maximize comparability between short- and full-version SAQ scores. Because the scores are essentially equivalent to unweighted averages of the item responses, we examined the concordance between each item and its domain score rather than the simple correlation. To accomplish this, we first rescaled the item responses to 0 to 100 to match the scale of the scores. We then calculated Lin concordance correlation coefficient, which measures the agreement between 2 variables. Values range from −1 (perfect negative agreement) to 1 (perfect positive agreement), with 0 denoting no agreement. Items with higher concordance coefficients were preferred. In cases where items demonstrated similar concordance rates, the clinical importance, response variability, and nonresponse rates of an item question were also considered in determining which item questions were retained in the shortened SAQ. For the Physical Limitation scale, which covers low-, moderate-, and high-intensity activities (3 items in each level), item selection was performed separately within each level, to preserve the range of activities covered in the full scale. Analyses were repeated for each of the 3 clinical settings described above (stable CAD, elective PCI, acute MI), and the items identified within each setting were combined to arrive at a final short version of the SAQ.

Once the final set of items was identified, scores for each of the 3 domains were calculated using methodology analogous to that of the full SAQ, so that scores ranged from 0 to 100 for each domain. In addition, an overall summary SAQ score was derived as the average of the 3 domain scores. A summary score was also derived for the full SAQ using the same 3 domains, and the psychometric properties of the new summary score were calculated as for each scale of the short SAQ.

Validation

Within each of the 3 clinical settings, we conducted a series of analyses in independent samples to evaluate construct validity, reproducibility, responsiveness, and predictive validity of the short SAQ and summary scores. Parallel analyses were conducted for the full SAQ, which served as the gold standard for comparison. The specific clinical settings, studies, and assessments used for each analysis are described in Table 2.

Construct Validity

To evaluate construct validity, we first compared each of the short SAQ scores with their respective score from the full SAQ. Means and SDs of scores, mean and SD of differences, and concordance coefficients, as described above, are reported. In addition, among stable CAD and PCI patients, we calculated mean SAQ summary scores by Canadian Cardiovascular Society (CCS) angina class 0 through IV and estimated the association between SAQ score and CCS class using Kendall τ-b rank correlation coefficient.

Reproducibility

Reproducibility of the short SAQ was assessed by comparing serial scores in stable patients. For this analysis, we compared scores at 5 and 6 months post-PCI among PRESS patients who had stable CAD, a period where patients’ health status is presumed to be stable. To further confirm stability of patients’ clinical status, we also required that patients in this analysis had no intervening coronary revascularization events and reported (by the SAQ Angina Stability scale, which is not part of the SAQ-7 or the summary score and asks patients about recent changes in their angina, at 6 months) that they had no change in angina symptoms during the past 4 weeks. In this cohort, we calculated the mean and SD of change scores and intraclass correlations. The intraclass correlation denotes the proportion of variability in scores because of between-patient (versus within-patient) differences. Intraclass correlations >0.4, 0.6, and 0.8 indicate moderate, substantial, and excellent reproducibility.

Responsiveness

The responsiveness of the short SAQ to clinical change was quantified by the change from baseline to 1 month after PCI in the PRISM study, a period when substantial improvements in patients’ health status are anticipated. We calculated the mean and SD of change as well as the standardized response mean, which is defined as the mean change divided by the SD of change. Standardized response means >0.5 and 0.8 indicate moderate and strong responsiveness, respectively.

Predictive Validity

Predictive validity was assessed by comparing 12-month outcomes of mortality and acute coronary syndrome hospitalization among post-acute MI patients within the TRIUMPH study. Mortality was assessed via query of the Social Security Administration Death Master File, and acute coronary syndrome hospitalizations were determined via physician panel adjudication of patient-reported hospital visits. In these analyses, we used patients’ 1-month assessment after MI hospitalization as time zero, to measure prognosis after a patient’s health status has stabilized after the acute event. Cumulative 12-month incidence was calculated using Kaplan–Meier methods within predefined score categories of 0 to <50
The activity” were also substantially higher). From the 2-item Angina Frequency scale, although concordance and variability were both greater for symptom frequency, we opted to retain both items for consistency with the full SAQ, given the wide use of this scale and the relatively minimal burden of a single additional item. From the 3-item Quality of Life scale, we selected items 9 (limitation of enjoyment of life) and 10 (feelings about spending the rest of your life with symptoms as they are now), which had superior concordance among both stable CAD patients and PCI patients. Item 11 (how often do you worry about having a heart attack or dying suddenly) was only slightly more concordant with the Quality of Life score among patients experiencing an acute MI. In summary, we identified 7 items (3 Physical Limitation, 2 Angina Frequency, and 2 Quality of Life items) to retain in the final short version of the SAQ (Figure).

Validation

Construct Validity

Agreement between the SAQ-7 and full SAQ scores was excellent in all clinical settings, with concordance ≥0.92 for Physical Limitation, Quality of Life, and summary scores, and categories of 0 to 60 (daily to weekly angina), >60 to <100 (monthly angina), and 100 (no angina) for the Angina Frequency score.8 Score discrimination was evaluated by c statistics from proportional hazards regression models.

Results

Across the 5 registries represented in these analyses, SAQ data were available on 10,408 patients. Descriptions of the studies, patient populations, and timing of SAQ assessments are listed in Table 1, and a summary of patient characteristics for the derivation and validation cohorts is provided in Table I in the Data Supplement.

Derivation

Item selection was conducted within independent samples representing each of the 3 clinical settings: stable CAD (PRISM 12-month assessment; n=975), elective PCI (PRISM baseline assessment; n=1116), and acute MI (TRIUMPH baseline assessment; n=4340). Item response means and SDs, missing rates, and item–score concordance coefficients within each of these settings are outlined in Table 3. In general, stable CAD patients had few limitations, minimal symptoms, and good quality of life; in comparison, acute MI patients had slightly more symptoms and worse quality of life, and PCI patients had the worst health status across the 3 domains. Nonresponse rates were minimal for all scales across all settings.

From the 9-item Physical Limitation scale, we selected 1 item from each of the 3 intensity levels: 1b (limitation walking indoors on level ground), 1e (limitation with gardening, vacuuming, and carrying groceries) and 1h (limiting lifting or moving heavy objects). These items had the strongest concordance with the Physical Limitation score in all but 1 clinical setting (concordance was nominally higher for the other 2 high-intensity items among stable CAD patients, but the rates of selecting “limited for other reasons or did not do
Limitation scores, ≥0.85 for Quality of Life scores, and ≥0.96 for summary scores (Table 4). Concordance was perfect for the Angina Frequency domain because the same items are used in both instruments. As with the full SAQ, missing data occurred primarily for Physical Limitation scores but was slightly less frequent in the SAQ-7. The SAQ-7 also demonstrated a strong association with CCS class, comparable with that of the full SAQ, with mean±SD summary scores ranging from 51±21 for class IV to 98±7 for class 0 patients with stable CAD (correlation of 0.62), and from 54±23 for class IV to 84±18 for class 0 patients before PCI (correlation of 0.38; Table 5). Finally, we confirmed that the performance of the SAQ-7 was concordant across patient demographic, educational, insurance, and comorbidity subgroups (Table II in the Data Supplement).

Predictive Validity
All SAQ-7 scores demonstrated a graded inverse relationship with 12-month outcomes, comparable with those of the full SAQ (Table 8). Predictive power for 12-month mortality was strongest for Physical Limitation scores, ranging from 2% for patients with scores of 75 to 100 to 10% for patients with scores <50 (c=0.64). Twelve-month acute coronary syndrome hospitalization was most strongly associated with Angina Frequency scores, ranging from 5% for patients with no angina to 16% for patients with daily to weekly angina (c=0.63).

Discussion
To achieve a more patient-centered healthcare system, a strategy to accurately document patients’ perspectives of their health status and track their health trajectories is a priority. Unfortunately, despite its importance, this goal often remains an unfulfilled need. Among those with CAD, the SAQ systematically quantifies patients’ angina symptoms, functional limitations because of angina, and the impact that angina has on perceptions of their quality of life. The SAQ has now been used for >20 years in clinical trials and observational research studies and has been a sensitive measure for describing the relative benefits of coronary revascularization,14–19 medical management of stable CAD,20 and disparities in healthcare...
The Seattle Angina Questionnaire-7

1. The following is a list of activities that people often do during the week. Although for some people with several medical problems it is difficult to determine what it is that limits them, please go over the activities listed below and indicate how much limitation you have had due to chest pain, chest tightness or angina over the past 4 weeks.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Extremely limited</th>
<th>Quite a bit limited</th>
<th>Moderately Limited</th>
<th>Slightly limited</th>
<th>Not at all limited</th>
<th>Limited for other reasons or did not do the activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Walking indoors on level ground</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>b. Gardening, vacuuming or carrying groceries</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>c. Lifting or moving heavy objects (e.g. furniture, children)</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

2. Over the past 4 weeks, on average, how many times have you had chest pain, chest tightness or angina?

- □ 4 or more times per day
- □ 1-3 times per day
- □ 3 or more times per week but not every day
- □ 1-2 times per week
- □ Less than once a week
- □ None over the past 4 weeks

3. Over the past 4 weeks, on average, how many times have you had to take nitroglycerin (nitroglycerin tablets or spray) for your chest pain, chest tightness or angina?

- □ 4 or more times per day
- □ 1-3 times per day
- □ 3 or more times per week but not every day
- □ 1-2 times per week
- □ Less than once a week
- □ None over the past 4 weeks

4. Over the past 4 weeks, how much has your chest pain, chest tightness or angina limited your enjoyment of life?

- □ It has extremely limited my enjoyment of life
- □ It has limited my enjoyment of life quite a bit
- □ It has moderately limited my enjoyment of life
- □ It has slightly limited my enjoyment of life
- □ It has not limited my enjoyment of life at all

5. If you had to spend the rest of your life with your chest pain, chest tightness or angina the way it is right now, how would you feel about this?

- □ Not satisfied at all
- □ Mostly dissatisfied
- □ Somewhat satisfied
- □ Mostly satisfied
- □ Completely satisfied

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Figure. The shortened SAQ-7 instrument. Although the original Seattle Angina Questionnaire (SAQ) instrument was designed to independently assess patients’ symptoms, function, and quality of life, the 19 items of the SAQ made interpretation more complex and less feasible to administer. In this figure, we present the shortened SAQ-7 instrument, with similar construct validity, predictiveness, reliability, and responsiveness as the original SAQ instrument.
multiple SAQ domains and allow clinicians to quickly screen patients for a significant change in their health status.

Although further testing is needed, we think that the SAQ-7 has the potential to improve the efficiency of clinical care by enabling patients to complete the 7-item instrument before an office visit and for clinicians to instantly compare the overall summary score with a previous score to know whether, and how much, patients’ CAD health status has changed. Such a measurement of angina and health status from the patients’ perspective can more accurately describe patient-reported outcomes than one assigned by physicians, such as the CCS class for angina. In fact, a recent study found substantial discordance between patients’ and physicians’ assessments of angina control.25 By systematically asking the same questions in the same way over time, the SAQ summary score offers substantial advantages compared with CCS class in assessing angina from the patients’ perspective, because it uses a reproducible and sensitive standard for quantifying their health status. In fact, it is possible that the SAQ-7 may facilitate measurement of CAD patients’ health status as a vital sign in routine clinical care, prompting physicians when a significant change in patients’ symptoms and quality of life has occurred. Whether the summary score can improve population management, shared decision making, or individual patients’ clinical outcomes needs to be formally tested in prospective studies.

The use of a shorter health status instrument and an overall summary score may also have applications in quality assessment. Recently, appropriate use criteria have been developed for coronary revascularization to better highlight the judicious use of procedures such as PCI in patients with obstructive CAD.26 In a subsequent study involving >500,000 patients undergoing PCI since the dissemination of these criteria, ≈12% of procedures performed in patients with stable CAD were categorized as inappropriate, wherein a technical panel determined that the benefits of the procedure were not felt to

| Table 4. Score Descriptive Statistics and Concordance With Full SAQ |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
|                         | SAQ-7                             | Full SAQ                             |                         |                         |
|                         | Mean±SD | Percent Missing | Mean±SD | Percent Missing | Correlation | Concordance | Mean±SD | Percent Missing | Correlation | Concordance |
| Stable CAD (n=1221)     |                   |                   |                   |                   |             |           |                   |                   |             |           |
| Physical Limitation     | 95±14    | 17%              | 95±14    | 21%              | 0.95         | 0.95       |
| Angina Frequency        | 93±15    | 0%               | 93±15    | 0%               | 1.00         | 1.00       |
| Quality of Life         | 87±20    | 0%               | 81±19    | 0%               | 0.89         | 0.85       |
| Summary score           | 91±15    | 0%               | 89±14    | 0%               | 0.96         | 0.95       |
| PCI (n=1455)            |                   |                   |                   |                   |             |           |                   |                   |             |           |
| Physical Limitation     | 79±25    | 10%              | 75±24    | 12%              | 0.93         | 0.92       |
| Angina Frequency        | 70±25    | 0%               | 70±25    | 0%               | 1.00         | 1.00       |
| Quality of Life         | 52±31    | 0%               | 56±26    | 0%               | 0.94         | 0.91       |
| Summary score           | 66±22    | 0%               | 67±21    | 0%               | 0.97         | 0.97       |
| Acute MI (n=2487)       |                   |                   |                   |                   |             |           |                   |                   |             |           |
| Physical Limitation     | 85±26    | 15%              | 83±25    | 17%              | 0.96         | 0.96       |
| Angina Frequency        | 84±22    | 0%               | 84±22    | 0%               | 1.00         | 1.00       |
| Quality of Life         | 57±29    | 0%               | 62±24    | 0%               | 0.91         | 0.88       |
| Summary score           | 74±21    | 0%               | 76±19    | 0%               | 0.98         | 0.96       |

CAD indicates coronary artery disease; MI, myocardial infarction; PCI, percutaneous coronary intervention; and SAQ, Seattle Angina Questionnaire.

<table>
<thead>
<tr>
<th>Table 5. Construct Validity of the SAQ-7</th>
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<tr>
<td>CCS class</td>
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<tr>
<td>Stable CAD (n=1221)</td>
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<tr>
<td>Physical Limitation</td>
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<td>Angina Frequency</td>
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<td>Quality of Life</td>
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<td>Summary score</td>
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<td>IV</td>
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<tr>
<td>PCI (n=1455)</td>
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<tr>
<td>Physical Limitation</td>
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<td>Angina Frequency</td>
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<td>Quality of Life</td>
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<td>Summary score</td>
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</table>

In patients with stable CAD and after PCI, the SAQ-7 differentiated varying levels of angina as well as the full SAQ instrument. CAD indicates coronary artery disease; CCS, Canadian Cardiovascular Society; PCI, percutaneous coronary intervention; and SAQ, Seattle Angina Questionnaire.

<table>
<thead>
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<th>Table 6. Reliability of the SAQ-7</th>
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<tr>
<td>PCI</td>
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<tr>
<td>Physical Limitation</td>
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<td>Angina Frequency</td>
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<td>Quality of Life</td>
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<tr>
<td>Summary score</td>
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In patients with stable CAD and after PCI, the SAQ-7 had good reliability, with a mean difference of <1 point over time for each domain (n=169). SAQ indicates Seattle Angina Questionnaire.
outweigh the risks. Importantly, a key determinant of the appropriateness of the PCI procedure is the patient’s symptoms, as measured by CCS angina class. However, CCS class has been shown to be variably reported by physicians and potentially can be gamed (ie, reporting more severe angina than is truly present) to artificially reduce rates of inappropriate PCI at one’s institution. With an ever-growing focus on procedural appropriateness by national quality organizations, insurers, and emerging accountable care organizations, there may be significant financial pressures on physicians and hospitals to reduce rates of inappropriate procedures. Because of concerns that the use of physician-assessed CCS class may be gamed, we think the use of a patient-centered shortened SAQ could ensure a more accurate, systematic, and objective reporting of patients’ symptoms in future assessments of procedural appropriateness with greater consistency across hospitals.

The development of a shortened version of the SAQ and its overall summary score should be interpreted in the context of several potential limitations. First, although we demonstrated excellent psychometric performance of the SAQ-7 and summary score, as compared with the original SAQ, all of the limitations of the original instrument likely apply to the shortened version. For example, shortness of breath was not included in the original SAQ because of a desire to focus on symptoms more uniquely associated with CAD, as opposed to chronic lung disease—a common comorbidity in angina patients. We have previously shown that shortness of breath, as quantified by the Rose Dyspnea Scale, can add to the prognostic ability of the SAQ in terms of both mortality and quality of life. As such, future applications of patient-reported outcomes may choose to supplement the SAQ-7 with the Rose Dyspnea Questionnaire. A second potential limitation is that many of our cohorts were assessed during a period of relative stability and few had severe symptoms or markedly diminished health status, requiring us to collapse the lowest 2 categories of each domain into single categories. Given prior reports showing worst prognosis in patients with worst health status, the prognostic ability of the SAQ-7 may be even greater than that reported in this study. Finally, although we included >10000 patients in our analyses within a variety of clinical settings, all patients had confirmed CAD; therefore, the applicability of the SAQ in populations with angina but without known CAD remains unknown.

In conclusion, we have developed and validated the SAQ-7 instrument and a SAQ summary score to facilitate the measurement of health status in patients with CAD. This shortened version of the SAQ preserves the high test–retest reliability, responsiveness, and prognostic ability of the original SAQ while reducing the response burden from 19 to 7 items. By overcoming the implementation challenges of the full SAQ and the limitations of physician assessments of patients’ health status, the SAQ-7 and SAQ summary score have the potential to transform care by facilitating the routine measurement of patient-reported outcomes and, in so doing, improving the quality and efficiency of care.

Acknowledgments
Dr Chan had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Drs Chan and Spertus were involved in study concept and design; Dr Spertus in acquisition of data; Drs Chan, Jones, Arnold, and Spertus in the analysis and interpretation of data; Dr Chan and Spertus in drafting of the article; Drs Chan, Jones, Arnold, and Spertus in critical revision of the article for important intellectual content; and Drs Chan and Spertus in study supervision.

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Disclosures
Dr Spertus owns patent rights for the Seattle Angina Questionnaire. The other authors report no conflicts.
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