

## Predictors of Physician Under-Recognition of Angina in Outpatients With Stable Coronary Artery Disease

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**Background**—Under-recognition of angina by physicians may result in undertreatment with revascularization or medications that could improve patients' quality of life. We sought to describe characteristics associated with under-recognition of patients' angina.

**Methods and Results**—Patients with coronary disease from 25 US cardiology outpatient practices completed the Seattle Angina Questionnaire before their clinic visit, quantifying their frequency of angina during the previous month. Immediately after the clinic visit, physicians independently quantified their patients' angina. Angina frequency was categorized as none, monthly, and daily/weekly. Among 1257 patients, 411 reported angina in the previous month, of whom 173 (42%) were under-recognized by their physician, defined as the physician reporting a lower frequency category of angina than the patient. In a hierarchical logistic model, heart failure (odds ratio, 3.06, 95% confidence interval, 1.89–4.95) and less-frequent angina (odds ratio for monthly angina [versus daily/weekly], 1.69; 95% confidence interval, 1.12–2.56) were associated with greater odds of under-recognition. No other patient or physician factors were associated with under-recognition. Significant variability across physicians (median odds ratio, 2.06) was observed.

**Conclusions**—Under-recognition of angina is common in routine clinical practice. Although patients with less-frequent angina and those with heart failure more often had their angina under-recognized, most variation was unrelated to patient and physician characteristics. The large variation across physicians suggests that some physicians are more accurate in assessing angina frequency than others. Standardized prospective use of a validated clinical tool, such as the Seattle Angina Questionnaire, should be tested as a means to improve recognition of angina and, potentially, improve appropriate treatment of angina. (*Circ Cardiovasc Qual Outcomes*. 2016;9:554-559. DOI: 10.1161/CIRCOUTCOMES.116.002781.)

**Key Words:** angina pectoris ■ coronary artery disease ■ quality of healthcare

Chronic angina is exceedingly common<sup>1</sup> and substantially worsens patients' quality of life.<sup>2,3</sup> Furthermore, although physicians often focus on managing ischemia, it is the patient-reported symptoms of angina that drives healthcare utilization.<sup>4</sup> A unique feature of angina is that laboratory and imaging tests cannot measure it. Instead, effective history taking by the physician is required to quantify the patient's burden of angina and guide diagnostic and management decisions. As such, the evaluation of angina is subject to limitations inherent in history taking, including pre-existing biases and time constraints on the part of physicians and patients.<sup>5</sup>

We quantified this difficulty by asking patients with documented coronary artery disease to complete the Seattle Angina Questionnaire (SAQ)—a patient-reported, standardized assessment of angina burden during the previous 4

weeks—and then compared responses with clinical impressions of their cardiologist after the visit. Although physicians effectively recognized the absence of angina among patients who reported being asymptomatic, we found that 25% patients who reported daily or weekly angina were thought to be chest pain free by their physician.<sup>6</sup>

Under-recognition of angina by physicians could affect patients' quality of life (by failing to intensify antianginal treatment) and increase costs to the healthcare system (because of increased hospital admissions).<sup>4</sup> Variability in physician assessment of angina has been described<sup>7,8</sup>; however, the patient and physician factors that contribute to under-recognition are unknown. Understanding those factors that drive under-recognition could support efforts to improve physicians' recognition and therefore effective treatment of angina.

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## WHAT IS KNOWN

- Angina is common among patients with stable coronary artery disease and requires an effective patient/physician interview to quantify this and guide diagnostic and management decisions.

## WHAT THE STUDY ADDS

- Among patients with coronary artery disease in cardiology outpatient practices who reported angina in the previous month, 42% were believed to have less (or no) angina by their physician.
- Most of the variation in under-recognition was unrelated to patient and physician characteristics, but there was large variation across physicians, suggesting some physicians are more accurate in assessing angina than others.
- These data underscore that a more systematic approach is needed for eliciting a history and assessing angina in patients with coronary artery disease to appropriately guide further testing and treatment.
- The use of a validated, patient-centered tool for eliciting patients' angina should be tested in routine clinical care to see whether it improves angina recognition, treatment, and outcomes.

## Methods

### Study Protocol and Population

We enrolled consecutive patients with a diagnosis of ischemic heart disease (defined as stable angina, previous myocardial infarction, previous percutaneous coronary intervention, or previous coronary artery bypass graft surgery) seen in cardiology practices in the APPEAR study (Angina Prevalence and Provider Evaluation of Angina Relief). APPEAR was a cross-sectional, observational study designed to assess the frequency of angina and its impact on quality of life among outpatients with coronary artery disease. US outpatient cardiology practices that are currently participating in the PINNACLE (Practice Innovation and Clinical Excellence) registry (a national practice-based cardiovascular quality improvement registry sponsored by the American College of Cardiology National Cardiovascular Data Registry) were invited to participate in APPEAR. We selected cardiology practices for analysis because we believed that this would represent the best-case scenario when physicians are assessing chest pain in routine practice. Patients were then recruited from the 25 participating practices between April 2013 and July 2015 (Figure 1 and Table 1 in the [Data Supplement](#)). For 1 to 2 weeks of active enrollment per site, local study co-ordinators recruited 25 to 50 consecutive adults with a history of coronary artery disease, irrespective of the reason for their appointment.

To be included in the study, patients had to be  $\geq 18$  years of age, have coronary artery disease, and have had at least 1 previous office visit to the practice. Patients who declined participation, had dementia, were unable to speak or read English, and were prisoners were excluded. For this specific analysis, because we were interested in under-recognition of angina by physicians, we included only patients who reported some angina in the previous 4 weeks. Clinical data were collected from chart abstraction, while patients' assessments of their angina was captured immediately before the visit, and physicians' reports of angina frequency were collected immediately after the clinic visit. Each participating site obtained Institutional Research Board approval, and all patients provided written, informed consent.

### Patient-Reported and Physician-Assessed Angina

Before the visit with the cardiologist, patients were asked to complete a questionnaire that included sociodemographic characteristics and patient-reported health status measures. Patients completed the SAQ, a 19-item self-administered, reliable, and valid questionnaire that measures 5 dimensions of health in patients with coronary artery disease.<sup>9,10</sup> The SAQ has a 4-week recall period, and domain scores range from 0 to 100, with higher scores indicating less disease burden. The primary domain of interest for our study was the SAQ angina frequency domain, which has been shown to correlate well with patient-reported daily diaries of angina.<sup>11</sup> To facilitate clinical interpretability, scores were categorized, congruent with previous work, as none (SAQ score=100), monthly (SAQ score=61–99), weekly (SAQ score=31–60), and daily (SAQ score=0–30).<sup>12</sup>

Immediately after the visit, physicians were asked: "In the past 4 weeks, has the patient had chest pain, angina or angina-equivalent symptoms?" If yes, the physician was then asked to describe the character of the patient's chest pain (typical angina, atypical angina, and noncardiac chest pain), frequency (daily, weekly, monthly, and less than monthly), location (chest, arm, back, neck, stomach, shoulder, leg, jaw, and other), associated symptoms (dyspnea, nausea, confusion, light-headedness, sweating, and other), and whether the symptoms were provoked by exertion or by emotional stress and if they were relieved by rest or by short-acting nitrates.

### Definition of Physician Under-Recognition

The SAQ-generated categories of none, monthly, or daily/weekly angina were used to represent the patients' reports of their angina frequency, and the physicians' documentation of angina frequency was used to quantify the physicians' perceptions of angina frequency. Using these categories, under-recognition was defined as the physician rating the patient's angina at a lower frequency category than what the patient reported.

### Statistical Analysis

Demographic and clinical characteristics were compared between patients who were and were not under-recognized using *t* tests for continuous variables and  $\chi^2$  tests or Fisher exact test for categorical variables. We then constructed a hierarchical logistic model to examine patient and physician factors associated with under-recognition by the physician. Variables for the model were selected a priori based on clinical judgment. Patient factors included age, sex, race, self-reported avoidance of care because of costs, chronic lung disease, chronic heart failure, diabetes mellitus, history of coronary artery bypass graft surgery, and category of angina frequency. Physician-level variables included sex and years since finishing cardiology training. Both physician and site were included as random effects, to account for patient clustering within physician and within site. Nonlinear spline terms were tested for all continuous variables, but none were significant and were therefore not retained in the model. Physician-level variability was explored with a median odds ratio, which estimates the average relative difference in 2 hypothetical patients being under-recognized if seen by 2 different physicians. Also, we calculated the intraclass correlation coefficient, which estimates the proportion of the total variance in under-recognition that is accounted for by physician variation (as compared with patient factors).<sup>13</sup> The intraclass correlation coefficient was calculated from the variance components of the hierarchical logistic regression model; this quantifies variation in an underlying continuous latent variable representing the propensity for recognition of patients' angina.

Goodness of fit of the model was examined with the c-index (to test discrimination) and by plotting predicted versus observed values and comparing these against the line  $y=x$  (to test calibration). Collinearity was determined not significant as the variance inflation factor was  $\leq 1.20$  for all variables, and the condition index was  $< 30$ . Baseline data had a high rate of completion, with only 2 patients missing 1 data element, which were estimated using a single imputation data set (IVEware; Institute for Social Research, University of Michigan, Ann Arbor, MI). All statistical analyses

were performed with SAS, version 9.4 (SAS Institute, Inc, Cary, NC) and R version 3.2.0.<sup>14</sup>

## Results

### Study Population

APPEAR enrolled 1257 patients, of whom 411 patients (32.6%) reported angina in the previous month and formed the analytic cohort. The mean age of the analytic cohort was 69.0 years, 60.3% were men, 91.4% were white, and 14.1% were current smokers at the time of their clinic visit. A history of previous myocardial infarction was noted in 38.2%, previous coronary stenting in 57.2%, and previous bypass graft surgery in 31.6%. Among the patients who reported having some angina in the previous month, daily angina was reported in 4.6% of patients, weekly angina in 18.7%, and monthly angina in 76.6%. Most patients were on 1 medication that reduces angina, which was most often a  $\beta$ -blocker.

There were 155 cardiologists from 25 sites located in 19 US states who participated in APPEAR (Figure I and Table I in the [Data Supplement](#)). After excluding patients who reported no angina in the month before their clinic visit, the physician pool was reduced to 121 cardiologists. Each physician saw a median of 5 patients who reported angina, with a range of 1 to 21, and 26 physicians contributed  $\geq 5$  patients to the analytic cohort. Physicians were mostly men (83.5%) and had practiced for a median of 18 years (interquartile range, 10–25).

### Rate and Predictors of Under-Recognition

Among the 411 patients who reported angina in the previous month, 173 (42.1%) were under-recognized by their physician. Demographic and clinical characteristics of the patients who were and were not under-recognized are shown in Table 1. Patients whose angina was under-recognized (versus not) were more likely to have a diagnosis of chronic heart failure (26.0% versus 9.2%;  $P < 0.001$ ), have lower burdens of angina (monthly angina: 82.7% versus 72.3%;  $P = 0.01$ ), and were on fewer antianginal medications (31.2% versus 45.8% were taking  $\geq 2$  antianginal medications;  $P = 0.002$ ). In a multivariable model, chronic heart failure (odds ratio, 3.06; 95% confidence interval, 1.89–4.95) and monthly angina (versus weekly/daily: odds ratio, 1.69; 95% confidence interval, 1.12–2.56) were independently associated with a greater odds of under-recognition (Table 2). Age, sex, race, socioeconomic status, and other comorbidities, importantly, were not associated with under-recognition of the patient's angina by the physician.

### Physician Factors and Variability

Neither the sex of the physician nor the number of years of experience of the physician were associated with better recognition of angina, either in univariable or multivariable analyses (Table 2). Typical symptom presentations were not the only symptoms that were recognized. Among patients whose angina was appropriately recognized, physicians reported that these patients had a wide range of presenting symptoms, with fewer than half presenting with typical angina (Table II in the [Data Supplement](#)). There was substantial variability in under-recognition across physicians, indicating that while patient demographics, comorbidities, and presenting symptoms largely

were not associated with better recognition, some physicians were much better at recognizing the frequency of patients' angina than others. In the model that accounted for patient and physician factors, the median odds ratio was 2.06, indicating that, on average, 2 statistically identical patients would have a 2-fold greater odds of having their angina under-recognized if seen by 1 random physician as compared with another. Furthermore, the amount of variability in under-recognition that could be attributed to physician-level variation (as opposed to patient-level differences), as measured with the intraclass correlation coefficient, was 15%. Among the 26 physicians who saw  $\geq 5$  patients who reported angina in the month before their clinic visit, the rate of under-recognition ranged broadly from 0% to 86% (Figure).

## Discussion

In a multicenter, cross-sectional sample of patients with coronary artery disease, we found that under-recognition of angina was common in routine clinical practice. Furthermore, there was large variation in the rates of under-recognition across physicians but few patient factors associated with under-recognition. These data underscore that a more systematic approach is needed for eliciting a history and assessing angina in patients with coronary artery disease. Because the physician's assessment of angina is key in guiding further testing and treatment, under-recognition of the patient's burden of angina could result in undertreatment. The use of a validated, patient-centered tool for eliciting patients' angina, such as the SAQ, should be tested in routine clinical care to see if it improves angina recognition, treatment, and outcomes.

### Previous Studies

Previous studies that have compared physician-reported and patient-reported angina also found discrepancies. Among 2031 stable angina patients treated at 207 primary care practices, physicians rated 61% of patients as having minimal angina, of whom 20% self-reported weekly, and 12% reported daily angina.<sup>7</sup> This discrepancy has also been observed in clinical trials. At 1-year follow-up in the Stent or Surgery trial, investigators systematically underestimated their subjects' symptom burden, often rating a patient as angina free when the patient was not.<sup>8</sup> Interestingly, before coronary revascularization, physicians were more likely to overestimate a patients' burden of angina and misclassified angina in 63% (overcoding  $\approx 37\%$ , undercoding  $\approx 26\%$ ). Even in this carefully conducted clinical trial, physicians were unable to accurately estimate the patients' burden of angina. Our study supports these findings by demonstrating variation in the recognition of angina by cardiologists among patients with coronary artery disease and extends these studies by examining predictors of under-recognition and variability.

### Implications and Future Directions

Although an accurate estimation of angina is the goal, we focused on under-recognition, because we think that the implications are missed opportunities to intensify medical treatment. The burden of patient-reported chest pain (regardless of whether or not it is related to myocardial ischemia) is strongly and independently associated with quality of

**Table 1. Baseline Characteristics According to Recognition of Angina During Clinic Visit**

	Under-Recognized, n=173	Recognized, n=238	P Value
Age, y	68.9±12.3	69.0±11.2	0.916
Male sex, %	61.8	59.2	0.593
White race, %	89.2	92.9	0.198
Insurance for medications, %	95.3	97.0	0.360
Avoidance of care because of cost, %	1.7	1.2	0.374
High school education, %	83.9	87.4	0.326
Hypertension, %	83.2	77.7	0.167
Chronic heart failure, %	26.0	9.2	<0.001
Previous myocardial infarction, %	43.9	34.0	0.041
Previous coronary stenting, %	56.6	57.6	0.853
Previous bypass graft surgery, %	31.2	31.9	0.877
Diabetes mellitus, %	39.9	37.0	0.548
Chronic lung disease, %	9.2	13.9	0.153
Chronic kidney disease, %	15.6	9.7	0.068
Smoking status			0.484
Current, %	13.5	14.6	
Former, %	56.7	60.9	
Never, %	29.8	24.5	
Number of antianginal medications			0.002
0, %	8.1	10.9	
1, %	60.7	43.3	
≥2, %	31.2	45.8	
Class of antianginal medications			
β-blocker, %	82.7	78.2	0.258
Calcium channel blocker, %	22.7	28.2	0.211
Long-acting nitrate, %	20.8	31.1	0.020
Ranolazine, %	6.4	17.6	<0.001
Patient-reported angina			0.015
Daily, %	1.7	6.7	
Weekly, %	15.6	21.0	
Monthly, %	82.7	72.3	

life, rehospitalization, and use of healthcare resources.<sup>4</sup> It is certainly notable that not all chest pain reported by the patient is appropriately treated with antianginal medications or coronary revascularization, because the chest pain may be noncardiac or the patient may be maximally treated (ie, on maximally tolerated antianginal medications and no revascularization options). However, regardless of the decision of treatment escalation, we think that it is important for the physician to understand the burden of chest pain experienced by the patient.

The routine assessment and documentation of patients' symptoms were highlighted in 2011 by the American College of Cardiology/American Heart Association/Physician Consortium for Performance Improvement, which advocated for the routine use of patient-reported outcomes,

such as the SAQ.<sup>15</sup> In addition, the appropriateness of coronary revascularization for stable angina relies heavily on the assessment of the severity of patients' angina.<sup>16</sup> Moreover, the Center for Medicare and Medicaid Services has highlighted the importance of patients' perceptions of their disease in quantifying quality and has begun developing performance measures based on patient-reported outcomes.<sup>17</sup> In fact, they are in the midst of developing a patient-reported outcome-based performance measure for percutaneous coronary intervention, and these data highlight the potential for this measure to more accurately assess patients' angina than physicians' reports.<sup>18</sup>

Despite the importance of assessing angina burden in patients with coronary disease, we still routinely depend solely on an unstructured interview, instead of directly asking

**Table 2. Association of Patient and Physician Characteristics With Under-Recognition of the Patient’s Angina by the Physician**

	Odds Ratio (95% CI)	P Value
<b>Patient factors</b>		
Age (per 5 y)	1.00 (0.93–1.08)	0.973
Male sex	1.13 (0.80–1.59)	0.499
White race	0.63 (0.39–1.04)	0.070
Self-reported avoidance of care because of cost	1.48 (0.51–4.28)	0.464
Chronic lung disease	0.61 (0.34–1.09)	0.093
Chronic heart failure	3.06 (1.89–4.95)	<0.001
Diabetes mellitus	1.02 (0.73–1.44)	0.891
Previous CABG	0.98 (0.68–1.42)	0.922
Monthly angina (vs daily/weekly angina)	1.69 (1.12–2.56)	0.012
<b>Physician factors</b>		
Male sex	0.66 (0.33–1.35)	0.258
Years of practice	0.99 (0.97–1.02)	0.678
Median odds ratio*	2.06	0.001

c-index=0.67. Calibration plot  $R^2=0.91$ . CABG indicates coronary artery bypass graft; and CI, confidence interval.

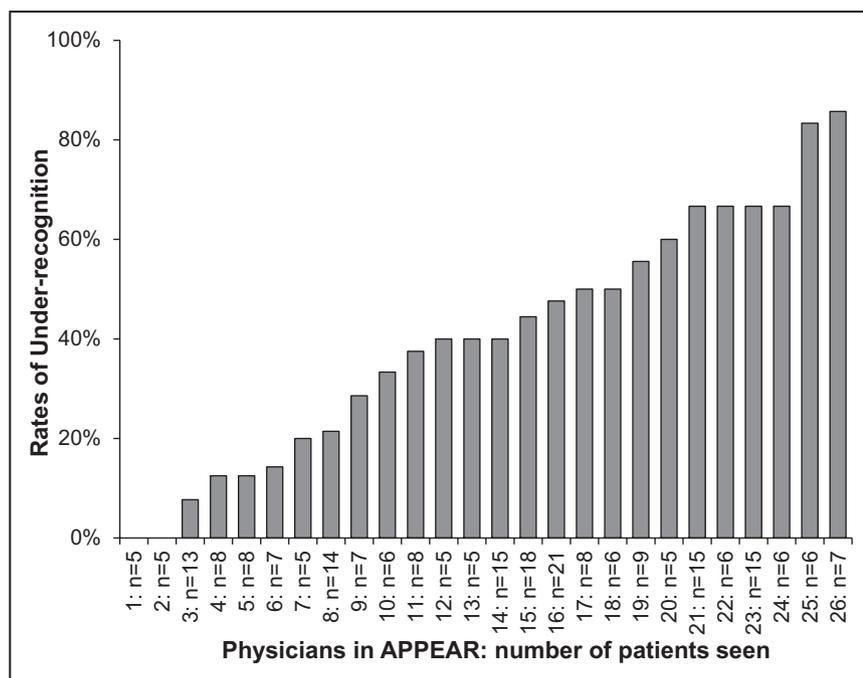
\*Assessment of variability across physicians. CI are not appropriate, because of the nature of the model.

patients using standardized assessments. The primary reason for this likely lies in the barriers of implementing a patient-reported outcome into regular clinical care.<sup>19</sup> However, our data highlight the limitations of relying on traditional physician/patient interactions to accurately assess angina burden. Moving patient-reported outcomes into routine clinical care requires creative implementation strategies to successfully

integrate such measures into routine practice, including novel mechanisms to collect, score, and interpret patient-reported outcomes data. Toward that end, a shorter, 7-item version of the SAQ has been introduced that retained the entire angina frequency domain of the original instrument.<sup>20</sup> Future studies should examine the feasibility of using such instruments as a means to improve recognition of angina in the outpatient setting and the impact that this may have on the treatment of angina and subsequent outcomes.

**Limitations**

Our data should be viewed in light of the following potential limitations. First, although we were able to examine a large number of patients and physicians across geographically diverse US practices, it is unclear whether our results are generalizable to the entirety of US cardiologists’ clinics or to noncardiologists. Furthermore, the number of patients with angina per physician was small, making examination of unadjusted variability in under-recognition rates limited. Second, the number of predictor variables was limited by the sample size to avoid overfitting and finding spurious associations. We selected covariates a priori based on clinical judgment, but we may have omitted important predictors of under-recognition. In addition, the distribution of particular covariates in our analytic cohort (eg, race) may have limited the identification of important patient predictors. Third, physicians were aware of the study and that they would be asked to estimate the patient’s chest pain after the clinic visit. As such, we expect that our findings represent the best-case scenario, and the rates of under-recognition likely would be higher outside of the confines of a structured study. Fourth, some may argue that assessment of angina with the patient-reported SAQ may not be accurate. However, the SAQ has been extensively validated against daily angina diaries<sup>11</sup> and shown to be reliable, valid, and predictive of future cardiac events.<sup>21,22</sup> It is likely to be the best method for identifying the frequency and implications of



**Figure.** Rates of under-recognition by physician. Includes only physicians who contributed  $\geq 5$  patients to the analytic cohort. APPEAR indicates Angina Prevalence and Provider Evaluation of Angina Relief.

angina from patients' perspectives. Finally, although we were able to identify the prevalence and predictors (or lack thereof) of under-recognition of angina in this cross-sectional study, we were unable to determine whether this under-recognition resulted in undertesting or undertreatment. Further research investigating the implications of under-recognition on treatment and outcomes is needed.

## Conclusions

Angina is frequently under-recognized in routine clinical practice, and rates of under-recognition varied widely across physicians. Given the importance of assessing patient's angina frequency to properly apply testing and treatment, these data support an assessment of angina directly from the patient. By incorporating standard tools, such as the SAQ-7, as routine clinical assessments during office visits, a more consistent recognition of angina may occur. Further work is needed to understand the implications of under-recognition on outcomes and how standardized assessments of angina impact both recognition and outcomes.

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## References

- Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Borden WB, Bravata DM, Dai S, Ford ES, Fox CS, Franco S, Fullerton HJ, Gillespie C, Hailpern SM, Heit JA, Howard VJ, Huffman MD, Kissela BM, Kittner SJ, Lackland DT, Lichtman JH, Lisabeth LD, Magid D, Marcus GM, Marelli A, Matchar DB, McGuire DK, Mohler ER, Moy CS, Mussolino ME, Nichol G, Paynter NP, Schreiner PJ, Sorlie PD, Stein J, Turan TN, Virani SS, Wong ND, Woo D, Turner MB; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2013 update: a report from the American Heart Association. *Circulation*. 2013;127:e6–e245. doi: 10.1161/CIR.0b013e31828124ad.
- Brown N, Melville M, Gray D, Young T, Munro J, Skene AM, Hampton JR. Quality of life four years after acute myocardial infarction: short form 36 scores compared with a normal population. *Heart*. 1999;81:352–358.
- Brorsson B, Bernstein SJ, Brook RH, Werkö L. Quality of life of patients with chronic stable angina before and four years after coronary revascularisation compared with a normal population. *Heart*. 2002;87:140–145.
- Arnold SV, Morrow DA, Lei Y, Cohen DJ, Mahoney EM, Braunwald E, Chan PS. Economic impact of angina after an acute coronary syndrome: insights from the MERLIN-TIMI 36 trial. *Circ Cardiovasc Qual Outcomes*. 2009;2:344–353. doi: 10.1161/CIRCOUTCOMES.108.829523.
- Goldman L, Hashimoto B, Cook EF, Loscalzo A. Comparative reproducibility and validity of systems for assessing cardiovascular functional class: advantages of a new specific activity scale. *Circulation*. 1981;64:1227–1234.
- Shafiq A, Arnold SV, Gosch K, Kureshi F, Breeding T, Jones PG, Beltrame J, Spertus JA. Patient and physician discordance in reporting symptoms of angina among stable coronary artery disease patients: Insights from the Angina Prevalence and Provider Evaluation of Angina Relief (APPEAR) study. *Am Heart J*. 2016;175:94–100. doi: 10.1016/j.ahj.2016.02.015.
- Beltrame JF, Weekes AJ, Morgan C, Tavella R, Spertus JA. The prevalence of weekly angina among patients with chronic stable angina in primary care practices: The Coronary Artery Disease in General Practice (CADENCE) Study. *Arch Intern Med*. 2009;169:1491–1499. doi: 10.1001/archinternmed.2009.295.
- Appleby C, Kemp I, Stables RH. Patient vs physician reported angina before and after revascularisation of coronary artery disease: evidence from a large randomised controlled trial (the SOS trial). *Heart*. 2011;97:A27–A28.
- Spertus JA, Winder JA, Dewhurst TA, Deyo RA, Fihn SD. Monitoring the quality of life in patients with coronary artery disease. *Am J Cardiol*. 1994;74:1240–1244.
- Spertus JA, Winder JA, Dewhurst TA, Deyo RA, Prodzinski J, McDonell M, Fihn SD. Development and evaluation of the Seattle Angina Questionnaire: a new functional status measure for coronary artery disease. *J Am Coll Cardiol*. 1995;25:333–341.
- Arnold SV, Kosiborod M, Li Y, Jones PG, Yue P, Belardinelli L, Spertus JA. Comparison of the Seattle Angina Questionnaire With Daily Angina Diary in the TERISA Clinical Trial. *Circ Cardiovasc Qual Outcomes*. 2014;7:844–850. doi: 10.1161/CIRCOUTCOMES.113.000752.
- Spertus JA, Salisbury AC, Jones PG, Conaway DG, Thompson RC. Predictors of quality-of-life benefit after percutaneous coronary intervention. *Circulation*. 2004;110:3789–3794. doi: 10.1161/01.CIR.0000150392.70749.C7.
- Snijders T, Bosker R. *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modelling*. London: Sage; 1999.
- R Core Team. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing; 2015. <http://www.R-project.org/>.
- Drozda J Jr, Messer JV, Spertus J, Abramowitz B, Alexander K, Beam CT, Bonow RO, Burkiewicz JS, Crouch M, Goff DC Jr, Hellman R, James T 3rd, King ML, Machado EA Jr, Ortiz E, O'Toole M, Persell SD, Pines JM, Rybicki FJ, Sadwin LB, Sikkema JD, Smith PK, Torcson PJ, Wong JB. ACCF/AHA/AMA-PCPI 2011 performance measures for adults with coronary artery disease and hypertension: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Performance Measures and the American Medical Association-Physician Consortium for Performance Improvement. *Circulation*. 2011;124:248–270.
- Patel MR, Dehmer GJ, Hirshfeld JW, Smith PK, Spertus JA. ACCF/SCAI/STS/AATS/AHA/ASNC/HFSA/SCCT 2012 Appropriate use criteria for coronary revascularization focused update: a report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, Society for Cardiovascular Angiography and Interventions, Society of Thoracic Surgeons, American Association for Thoracic Surgery, American Heart Association, American Society of Nuclear Cardiology, and the Society of Cardiovascular Computed Tomography. *J Am Coll Cardiol*. 2012;59:857–881. doi: 10.1016/j.jacc.2011.12.001.
- Department of Health and Human Services. Federal Register. Medicare program; comprehensive care for joint replacement payment model for acute care hospitals furnishing lower extremity joint replacement services; proposed rule. 2015;80:41198–41316.
- Centers for Medicare & Medicaid Services. Technical expert panel summary web page posting. Hospital-Level patient-reported outcome performance measure for patients undergoing non-emergent percutaneous coronary intervention. <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/MMS/TechnicalExpertPanels.html>. Accessed September 10, 2015.
- Spertus J. Barriers to the use of patient-reported outcomes in clinical care. *Circ Cardiovasc Qual Outcomes*. 2014;7:2–4. doi: 10.1161/CIRCOUTCOMES.113.000829.
- Chan PS, Jones PG, Arnold SA, Spertus JA. Development and validation of a short version of the Seattle angina questionnaire. *Circ Cardiovasc Qual Outcomes*. 2014;7:640–647. doi: 10.1161/CIRCOUTCOMES.114.000967.
- Spertus JA, Jones P, McDonell M, Fan V, Fihn SD. Health status predicts long-term outcome in outpatients with coronary disease. *Circulation*. 2002;106:43–49.
- Mozaffarian D, Bryson CL, Spertus JA, McDonell MB, Fihn SD. Anginal symptoms consistently predict total mortality among outpatients with coronary artery disease. *Am Heart J*. 2003;146:1015–1022. doi: 10.1016/S0002-8703(03)00436-8.

## Predictors of Physician Under-Recognition of Angina in Outpatients With Stable Coronary Artery Disease

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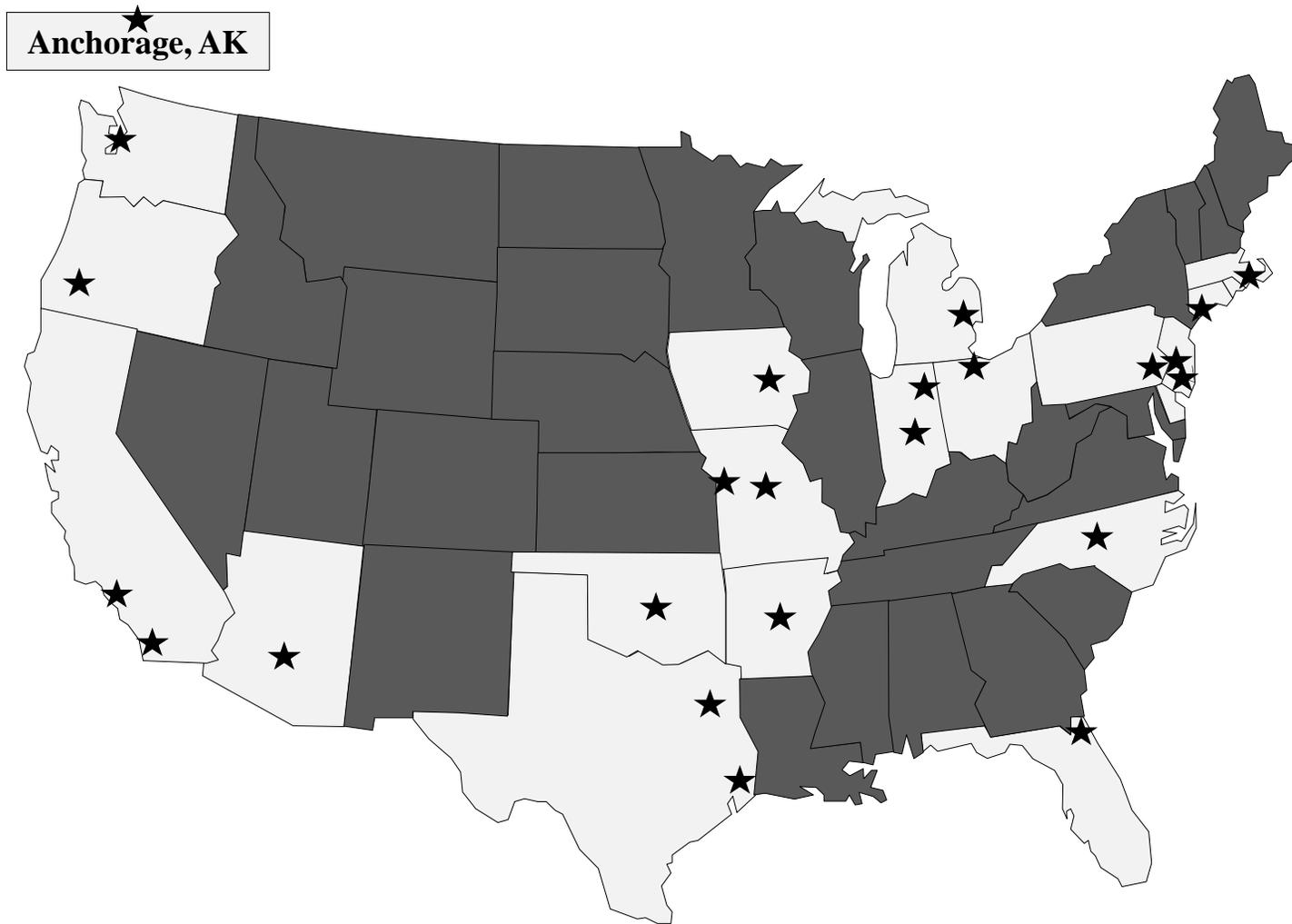
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## SUPPLEMENTAL MATERIAL

**Supplemental Table 1. APPEAR study sites**

<b>Clinic Name</b>	<b>Location</b>	<b>Number of Physicians Participating</b>	<b>Number of Patients Enrolled</b>
Advanced Cardiovascular Specialists	Beaumont, TX	8	50
Alaska Heart Institute	Anchorage, AK	10	26
Arizona Cardiology Group	Phoenix, AZ	8	52
Arkansas Cardiology	Little Rock, AK	1	50
Cardiology Consultants	Toms River, NJ	4	50
Cardiology Consultants of Philadelphia (2 sites)	Philadelphia, PA	12	100
Cardiovascular Consultants of Cape Cod	Cape Cod, MA	5	50
Cardiovascular Medical Associates	Downey, CA	4	50
First Coast Cardiovascular Institute	Jacksonville, FL	4	50
Greenwich Cardiology Associates	Greenwich, CT	1	50
INTEGRIS Baptist Medical Center	Oklahoma City, OK	17	51
Krannert Institute of Cardiology	Indianapolis, IN	4	50
Michigan Heart Group	Troy, MI	4	50
Missouri Cardiovascular Specialists	Columbia, MO	9	50
Parkview Research Center	Fort Wayne, IN	9	49
ProMedica Toledo Hospital	Toledo, OH	5	50
Rapeport Medical Corporation	La Mesa, CA	2	50
Saint Luke's Cardiovascular Consultants	Kansas City, MO	13	70
Sigal Heart Center	Tyler, TX	2	55
Southern Oregon Cardiology	Medford, OR	9	50
Swedish Heart & Vascular	Seattle, WA	4	56
UnityPoint Clinic Cardiology	Cedar Rapids, IA	7	50
Virtua - The Cardiology Group	Marlton, NJ	12	50
W. Spencer Tilley, Jr.	Greensboro, NC	1	50

Supplemental Figure 1. APPEAR Study Sites



**Supplemental Table 2. Physician descriptions of patient's symptoms, among patients whose angina was appropriately recognized**

		<b>Recognized Angina n=238</b>
<hr/>		
Category of symptoms		
	Typical angina	45.8%
	Atypical angina	38.2%
	Non-cardiac chest pain	16.0%
Associated symptoms		
	Dyspnoea	43.5%
	Nausea	3.4%
	Confusion	0.4%
	Light-headedness	3.4%
	Sweating	3.8%
	Other	9.2%
Provocation/relief factors		
	Provoked by exertion	68.8%
	Provoked by emotional stress	28.3%
	Relieved by rest	66.2%
	Relieved by short-acting nitrates	41.8%
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