ORIGINAL ARTICLE

Appropriateness of referrals for single-photon emission computed tomography myocardial perfusion imaging (SPECT-MPI) in a developing community: A comparison between 2005 and 2009 versions of ACCF/ASNC appropriateness criteria

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Introduction. **Appropriateness of referrals for myocardial perfusion imaging (MPI) in developing countries has not been extensively studied. Our study was conducted to describe the ordering practices of physicians and appropriateness of MPI referrals in Iran.**

Method. **We prospectively applied 2005 and 2009 versions of the Appropriateness Use Criteria published by the American College of Cardiology Foundation (ACCF) and the American Society of Nuclear Cardiology (ASNC) to 291 consecutive patients (age 55.3 ± 10.3 years) who underwent SPECT-MPI. For this purpose, we convened a panel, consisting of two academic cardiologists, one academic clinician in internal medicine, and one academic clinician in nuclear medicine. The panelists were invited for a face-to-face meeting to judge appropriateness of SPECT-MPI and independently assign a specific indication (scenario), whenever possible, for each case in accordance with ACCF/ASNC appropriateness scenarios.**

Results. **Based on the 2005 ACCF/ASNC criteria, SPECT-MPI studies were judged appropriate for 211 (72.5%), uncertain for 36 (12.4%), inappropriate for 32 (11.0%), and unclassifiable for 12 (4.1%) referrals. The same figures based on the 2009 version were 219 (75.3%), 15 (5.2%), 49 (16.8%), and 8 (2.7%) patients, respectively. Overall agreement between the 2005 and 2009 versions was good (κ 0.63). Lack of chest pain and age below 60 years were significant indicators increasing the likelihood of inappropriate referrals by 2.9-3.4 fold. Absence of diabetes mellitus and hypertension, a normal lipid profile, lack of a past history of myocardial infarction or cardiovascular interventions (CABGs or PCI), as well as lack of application and exercise ECG stress test as the gate keeper (keeping abnormal ETT or inability of the patient to perform exercise as the appropriate indication for SPECT-MPI referral) were significant indicators, decreasing the odds of appropriate referrals. Generally a higher percentage of referrals with inappropriate indications had normal MPI.**

Conclusion. **Our study provides an evidence for the fact that SPECT-MPI ordering practices in our developing community largely parallel the ACCF/ASNC recommendations. The implementation of appropriateness criteria is feasible in clinical settings and might provide an alternative to utilization management. (J Nucl Cardiol 2011;18:1044–52.)**

Key Words: Appropriateness criteria • guidelines • myocardial perfusion imaging

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Received for publication Dec 16, 2010; final revision accepted Jun 8, 2011.

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1071-3581/$34.00

doi:10.1007/s12350-011-9419-3

See related editorial, pp. 997–999

INTRODUCTION

Despite the relatively high cost, clinical imaging modalities have shown rapid diffusion and increasing application, even in low income countries.[1,2] In fact, documented evidence reveal that the number of clinical imaging procedures and instruments have continued to increase over the past decades.[1-5] Accordingly, there has been a movement for evidence justifying the cost of any diagnostic or therapeutic procedure, ''a movement of evidence-based medicine which began as a result of dramatic increases in the costs of health care that far outpaced inflation and encumbered greater percentages of the gross domestic product''.[6,7] In fact, dramatic growth in the physicians' request of imaging modalities and their dependence on clinical imaging for diagnosis[8] has led authorities to question the appropriateness of referrals and to consider strategies to constrain further diagnostic test growth. In this regard, special attention has been paid to cardiovascular diagnostic procedures due to their clinical importance and high costs. Numerous studies are available that evaluate the contributing factors in physicians' decisions to refer a patient for cardiac catheterization[9-12] or cardiac computed tomography.[13]

The number of single-photon emission computed tomography myocardial perfusion imaging (SPECT-MPI) performed annually has increased in many countries.[5,14] For example, in Ontario (Canada) the number has increased by 101% between 1996/1997 and 2005/2006.[3] In Germany, the number of myocardial perfusion scintigraphies increased between 2005 and 2006, despite the emergence of competing modalities.[15] Until recently, the same trend was observed in other European countries and the United States: since 1998, the rates for SPECT-MPIs increased from 10% to 30% per year.[5,6] On the other hand, in recent years almost 80% of cardiovascular disease (CAD) deaths have occurred in low- to middle-income countries.[14] Therefore, it is logically expected that application of SPECT-MPI is also increasing in these nations.[14,16] Such an expectation was confirmed by Koh et al,[17] who showed a 10% yearly growth in the application of SPECT-MPI in Singapore since 1996.

Appropriateness of MPI referrals in developing countries has not been studied extensively.[18-20] Although emphasis has been made by authorities in the American College of Cardiology Foundation (ACCF) and the American Society of Nuclear Cardiology (ASNC),[21,22] it seems that little attention has thus far been paid to this issue. This is mainly because health technology assessment is not an organized scientific effort in developing nations.[1,23] On the other hand, ethnic differences in the appropriateness of referrals have been suggested. In a preliminary report from Singapore, Indians were more likely to have an appropriately ordered and positive MPI than Chinese and Malays.[24] Accordingly, our study was conducted to describe the ordering practices of physicians, and appropriateness of MPI referrals, in multiple clinical sites of a developing country (Iran), by use of the 2005 and 2009 versions of ACCF/ASNC criteria as the major background reference.[25,26]

METHOD

All consecutive patients who underwent SPECT-MPI from January to mid-February 2009 in four nuclear medicine imaging centers (two private free-standing centers and two in hospital governmental centers) were prospectively entered to the study. After obtaining consent, all patients underwent systematic history taking, physical examination and review of the past medical records, to collect clinical data on the day of their MPI appointment. For each patient, the following clinical variables were recorded: patient age; sex; symptoms; whether chest pain was typical, atypical, or non-anginal (patients who had dyspnea rather than chest pain as a presenting symptom were considered symptomatic with atypical angina[27]); cardiovascular disease risk factors (including smoking, hypertension, dyslipidemia, diabetes status, and family history of CAD); history of previous CCU admissions; resting ECG; the results of the exercise ECG test; and results of other diagnostic tests (resting echocardiography, stress echocardiography, previous SPECT-MPI scans, CT angiography or interventional angiography) or invasive revascularization (CABGs or PCI) undertaken prior to SPECT-MPI referral. Only the most recent revascularization procedures were considered if the patient had previously undergone more than one therapeutic intervention.[27] The physician interviewer reported that data entry required at least 12 minute/patient.

Subsequently, as requested by the referring cardiologist, and regardless of the results of the clinical variables reviewed by the physician interviewer, SPECT-MPI was performed. Two nuclear medicine physicians blinded to other clinical characteristics interpreted the SPECT-MPI data. For study purposes, each SPECT-MPI was interpreted as normal or abnormal (including fixed defect(s), completely reversible defect(s), or a partially reversible defect(s)).

Rating of Appropriateness

We convened a panel, consisting of two academic cardiologists (AS and MR), one academic clinician in

internal medicine (AA), and one academic clinician in nuclear medicine (MM). The moderator, who was the physician responsible for collecting clinical data, history taking, physical examination data and reviewing of past medical records of the patients, and was unaware of the other panelists' ratings and SPECT-MPI results, presented each case in the face-to-face panel meeting. Then the panelists were invited to judge appropriateness of SPECT-MPI for each patient on a 9-point scale (Rating 1), on which scores of 1-3 denoted inappropriate referral (no benefit of SPECT-MPI), 4-6 denoted uncertainty about use (when harms and benefits were judged as approximately equal, or when the best available evidence did not support a judgment either way), and 7-9 denoted appropriate use (benefits were judged to outweigh harms).[28] Panel members had the opportunity to modify their scores in light of the panel discussions, but no effort was made to oblige the panelists for consensus. After calculating the mean of scores from four panelists, a mean score of 7-9 was considered appropriate (A), a score of 3.1-6.9 considered uncertain (U), and score of 1-3, inappropriate (I).

At the next step, panelists were asked to independently assign a specific indication (scenario), whenever possible in accordance with the 52 ACCF/ASNC appropriateness criteria scenarios of version 2005, for each case (Rating 2). SPECT-MPI studies were then classified into appropriate, inappropriate, uncertain, or remained unclassified (i.e., when the consensus of the panelists was that the case could not be matched to any of the 52 presented scenarios of 2005 ACCF/ASNC criteria). Similarly, Rating 3 was performed in accordance with the 67 ACCF/ASNC appropriateness criteria scenarios from the 2009 revision.[26]

The study was conducted with approval from the research and ethical committee at the Golestan Cardiovascular Research Center, Gorgan, Iran.

Statistical Analysis

Descriptive statistics, frequencies, and mean ± SD were computed, as appropriate, for demographic and clinical characteristics, presenting symptoms, previous diagnostic tests performed, and results of SPECT-MPI. Agreement between panelists beyond chance for Rating 1, based on the 3 defined categories (i.e., inappropriate, uncertain, and appropriate) was evaluated using the intra-class correlation (ICC) statistic and values of 0.40-0.60 were considered as moderate agreement and values greater than 0.60-0.80 were considered as good agreement. Agreement between Ratings 2 and 3 beyond chance was evaluated using kappa statistics.

Variations in the rate of appropriateness by baseline demographic and clinical characteristics and SPECT-MPI results were examined using chi-square and ANOVA for categorical and continuous variables. Moreover, odds ratios (OR) and their 95% confidence interval were calculated with the appropriateness level as the dependent variable and baseline demographic and clinical characteristics results as independent variables. A P value of $<.05$ was considered statistically significant. All statistical analyses were conducted using SPSS version 13 (SPSS Inc., Chicago, IL, USA).

Table 1. Baseline demographic and clinical characteristics of the study population

Demographic and clinical characteristics	Frequency (%)
Age (mean ± SD) [≥60 years]	55.3 ± 10.3 [95 (32.6%)]
Male gender	124 (42.6%)
Nuclear Medicine Center	
Hospital-based governmental	115 (39.5%)
Private free-standing	176 (60.5%)
Chest pain	
Typical	54 (18.6%)
Atypical	111 (38.1%)
Non-anginal	59 (20.3%)
No chest pain	67 (23.0%)
Dyslipidemia	173 (59.7%)
Hypertension	146 (50.2%)
Diabetes mellitus	63 (21.6%)
Smoking	44 (15.1%)
Family history of CAD	19 (6.5%)
History of myocardial infarction	33 (11.3%)
Previous CABGs or PCI	40 (13.7%)
Exercise ECG test	
Unable to ETT	99 (34.0%)
Able to ETT	191 (65.6%)
Performed	86 (29.6%)
Abnormal	53 (18.2%)
Normal	32 (11.0%)
Missed data	1 (0.3%)
Not performed	105 (36.1%)
Missed data	1 (0.3%)
Resting echocardiogram	
Performed	217 (74.6%)
Abnormal	102 (35.1%)
Normal	99 (34.0%)
Missed data	16 (5.5%)
Not performed	74 (25.4%)

There was no significant difference between hospital-based governmental and private free-standing nuclear medicine centers regarding the age (P .57), gender (P .053), chest pain (0.67), dyslipidemia (P .37), hypertension (P .75), diabetes mellitus (P .39), family history of CAD (P .46), history of myocardial infarction (P .061), previous CABG or PCI (P .14), exercise ECG test (P .29), and resting echocardiogram (P .37). Smoking was significantly higher in patients of hospital-based governmental centers as compared to private free-standing nuclear medicine centers (21.7% vs 10.8%, P .01).

RESULTS

Two hundred and ninety-one patients (167 female, 124 male) were entered into the study. The mean age of the participants was 55.3 ± 10.3 years (range 24-88 years). The demographic profile and baseline clinical characteristics of the patients are shown in Table 1. During the study period, the number of SPECT-MPI studies performed in hospital-based governmental centers was significantly lower than the private free-standing nuclear medicine centers (115 vs 176, $P < .001$).

Appropriateness of Referrals

Based on the Rating 1, the level of appropriateness of referrals for SPECT-MPI were judged appropriate for 163 of 291 (56.0%), uncertain for 97 of 291 (33.3%), and inappropriate for 31 of 291 patients (10.7%).

Based on the 2005 ACCF/ASNC appropriateness criteria (Rating 2), SPECT-MPI testing were judged appropriate for 211 referrals (72.5%), uncertain for 36 (12.4%), and inappropriate for 32 (11.0%). The same figures based on the 2009 version of ACCF/ASNC appropriateness criteria (Rating 3) were 219 (75.3%), 15 (5.2%), and 49 (16.8%), respectively (Table 2). Panelists had consensus that in 12 (4.1%) referrals, the cases did not match to any of the 52 presented scenarios of the 2005 ACCF/ASNC criteria (*unclassified*). Out of these, clinical interpretation of the panelists (Rating 1) was appropriate, uncertain and inappropriate in 4, 6, and 2 patients, respectively. However, according to the 2009 version of the ACCF/ASNC criteria (Rating 3) the number of unclassified cases was reduced to just eight referrals (2.7%). Out of these, clinical interpretation of the panelists (Rating 1) was appropriate, uncertain, and inappropriate in 2, 6, and 0 patients, respectively.

Regarding the level of appropriateness of referrals, there was no significant difference between hospital-based governmental and private free-standing nuclear medicine centers in Ratings 1, 2, and 3 (P values .44, .25, and .22, respectively).

Indications for Referrals

Based on the Rating 2, just two clinical situations accounted for more than 90% (29/32) of patients with inappropriate referrals. These were evaluation of non-acute ischemic equivalents in patients with low pre-test probability of CAD and an interpretable ECG, and able to exercise (No. 1), and the detection of CAD in low-risk patients without chest pain syndrome (No. 10). According to Rating 3, four clinical situations accounted for almost 94% (46/49) of patients with inappropriate referrals. These were evaluation of non-acute ischemic equivalents in patients with low pre-test probability of CAD and interpretable ECG and able to exercise (No. 1), detection of CAD or risk assessment in low or intermediate risk patients without ischemic equivalents and an interpretable ECG (No. 12 and 13), and patients with low-risk Duke Treadmill Score (No. 37).

According to Rating 3, those tests designated as unclassifiable could be separated in three categories: detection of CAD or risk assessment in intermediate risk patients without ischemic equivalent and uninterpretable ECG, but unable to perform exercise treadmill test (5 patients); valvular heart disease without chest pain syndrome (2 patients); and, new-onset/diagnosed heart failure with chest pain syndrome (1 patient).

According to Rating 2, those tests designated as unclassifiable could be separated into these categories: patients with a prior low (7 patients) and high (2 patients) risk Duke Treadmill Score; normal coronary angiography in a patient with new symptoms; asymptomatic patient at high risk for CAD; risk assessment within 3 months of an acute coronary syndrome to evaluate inducible ischemia.

Table 2. The agreement across the appropriateness levels between Rating 2 and 3

	Rating 3 (2009)				
Rating 2 (2005)	**Appropriate**	**Inappropriate**	**Uncertain**	**Unclassified**	**Total**
Appropriate	**204 (70.1%)**	0 (0.0%)	6 (2.1%)	1 (0.3%)	211 (72.5%)
Inappropriate	0 (0.0%)	**32 (11.0%)**	0 (0.0%)	0 (0.0%)	32 (11.0%)
Uncertain	11 (3.8%)	10 (3.4%)	**8 (2.7%)**	7 (2.4%)	36 (12.4%)
Unclassified	4 (1.4%)	7 (2.4%)	1 (0.3%)	**0 (0.0%)**	12 (4.1%)
Total	219 (75.3%)	49 (16.8%)	15 (5.2%)	8 (2.7%)	**291 (100.0%)**

κ 0.63, $P < .001$.
*P values are presented in detail in "Results" section

Agreement

The overall agreement among the panelists across the three appropriateness categories of Rating 1 was good (ICC 0.68, $P < .001$). The agreement across the appropriateness levels between Rating 1, 2, and 3 was also good (ICC 0.73, $P < .001$). The overall agreement between the 2005 and 2009 versions of the ACCF/ASNC appropriateness criteria (Table 2) was good (κ 0.63, $P < .001$).

Risk Factors and Clinical Characteristics

The mean age of patients with inappropriate referrals of Rating 3 was significantly lower than others (49.9 ± 9.0 years vs 56.4 ± 10.2 years, $P < .001$). Lack of chest pain and age below 60 years were significant indicators increasing the likelihood of inappropriate referrals by 2.9-3.4 fold (Table 3). On the other hand, lack of diabetes mellitus and hypertension, normal lipid profile, lack of past history of myocardial infarction or cardiovascular interventions (CABGs or PCI), as well as lack of application of exercise ECG test as the gate keeper test (keeping abnormal ETT or inability of the patient to perform exercise as the appropriate indication for SPECT-MPI referral), were significant indicators which decreased the odds of appropriate referrals. Type of imaging center (private or governmental), gender, smoking, and family history of CAD as well as application of resting echocardiography as the gate keeper test (abnormal resting echocardiogram as the appropriate indication for SPECT-MPI referral) did not affect appropriateness of the referrals (Table 3).

Table 3. Factors related to inappropriate referral for SPECT-MPI, according to the 2009 version of the ACCF/ASNC criteria (Rating 3)

Clinical characteristic and gate keeper tests	Odds ratio	95% CI	*P* value
Age <60 years	3.4	1.5-8.0	<.01
Female gender	1.7	0.9-3.2	.12
Private free-standing centers	1.4	0.7-2.7	.28
No chest pain	2.9	1.5-5.5	<.01
Diabetes mellitus	0.2	0.1-0.7	<.01
Hypertension	0.4	0.2-0.8	<.01
Dyslipidemia	0.5	0.3-0.9	.02
Smoking	1.1	0.5-2.6	.79
Family history of CAD	0.9	0.3-3.3	.89
History of myocardial infarction	0.8	0.8-0.9	<.01
Past history of CABGs or PCI	0.8	0.8-0.9	<.01
Exercise ECG test as the gate keeper test (abnormal ETT or patient unable to exercise)	0.2	0.1-0.4	<.001
Resting echocardiography as the gate keeper test (abnormal resting echocardiogram)	1.3	0.7-2.5	.47

More or less, similar results were obtained using Rating 1 and 2, which are not presented here, in order to concise the report.

Myocardial Perfusion Status

SPECT-MPIs were interpreted as normal in 203 (69.8%) and abnormal in 88 (30.2%) patients. Regarding the myocardial perfusion status, no significant difference existed between hospital-based governmental (ischemia in 40 out 115 patients) and private free-standing nuclear medicine centers (ischemia in 48 out 176 patients) (P .17).

There was significant association between the level of appropriateness and myocardial perfusion status in both Rating 1 and 3 (P values of .003 and .006, respectively), but in Rating 2 just a trend toward association was present (P .059). Generally a higher percentage of referrals with inappropriate indications were normal (Figure 1).

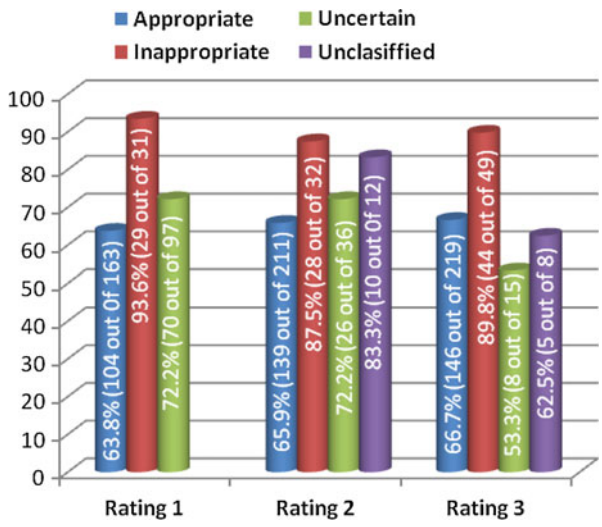

Figure 1. Percentage of normal SPECT-MPI results based on the level of appropriateness in different ratings. *P values are presented in detail in ''Results'' section.

DISCUSSION

Although our study population is considerably younger (mean age of 55 years) than that reported from prior studies,[19,20,27] a fact that at first glance increases the likelihood for inappropriate referrals, a high percentage of SPECT-MPI procedures in Iran are being done with appropriate indications. In fact, using the same criteria, our findings for appropriate requests for SPECT-MPI is comparable to that found in developed[19,20,27] and other developing nations,[24] where 64%-87% of studies were deemed appropriate. Non-significant differences between these studies can be explained partly by patient-related factors, given that differences in patient characteristics and their overall risk for CAD exist among different populations.[19]

Although the majority of referrals (>70%) in our population were deemed appropriate, there are a substantive proportion of referrals that are judged to be uncertain, inappropriate, or categorized as unclassified. It is noteworthy that a remarkable percentage of the inappropriate referrals ended in normal SPECT-MPIs (Figure 1), a fact which is supported by other reports.[24] Hence, regardless of the fact that in our community most of the referrals are ordered with appropriate indications, educational programs should be implemented to increase knowledge and familiarity of cardiologists with the current Appropriate Use Criteria and recommendations,[26] in order to reduce the number of inappropriate referrals, and subsequently total burden of health care expenditures.

Our expertise and non-documented interviews with cardiologists or non-cardiologists of our community who order SPECT-MPI, even in academic environments, indicate that most of these physicians have minimal awareness of the publication of appropriateness criteria for the referral of diagnostic procedures, such as ACCF/ASNC criteria. Although implementation of such criteria into clinical practice is difficult to achieve, and requires extensive education for cardiologists, educational interventions increase the adherence to the criteria. Dissemination of the ACCF/ASNC criteria for appropriate use of MPI[26] as well as delivery of didactic lectures and discussions about appropriate use criteria to physicians who are authorized to order MPI studies have been suggested to improve the ordering practices of physicians.[29] By emphasizing clinical indications for SPECT-MPI testing based on published criteria, significant reductions in inappropriate referrals, especially of low-risk patients, and an increase in appropriate referrals, particularly for patients prior to non-cardiac surgeries, have been demonstrated, although cost-effectiveness and clinical implications of these changes have not yet been investigated.[29]

The Effect of Clinical Judgment

Our study showed that the proportion of appropriate referrals is considerably lower in Rating 1 as compared to Rating 2 and 3. There are a very large number of uncertain categorizations by the panel in Rating 1, which is very problematic; this finding lends support in favor of the published ACCF/ASNC criteria (Rating 2 and 3), as both versions provide a more definitive categorization.

Several factors influence appropriateness of utilization of SPECT-MPI. Unfortunately the ACC/ASNC appropriateness criteria cannot take into account some of the important baseline clinical descriptors that influence the decision to order SPECT-MPI, such as severity and duration of patient's complaints, as well as race, ethnicity, and sex,[30-34] factors which are taken into account by a dynamic and flexible panel of experts (as compared to inflexible criteria). For example, in the judgment of our panelists, duration of 20 years of diabetes mellitus was different from the duration of just less than 1 year,[35] a fact which was not taken into consideration by the current criteria. Other possible factors not included in the current ACC-ASNC appropriateness criteria are regional practice patterns, socioeconomic factors, patients' preference, availability of diagnostic facilities, reimbursement, and insurance status, although it can be assumed that they should not be considered in any form of appropriateness criteria for any diagnostic/risk assessment test. These limitations of guidelines can be considered as an explanation of why inappropriate referrals could never reach 0%.

Are Inappropriate Referrals Always Inefficient?

Mehta et al[27] have stated that some of the inappropriate referrals may have a clinically valuable impact that alters long-term patients' outcome. For example, patients who are informed that they have an abnormal SPECT-MPI, may be more apt to start and continue lifestyle modifications including weight reduction and smoking cessation, which may alter their long-term risk. Also, based on our study findings, up to 12% of patients with inappropriate referrals have SPECT-MPI abnormalities, which warrant further clinical work-up. Based on this data, ''NNI'' (number needed to image) in the inappropriate group to find a positive test is 8.3. This observation shows that not all inappropriate referrals are useless. On the other hand, as there are significant concerns regarding the application of the ACCF/ASNC criteria to prevent performance of, or deny reimbursement, for those tests with ''inappropriate'' indication, further outcomes data are required to carefully address these indications.[27] According to the introduction of

both versions of ACCF/ASNC criteria, the inappropriate rate is not anticipated to be 0%, as clinical judgment must be considered, a fact which is supported by our study findings. All health plans and regulatory bodies are advised not to prevent testing for these indications, but instead to track patterns and performance.

Unclassified Referrals

Based on the 2005 version of the ACCF/ASNC criteria, 12 out of 291 patients (4.1%) were labeled as unclassified since they were ordered for indications not adequately addressed in the ACCF/ASNC criteria. This figure was closely comparable to those (3%-7%) previously reported.[19,27] However, the 2009 version of the ACCF/ASNC criteria seems to be a little more comprehensive, as the number of unclassified cases was reduced to just eight (2.7%). On the other hand, there was no patient unclassified in both Rating 2 and 3. For example, in our population we found a 62-year-old female patient with moderate Framingham risk stratification presented for myocardial perfusion imaging to guide decision for invasive studies, which was clearly classified as uncertain in the 2005 ACC/ASNC criteria. No such corresponding scenario was listed in the 2009 ACC/ASNC criteria.

How to Improve Appropriateness of Referrals?

Although the decisive role of clinician judgment in the face of diverse medical presentations and varying patient characteristics cannot be overlooked and constrained,[27] appreciation of our study results will assist clinicians to improve quality of patient care, and their ordering practice in a cost-effective manner. Age of younger than 60 years and lack of chest pain increases the odds of inappropriate referrals 3.4 and 2.9 times, respectively, and should be taken into account more cautiously by the referring physician at the point of ordering. On the contrary, concomitant cardiovascular disease risk factors (including hypertension, dyslipidemia, and most importantly diabetes mellitus) and past history of myocardial infarction and invasive revascularizations are significant predictors that reduce the number of inappropriate referrals (Table 3). Supporting our study findings, Koh et al[24] reported that a grading of appropriate is significantly associated with patients who are older or who had major cardiac risk factors, including hypertension, dyslipidemia, or diabetes mellitus. Although previous reports stated that ''the inappropriate group of referrals is predominantly composed of female patients'',[27] in our study this relationship was not significant.

The clinical importance of exercise ECG test as the gatekeeper test to order SPECT-MPI procedures cannot be overemphasized. Our study confirmed that the exercise ECG test possesses the ability to determine which patients should or should not undergo these costly, but inherently cost-saving diagnostic tests. Bypassing exercise ECG test—unless the patient is unable to perform exercise due to physical disabilities or other clinical limitations—leads to an increase in the number of inappropriate referrals with the potential of rising costs vs the benefits of the imaging modality.

LIMITATIONS

Although no effort was made to reach consensus after panel discussion, this may limit the true individual scoring and introduce some form of harmonization and will impact the calculated measures of agreement.

The main drawback of our study was the sample size studied. Larger sample sizes have been studied using an automated system.[19] However, we believe that such a computerized software analysis is not as reliable as a panel of experts in this field who make judgments after reviewing all clinical data, and more precisely report their decision.

Also regarding the fact that in our study angiographic and follow-up outcomes data were not prospectively sought, it was impossible to correlate perfusion abnormalities with angiographic abnormalities and prognosis. Nevertheless, the accuracy of SPECT-MPI to reveal angiographic stenosis is well described, and the potential of SPECT-MPI to predict prognosis is also well established and has been reported to exceed that of angiography.[28]

CONCLUSION

Our study provides evidence that SPECT-MPI ordering practices in a developing country largely parallel the ACCF/ASNC recommendations. The implementation of appropriateness criteria is feasible in clinical settings and might provide an alternative to utilization management.

Acknowledgments

This study was supported by Cardiovascular Research Center, Golestan University of Medical Sciences, Gorgan, Iran. The author wishes to thank Dr Mohammad Hoseyn Najafi for his kind assistance and guidance.

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