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Can Physicians Identify Inappropriate Nuclear Stress Tests? An Examination of Inter-rater Reliability for the 2009 Appropriate Use Criteria for Radionuclide Imaging

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Abstract

Background—We sought to determine inter-rater reliability of the 2009 Appropriate Use Criteria (AUC) for radionuclide imaging (RNI) and whether physicians at various levels of training can effectively identify nuclear stress tests with inappropriate indications.

Methods and Results—Four hundred patients were randomly selected from a consecutive cohort of patients undergoing nuclear stress testing at an academic medical center. Raters with different levels of training (including cardiology attending physicians, cardiology fellows, internal medicine hospitalists, and internal medicine interns) classified individual nuclear stress tests using the 2009 AUC. Consensus classification by two cardiologists was considered the operational gold standard, and sensitivity and specificity of individual raters for identifying inappropriate tests was calculated. Inter-rater reliability of the AUC was assessed using Cohen's kappa statistics for pairs of different raters. The mean age of patients was 61.5 years; 214 (54%) were female. The cardiologists rated 256 (64%) of 400 NSTs as appropriate, 68 (18%) as uncertain, 55 (14%) as inappropriate; 21 (5%) tests were unable to be classified. Inter-rater reliability for non-cardiologist raters was modest (unweighted Cohen's kappa, 0.51, 95% confidence interval, 0.45 to 0.55). Sensitivity of individual raters for identifying inappropriate tests ranged from 47% to 82%, while specificity ranged from 85% to 97%.

Conclusions—Inter-rater reliability for the 2009 AUC for RNI is modest, and there is considerable variation in the ability of raters at different levels of training to identify inappropriate tests.

Keywords

appropriateness criteria; coronary heart disease; imaging; radioisotopes

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Utilization of cardiovascular imaging has increased dramatically over the past decade,[1–4] leading to concerns that many of the nuclear cardiology tests being performed may have inappropriate indications, offer limited clinical value, while also increasing medical costs and patient radiation exposure.[2, 3, 5] To promote appropriate utilization of nuclear cardiology testing, the American College of Cardiology Foundation and other professional societies jointly released in 2005 and updated in 2009 the Appropriate Use Criteria (AUC) for radionuclide imaging (RNI).[6, 7] However, while a number of studies have shown that nuclear stress tests with inappropriate indications are commonly performed,[8–14] efforts for broad application of the AUC to reduce inappropriate nuclear stress testing have frequently been unsuccessful.[9, 15, 16] Moreover, reported rates of inappropriate nuclear testing have ranged widely between studies. For example, while studies by Gibbons et al[17] and Saifi et al[18] have reported rates of inappropriate nuclear stress testing of below 10%, a recent report by Doukky et al[14] noted an inappropriateness testing rate that was as high as 45%.

One potential barrier for the effective implementation of the AUC to reduce inappropriate nuclear stress testing is the complexity of the classification process, which can lead to marked classification disagreements between different raters.[8] To inform the future use and improvement of the 2009 AUC for RNI, it is critical to understand the extent to which such disagreements occur and their impact on the identification of appropriate and inappropriate nuclear stress tests. We therefore undertook a thorough investigation of the inter-rater reliability of the 2009 AUC for RNI for raters at different levels of training, by performing additional analysis of nuclear stress tests included in the COlumbia Nuclear CardiOlogy Radiation Dose (CONCORD) study.[5]

Methods

Study Sample

Details of the CONCORD study have been published previously.[5] Briefly, all 1097 consecutive patients undergoing nuclear stress testing during the first 100 days of 2006 (January 1–April 10) at Columbia University Medical Center (CUMC), New York, New York, were identified through query of the electronic health records. Of these, 400 patients were randomly chosen as the study sample for the present analysis, with a separate 40 patients randomly chosen as the training sample to standardize AUC classification for different raters (as described below). As part of the CONCORD study, patient demographic data, including age, sex, race, insurance coverage, and zip code, were obtained through querying the electronic health records. Median annual household income in individual patient's zip code, a surrogate for socioeconomic status, was obtained using the 1999 US Census Bureau data.[19] For the present analysis, we further abstracted additional medical covariates from the electronic health records, including risk factors such as hypertension, hyperlipidemia, diabetes, and tobacco use; use of medications such as aspirin, beta-blockers, statins, and other anti-hypertensive medications; history of prior coronary artery disease (CAD), myocardial infarction (MI), percutaneous coronary intervention (PCI), or coronary artery bypass grafting (CABG); and results of the nuclear stress test. Symptoms at time of nuclear stress testing were also abstracted. Specifically, chest pain was classified as typical angina, atypical angina, and non-cardiac chest pain, and other signs and symptoms including

dyspnea, palpitations, and abnormal electrocardiogram (ECG) were captured as potential ischemic equivalents, all in accordance with the 2009 AUC for RNI.[7] Complete radiation dosimetric data for all procedures was recorded;[5] its relationship to appropriateness will be evaluated in a separate report. The study was approved by the Institutional Review Board of the Columbia University Medical Center, and informed consent was waived due to the retrospective nature of this research.

AUC Classification and Assumptions

For AUC classification, the hierarchical flowchart outlined in the 2009 AUC for RNI was followed strictly.[7] In addition, similar to the method previously described by Gibbons and colleagues,[8] we made a number of assumptions to standardize the application of the AUC. These include:

1. In accordance with the 2009 AUC for RNI definition for what should be considered "angina equivalent", patients undergoing tests for symptoms other than chest pain, such as dyspnea, were defined as symptomatic and have "atypical angina" or "non-anginal chest pain" for the purpose of determining the pre-test probability of coronary artery disease (CAD).[7]

2. Symptoms of chest pain were classified as "typical angina", "atypical angina", or "non-cardiac" according to the Diamond and Forrester classification,[20] which was then used to determine the pretest probability of CAD in conjunction with age and gender, in accordance with recommendations contained in the 2009 AUC for RNI.[7]

3. Due to the retrospective design of the present study, for patients with missing data that were not captured in our electronic health records but that are needed for AUC classification (e.g., results from tests performed at other facilities, such as prior cardiac imaging or lipid levels), their nuclear stress tests were considered as unable to be classified by the raters.

4. For a nuclear stress test that can be classified with more than one indication that have the same appropriateness category, the indication with the smallest numerical value is assigned as the AUC classification. An example is pre-op evaluation for patients undergoing non-cardiac, intermediate-risk surgery who has both moderate to good functional capacity and no clinical risk factors. Nuclear stress testing in this setting qualifies for indications 41 and 42 of the AUC, both inappropriate. In this analysis they are assigned indication 41.

5. For pre-operative nuclear stress testing, risk classification of planned non-cardiac surgeries (i.e., as vascular, intermediate risk, or low risk) was performed using the 2007 ACC/AHA Guidelines on Perioperative Cardiovascular Evaluation and Care for Noncardiac Surgery,[21] as recommended by the 2009 AUC for RNI.[7]

Raters Recruitment and Training

For this analysis, eight individual raters were recruited: two board-certified/eligible cardiologists not affiliated with the nuclear cardiology lab (L.E.R. and S.Y.), two first-year cardiology fellows (M.L. and S.R.), two internal medicine hospitalists (M.R.K. and C.L.P.), and two internal medicine interns (C.R.K. and Y.P.). The two cardiologists separately

assigned AUC classification for 20 nuclear stress tests of the training subset, met to reconcile discrepancies, then repeated the process for the other 20 tests of the training sample. They then separately assigned AUC classifications for the 400 nuclear stress tests in the study sample and reconciled all discrepancies; a third cardiologist (A.J.E.) was available to adjudicate in case reconciliation was not possible.

For the other raters, the training process began with a 30-minute orientation session explaining the 2009 AUC for RNI, with specific emphasis on the classification process described above. In addition, to maximize the standardization of different raters, detailed instructions were provided on which data sources within the electronic health records should be used to carry out the rating process, and all raters were provided with both printed and electronic versions of the AUC document. Each rater then separately completed two training sessions. These sessions composed of assigning AUC classification to 20 nuclear stress tests from the training sample, followed by a one-on-one in-person feedback session with one of the cardiologists (S.Y.) to review discrepancies with the cardiologist consensus and to reinforce the classification process. After the two training sessions, each rater independently completed AUC classifications for the 400 nuclear stress tests from the study sample, assigning to each test one of 67 possible AUC indications or, when key data were missing, to the category "Unable to Classify". For each test that could be classified, the indication assigned by each rater was then mapped to its corresponding appropriateness category of Appropriate, Uncertain, or Inappropriate.

Statistical Analysis

For this analysis, the consensus AUC classification of the two cardiologists was considered the operational gold standard. Baseline characteristics of patients were compared across appropriateness categories, using chi-squared tests for categorical variables and the Kruskal-Wallis rank test for age (due to skewed distribution). Subsequently, multivariable analysis to identify predictors of inappropriate nuclear stress testing was performed using logistic regression, with having an inappropriate indication being the binary dependent variable. In the multivariable model, potential predictors of inappropriate testing was selected using a cut-off of $p<0.20$ in univariable analysis, as suggested by Maldonado & Greenland.[22] Furthermore, to avoid over-fitting the model, we used the variable being asymptomatic to capture symptoms and the variables prior CAD and prior revascularization to capture previous cardiac history and revascularization status.

We tabulated the most common indications for appropriate and inappropriate testing both for the consensus cardiologist rating and for other individual raters. We determined the proportion of tests with results that were normal or probably normal by each appropriateness category. To determine inter-rater reliability, we calculated un-weighted kappa for each pairs of raters and for all non-cardiologist raters jointly. Weighted Cohen's kappa for each pairs of raters was also calculated using a weight of 0 for disagreements in which one rater determine a test to be inappropriate while another determined the test to be appropriate, and a weight of 0.5 for all other disagreements. The weighting scheme is designed to account for the fact that the distinction between appropriate and inappropriate indications is likely to be more important than other kinds of disagreements (for example, between appropriate and

uncertain indications). The 95% confidence intervals for un-weighted and weighted Cohen's kappa was derived for each pairs of raters, using a bootstrap approach with 1000 replications of the entire sample with replacement, performed with the Stata program *kapci*.[23] The kappa statistic is conventionally interpreted as representing excellent inter-rater agreement when its value is above 0.75, modest inter-rater agreement when its value is 0.40 to 0.75, and poor agreement when its value is below 0.40.[24] We also calculated the proportions of agreement for raters at different training levels and for all non-cardiologist raters, as well as the proportions of specific agreement for appropriate and inappropriate indications using the same groupings of raters. The 95% confidence intervals for all proportions were estimated through the asymptotic (Wald) method.

To describe the ability of individual raters to identify inappropriate tests, we also performed a validity analysis examining the sensitivity and specificity of each non-cardiologist rater for identifying these tests as inappropriate. In this context, sensitivity is defined as the proportion of nuclear stress tests with inappropriate indications (according to the cardiologist consensus) that were correctly classified as inappropriate by an individual rater. Similarly, specificity is calculated as the proportion of nuclear stress tests that do not have inappropriate indications (according to the cardiologist consensus) that were classified by an individual rater into a category other than inappropriate. For all statistical tests, a p-value of 0.05 was considered statistically significant, and all analyses were conducted using Stata software, version 12.0 (Stata Corp., College Station, TX).

Results

Of the 400 patients included in this analysis, the mean (SD) age was 61.5 (13.8) years, and 214 (54%) were female. Other baseline characteristics are as shown in Table 1. The most frequent indications for nuclear stress testing in our sample are indications 55 (evaluation of ischemia in symptomatic patients after PCI or CABG; 61/15%), 8 (possible ACS, no ECG changes, low-risk TIMI score, negative troponins; 56/14%), 31 (pre-operative evaluation for vascular surgery, no clinical risk factors; 46/12%), 3 (evaluation of ischemia, intermediate pre-test probability, ECG interpretable and able to exercise; 41/10%), and 4 (evaluation of ischemia, intermediate pre-test probability, ECG uninterpretable or unable to exercise; 22/6%). The two cardiologists classified 256 (64%) of 400 tests as appropriate, 68 (18%) as uncertain, 55 (14%) as inappropriate; 21 (5%) tests were not able to be classified by the raters. Of the 55 nuclear stress tests classified as inappropriate, 47 (85%) had indications 1, 40, 41, or 42 (Figure 1).

In univariable analysis, there were significant differences across appropriateness categories for age, race, and median zip code income. Types of angina symptoms, being asymptomatic, having prior history of CAD, and having PCI, CABG, or revascularizations also differed across appropriateness categories. In the multivariable logistic regression model (Table 2), being asymptomatic (odds ratio [OR] 7.26, 95% confidence interval [CI] 3.50 to 15.07, p<0.001) and having diabetes mellitus (OR 0.41, 95% CI 0.18 to 0.92, p=0.03) independently predicted inappropriate nuclear stress testing.

Inter-rater Reliability of AUC Classification

Individual raters identified 61% to 70% of nuclear stress tests as appropriate, and 11% to 23% of nuclear stress tests as inappropriate. The most common appropriate and inappropriate indications were also broadly similar for individual raters. Reliability was modest between raters at the same level of training, with unweighted kappa ranging from 0.37 to 0.61. The overall kappa for all 6 non-cardiologist raters was 0.51 (95% CI, 0.45 to 0.55) (Table 3). Unweighted and weighted Cohen's kappas for all pairs of raters are as presented in the Supplementary Table. The proportion of agreement for raters at the same level of training ranged from 0.66 to 0.79, and was 0.74 (95% CI, 0.73 to 0.75) for all 6 non-cardiologist raters. The proportion of specific agreement was higher for appropriate indications than for inappropriate indications (Table 3). For validity of AUC rating, there was marked variation in the sensitivity and specificity of different raters for the identification of inappropriate tests compared to the cardiologist consensus, with sensitivity ranging from 47% (fellow 1) to 82% (hospitalist 1) and specificity ranging from 85% (fellow 1) to 97% (intern 1) (Figure 2).

Discussion

In our application of the 2009 AUC for RNI to nuclear stress tests performed at a single academic medical center in 2006, we found that approximately 15% of the tests examined were performed for inappropriate indications, with a small number of indications capturing a majority of these tests. Furthermore, we also found that inter-rater reliability for AUC classification was only modest, and that there was considerable variation in the ability of different raters to accurately identify tests with inappropriate indications despite standardized training.

Our results on the prevalence, make-up, and findings of nuclear stress tests with inappropriate indications are also broadly consistent with prior studies. Similar to our findings, Gibbons et al and Mehta et al both used the earlier 2007 AUC document to identify 13–14% of nuclear stress tests performed at academic medical centers as having inappropriate indications.[8, 13] In contrast, other studies have reported both higher and lower proportions of nuclear stress tests with inappropriate indications, likely reflecting differences in practice settings and institutional, geographical and temporal differences in ordering patterns.[9–12, 14] Previous studies also support our finding that a small number of inappropriate indications explained a majority of inappropriate nuclear stress tests that were performed,[8–10, 13]. Nonetheless, as we applied the 2009 AUC for RNI to a time period before its widespread adoption, it is possible that the prevalence and characteristics of nuclear stress tests with inappropriate indications in the current era may differ from our subgroup analysis of the CONCORD study. It is important to note however that the differences in era should not affect our finding that individual providers may have difficulty applying the AUC to identify inappropriate tests. While Gibbon et al has previously demonstrated modest agreement for AUC classification between two nurse practitioners,[8, 17] our study is the first to extensively examine inter-rater reliability of the AUC for physician raters with different clinical backgrounds. The substantial disagreements between AUC classifications of different raters despite standardized training highlight potential challenges

for using the AUC at point-of-care to guide appropriate test ordering, especially as there is considerable disagreement and variable sensitivity for different raters applying the AUC to identify tests with inappropriate indications.

There may be several explanations for the sub-optimal inter-rater reliability of the AUC observed in our study. The assignment of AUC ratings to individual tests is a cognitively complex task that involve many steps, such as determination of past history of cardiac testing, assessment of pre-test probability for CAD, and identification of the AUC indication that best describes the clinical scenario at hand. Potential errors can occur at each step of the process, and can potentially cascade to result in incorrect AUC classification. The rating process could also be influenced by heuristic biases that have been well described in medical decision-making literature.[25, 26] For instance, a recent encounter by a rater with a young patient admitted for myocardial infarction could affect perceptions of risk and appropriateness, leading to deviations from the AUC document as the result of availability bias. Finally, it is possible that the training sessions provided in our study was not of sufficient duration or intensity to ensure that raters conform to the recommended AUC rating process.

Our study also has implications for the effective use of AUC in clinical settings. The substantial variation between different raters' abilities to identify inappropriate nuclear stress tests suggest a potential explanation for why AUC interventions that relied on judgment of appropriateness by individual providers did not reduce inappropriate nuclear stress testing.[15] Future efforts will need to address the complexity of the AUC classification system, through steps such as consolidation of overlapping indications and further streamlining of the classification process, or through improved decision support such as that offered by the ACC FOCUS initiative.[27] Ultimately, in order for AUC documents to successfully realize their mission of promoting appropriate utilization of medical resources, more research is also needed to address the usability of AUCs and to determine the most effective and efficient approaches to implementing them.

There are several limitations to our study. We used the kappa statistic to assess inter-rater reliability of the AUC, which can be affected by the baseline rates of appropriate and inappropriate tests. The retrospective design of our study may affect the accuracy of clinical data collected and could impact appropriateness determination, and the affiliation of individual raters with the academic medical center studied could also introduce bias. However, our findings on the prevalence and make-up of tests with inappropriate indications are broadly consistent with prior literature. Furthermore, our demonstration of only modest inter-rater reliability between different raters is more likely an intrinsic characteristic of the AUC classification system, and is unlikely to be affected by the retrospective nature of our study or by rater affiliations. The number of raters involved in our study is modest and limits our ability to assess the effect of training level on inter-rater reliability. We also cannot rule out the possibility that our raters may not be representative of all potential users of the 2009 AUC for RNI. Future research will need to confirm our findings with broader sample of raters, and to determine most effective approaches to training clinicians to identify inappropriate tests. Finally, we used the terminology of "appropriate", "uncertain", and "inappropriate" as set forth in the 2009 AUC document, and used the consensus between

ratings of two cardiologists as the operational gold standard for our analysis. Prior studies, however, have suggested that valid differences in opinions may exist for what should be considered appropriate and inappropriate,[28–30] contributing to a recent AUC Methodology Update that has changed the terminology of AUC classifications for subsequently-issued AUC criteria to "appropriate", "may be appropriate", and "rarely appropriate".[31] This change in terminology should not affect our overall findings, and we agree with the implication of the change that for some nuclear stress tests, appropriateness classification may not fully capture their clinical utility or lack thereof.

In conclusion, in this retrospective analysis of the appropriate use of nuclear stress tests at an academic medical center, we characterized the pattern of inappropriate testing and demonstrated the difficulty that individual clinicians may have in using the AUC to identify inappropriate tests. These findings identify an important barrier for successful implementation of AUCs and can inform future interventions that promote the appropriate use of cardiovascular imagining.

Supplementary Material

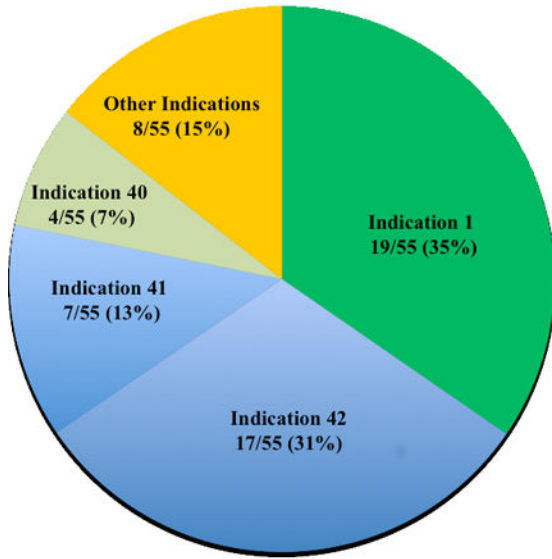Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Figure 1. Most common indications for inappropriate tests, by frequency
Left panel, frequency of most common inappropriate indications; right panel, descriptions of
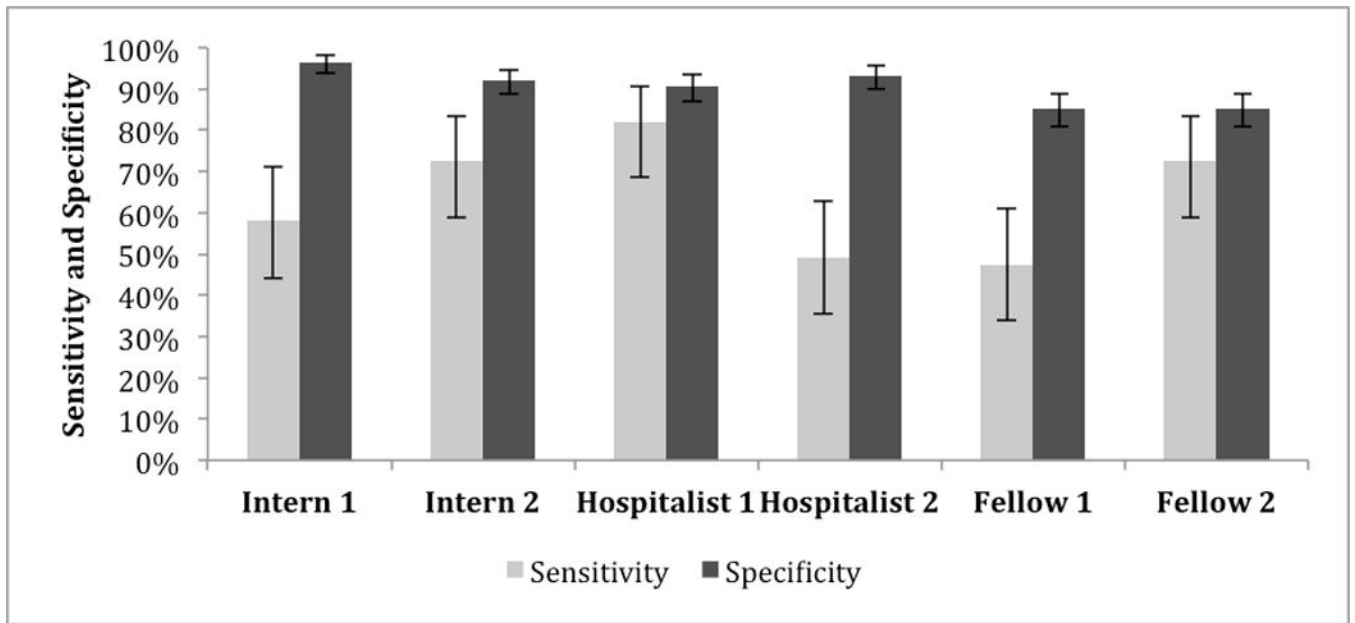most common inappropriate indications.

Figure 2. Sensitivity and specificity of individual raters for identifying inappropriate nuclear stress tests
Error bars represent 95% confidence intervals.

Table 1

Baseline characteristics, by appropriate use categories.

	Total (n=400)	Unable to classify (n=21)	Appropriate (n=256)	Uncertain (n=68)	Inappropriate (n=55)	p-value *
Age, yrs, mean (SD)	61.5 (13.8)	61.2 (10.7)	61.0 (13.9)	66.1 (12.4)	58.3 (14.7)	**0.017**
Female, n (%)	214 (54%)	11 (52%)	133 (52%)	37 (54%)	33 (60%)	0.75
Non-white, n (%)	296 (74%)	14 (67%)	200 (78%)	42 (62%)	40 (73%)	**0.042**
Medicaid / no insurance, n (%)	128 (32%)	2 (10%)	91 (36%)	21 (31%)	14 (25%)	0.058
Tertile of median zip code income, n (%)						**0.044**
Lowest tertile	150 (38%)	6 (29%)	105 (41%)	23 (34%)	16 (29%)	
Middle tertile	117 (29%)	3 (14%)	79 (68%)	21 (31%)	14 (25%)	
Highest tertile	133 (33%)	12 (57%)	72 (28%)	24 (35%)	25 (45%)	
Angina symptoms, n (%)						**<0.001**
Typical angina	44 (11%)	2 (10%)	33 (13%)	8 (12%)	1 (2%)	
Atypical angina	130 (33%)	5 (24%)	96 (38%)	23 (34%)	6 (11%)	
Non-cardiac chest pain	70 (18%)	0 (0%)	55 (21%)	7 (10%)	8 (15%)	
No chest pain	120 (30%)	11 (53%)	49 (19%)	22 (32%)	38 (69%)	
Unable to classify	36 (9%)	3 (14%)	23 (9%)	8 (12%)	2 (4%)	
Asymptomatic status, n (%)	87 (22%)	9 (43%)	30 (12%)	20 (29%)	28 (51%)	**<0.001**
Medication use, n (%)						
Aspirin	196 (49%)	10 (48%)	131 (51%)	38 (54%)	18 (33%)	0.068
Beta-blocker	163 (41%)	8 (38%)	111 (43%)	28 (42%)	16 (29%)	0.27
Statins	165 (41%)	10 (48%)	109 (43%)	30 (44%)	16 (29%)	0.25
Anti-hypertensives	232 (58%)	10 (48%)	157 (61%)	37 (54%)	28 (51%)	0.31
Risk factors, n (%)						
Hypertension	293 (73%)	14 (67%)	195 (76%)	51 (75%)	33 (60%)	0.085
Hyperlipidemia	215 (54%)	14 (67%)	136 (53%)	39 (57%)	26 (47%)	0.44

	Total (n=400)	Unable to classify (n=21)	Appropriate (n=256)	Uncertain (n=68)	Inappropriate (n=55)	p-value*
Diabetes mellitus	126 (32%)	8 (38%)	87 (34%)	21 (31%)	10 (18%)	0.13
Tobacco use	56 (14%)	3 (14%)	39 (15%)	6 (9%)	8 (15%)	0.60
Prior CAD, n (%)	121 (30%)	6 (29%)	92 (36%)	16 (24%)	7 (13%)	**0.004**
Prior MI, n (%)	71 (18%)	5 (24%)	50 (20%)	11 (16%)	5 (9%)	0.26
Prior PCI, n (%)	55 (14%)	1 (5%)	44 (17%)	7 (10%)	3 (5%)	**0.049**
Prior CABG, n (%)	29 (7%)	0 (0%)	28 (11%)	0 (0%)	1 (2%)	**0.002**
Prior revascularization, n (%)	77 (19%)	1 (5%)	65 (25%)	7 (10%)	4 (7%)	**0.001**

CAD, coronary artery disease; MI, myocardial infarctions; PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting. Prior revascularization includes having either prior percutaneous coronary intervention or coronary artery bypass grafting.

Asymptomatic status is defined as the absence of chest pain and other signs and symptoms that could be considered as ischemic equivalents, including dyspnea, palpitations, and abnormal electrocardiogram.

Patient is considered asymptomatic if there was no reported chest pain, dyspnea, palpitations, or abnormal ECG.

*
p-values were calculated for comparison across different appropriate use categories; chi-squared tests were used except for age, where Kruskal-Wallis rank test was used due to skewed distribution.

Table 2

Predictors of inappropriate nuclear stress tests in multivariable logistic regression model.

	Odds Ratio (95% Confidence Interval)	p-value
Age	0.98 (0.96–1.01)	0.15
Non-white	0.48 (0.19–1.23)	0.13
Medicaid / no insurance	0.78 (0.37–1.62)	0.50
Median zip code income		
Lowest tertile	Ref	Ref
Middle tertile	1.22 (0.54–2.75)	0.63
Highest tertile	1.68 (0.70–4.05)	0.25
Asymptomatic status	**7.26 (3.50–15.07)**	**<0.001**
Aspirin	0.75 (0.37–1.54)	0.44
Hypertension	0.90 (0.43–1.88)	0.79
Diabetes mellitus	**0.41 (0.18–0.92)**	**0.03**
Prior CAD	0.39 (0.11–1.41)	0.15
Prior revascularization	0.89 (0.17–4.66)	0.89

CAD: coronary artery disease. Prior revascularization includes prior percutaneous coronary intervention or coronary artery bypass grafting. Asymptomatic status is defined as the absence of chest pain and other signs and symptoms that could be considered as ischemic equivalents, including dyspnea, palpitations, and abnormal electrocardiogram.

Table 3

Inter-rater reliability and proportion of agreement (overall, and specific for appropriate and inappropriate tests), by training level and for all non-cardiologist raters.

Rater Groupings (Number of raters)	Unweighted Kappa (95% CI)	Proportion of Agreement, All Indications (95% CI)	Proportion of Specific Agreement for Appropriate Indications (95% CI)	Proportion of Specific Agreement for Inappropriate Indications (95% CI)
Interns (2)	0.61 (0.54–0.68)	0.79 (0.75–0.83)	0.88 (0.85–0.91)	0.52 (0.43–0.62)
Hospitalists (2)	0.63 (0.55–0.70)	0.81 (0.77–0.85)	0.87 (0.84–0.89)	0.57 (0.48–0.65)
Fellows (2)	0.37 (0.30–0.46)	0.66 (0.61–0.71)	0.76 (0.72–0.80)	0.48 (0.40–0.55)
All Non-Cardiologist Raters (6)	0.51 (0.46–0.55)	0.74 (0.73–0.75)	0.83 (0.82–0.84)	0.52 (0.50–0.54)