

Application of the American College of Cardiology Foundation/American Society of Nuclear Cardiology Appropriateness Criteria for Single-Photon Emission Computed Tomography Myocardial Perfusion Imaging at the Philippine Heart Center

Belinda R. Dancel-San Juan, MD; Jerry M. Obaldo, MD

Background --- Myocardial perfusion imaging studies play an important role in the diagnosis and prognostic assessment of patients with suspected or known coronary artery disease. This study determined the appropriateness of the indications for myocardial perfusion imaging of patients referred to the Division of Nuclear Medicine of the Philippine Heart Center.

Methods --- Clinical information and myocardial perfusion imaging findings of patients who underwent myocardial perfusion imaging from January 2008 to December 2009 were reviewed. The ACCF/ASNC Appropriateness Criteria for SPECT Myocardial Perfusion Imaging was used to classify indications for referral.

Results --- A total of 700 patients with a mean age of 55 years old were included in the study. There were 504 patients (72%) in the appropriate category and majority of them had abnormal myocardial perfusion imaging results (70.2%). There is highly significant association between appropriateness category and myocardial perfusion imaging findings. Most of the referring physicians were cardiologists. There is no association between myocardial perfusion imaging results and specialty of referring physicians among appropriateness categories.

Conclusions --- The ACCF/ASNC Appropriateness Criteria for SPECT Myocardial Perfusion Imaging may serve as a guide for attending physicians in the management of their patients with suspected or known coronary artery disease. *Phil Heart Center J 2013;17(1):43-49.*

Key Words: Appropriateness, Myocardial Perfusion Imaging ■ Coronary Artery Disease

Cardiovascular disease is the leading cause of death globally. According to the World Health Organization, an estimated 17.5 million people died from cardiovascular disease in 2005, representing 30 % of all global deaths. Of these deaths, 7.6 million were due to heart attacks. About 80% of these deaths occurred in low- and middle-income countries. If current trends are to continue, by 2015 an estimated 20 million people will die from cardiovascular disease, mainly from heart attacks and strokes.¹ Ischemic heart disease and hypertensive heart disease make up a total of 17% of all deaths in the Philippines.²

Myocardial perfusion imaging studies play an important role in the diagnosis and prognos-

tic or known coronary artery disease. The sensitivity of the test range between 71% to 97% with an average of 87% and the specificity is between 36 to 92% with an average of 74%.³ In the year 2007, 1609 myocardial perfusion scintigraphy studies were done (66% of all procedures) in the Division of Nuclear Medicine, Philippine Heart Center.

The American College of Cardiology Foundation (ACCF) and the American Society of Nuclear Cardiology (ASNC) believe that formulating appropriateness criteria based on “evidence-based information and clinical experience can help guide a more efficient and equitable allocation of health care resources.”⁴

The objective is to improve patient care and health outcomes in a cost-effective manner, without constraining the crucial role of physician judgment.⁴

The ACCF/ASNC appropriateness review was specifically conducted for gated single-photon emission computed tomography myocardial perfusion imaging. The 52 indications that were included came from major scenarios faced by referring physicians, analyzed with existing clinical practice guidelines and modified based on discussion by the ACCF Appropriateness Criteria Working Group and the Technical Panel members who rated the indications. There were 12 members of the technical group which comprised of nuclear cardiologists, referring physicians, health services researchers and a payer (chief medical officer). The panel used a modified Delphi technique and was based on the RAND/UCLA approach for evaluating appropriateness, which blends scientific evidence and practice experience.⁴ (Appendix A) They assessed the risks and benefits of the test for several indications or clinical scenarios and scored them based on a scale of 1 to 9 where scores from 7 to 9 are generally acceptable, scores of 4 to 6 may be generally acceptable and scores of 1 to 3 are generally not acceptable.

Paying for health care is an issue because of its poverty impacts. The 2004 national health accounts show that the most common source of funds for health in the country today is still out-of-pocket payments (around 47%). Under the current health care financing arrangements, low-income families are pushed into poverty due to payments for health care.⁵ Patients who suffer from coronary artery disease shell-out a lot of their savings for diagnostic modalities, medicines and therapeutic procedures. Myocardial perfusion imaging is expensive therefore it is imperative that health care providers know how to responsibly request for these studies for their patients.

The appropriateness criteria may give physicians, most specially non-cardiologists, an idea of what type of patients are rightfully indicated to undergo a myocardial perfusion scan and are most likely to have a positive result. It may also be useful not only for clinicians, but also for

health care facilities and third-party payers in the delivery of cardiovascular care.⁴ Third-party payers may use this tool in giving the patient with an appropriate indication reimbursement for the procedure.

An evaluation of the ACCF/ASNC appropriateness criteria for SPECT myocardial perfusion imaging was done by Mehta, et al.⁶ They assessed indications for testing in 1209 patients. There were 940 (80%) appropriate, 154 (13%) inappropriate, and 79 (7%) uncertain tests; 36 tests were labeled “no category,” as these were ordered for indications not clearly addressed in the appropriateness criteria. They concluded that although the majority of the myocardial perfusion studies were appropriate, there were still a large proportion of studies that are uncertain or inappropriately indicated. Inappropriate studies were more likely to be normal, have less ischemia and higher ejection fractions, more common in women and are ordered for preoperative evaluation.

This study will answer the research question: How appropriate are myocardial perfusion imaging studies done at the Philippine Heart Center as assessed using the American College of Cardiology Foundation/American Society of Nuclear Cardiology Appropriateness Criteria for Single-Photon Emission Computed Tomography Myocardial Perfusion Imaging?

METHODOLOGY

This is a cross-sectional study involving myocardial perfusion imaging studies done using either Thallium-201 or Technetium-99m Sestamibi radiopharmaceuticals. Treadmill stress, dipyridamole and rest redistribution protocols among adults 30 to 69 years old at the Division of Nuclear Medicine of the Philippine Heart Center from January 2008 to December 2009. No coronary heart disease risk data exist for patients less than 30 or greater than 69 years old but it may be assumed that prevalence of coronary artery disease increases with age.⁴ However for the study, the inclusion was limited to patients 30 to 69 years old.

The patient's databases were used to assess

the history and indications for requesting the myocardial perfusion imaging. The variables needed for classifying the different indications into appropriateness categories were found in each patient database. An exception is the exact cholesterol values because only history of dyslipidemia was reported. The databases are filled up by the nuclear medicine residents or fellows who interviewed the patients prior to the procedures. The Division of Nuclear Medicine has proper filing of these databases. For patients who have been admitted because of an acute coronary syndrome, hospital database was accessed through Medtrak for additional information such as administration of thrombolytic therapy.

Majority of the physicians who request for myocardial perfusion imaging studies were cardiologists. Because of this, data collection from databases of patients referred by cardiologists was stopped at a certain number to ensure that there is adequate representation of patients referred by physicians from other specialties.

Once the variables are complete and tabulated, these were the basis for referrals to be categorized as having an appropriate, inappropriate or uncertain indication for myocardial perfusion imaging. The 52 indications from the ACCF/ASNC Appropriateness Criteria for SPECT Myocardial Perfusion Imaging are shown in Appendix B.

Myocardial perfusion scan images are archived in the Philips JETStream Workspace Release 3.0 (Nuclear Medicine Module with Review). The AUTOQUANT Plus applications are intended to enable a fully automated display, review, and quantification of Nuclear Medicine Cardiology medical images and data sets. The official results were retrieved from digital records. The scans were read by at least 2 nuclear medicine physicians and were signed for release when they reach a consensus. The results were converted to semi-quantitative defect extent and severity using the AHA 17-segment scoring. (Appendix C) A 5-point scale was used where 0 is normal, 1 is mildly reduced tracer uptake, 2 is moderately reduced tracer uptake, 3 is severely reduced tracer uptake and 4 is absent or background tracer uptake. The summed stress score (SSS) was obtained by adding the scores

of the 17 segments of the stress images. A similar procedure was applied to the resting images to calculate the summed rest score (SRS). The summed difference score (SDS) represents the difference between the stress and rest scores and is taken to be an index of ischemic burden. Left ventricular ejection fraction (LVEF) is an output that is calculated by the program based on ventricular counts. The percent LVEF was calculated utilizing the end-diastolic (ED) and end-systolic (ES) ventricular count rates as shown in the formula (ED-ES) divided by (ED) x 100.

The ACCF/ASNC Appropriateness Criteria for Single-Photon Emission Computed Tomography Myocardial Perfusion Imaging paper served as the instrument for this study. It lists 52 indications by purpose, clinical scenario and their ratings. (Appendix B) The indication of each myocardial perfusion imaging study was reviewed using the variables mentioned earlier.

Pre-test probability of coronary artery disease was determined after presence of chest pain syndrome was established. The method used by the appropriateness criteria report is a modification of a literature review 7 recommended by the ACC/AHA 2002 Guideline Update for Exercise Testing⁸ and ACC/AHA 2002 Guideline Update for Management of Patients With Chronic Stable Angina⁹ (Appendix D). The classification of angina as defined by the ACC/AHA 2002 Guideline Update on Exercise Testing⁸ is as follows:

- Typical angina (definite): 1) Substernal chest pain or discomfort that is 2) provoked by exertion or emotional stress and 3) relieved by rest and/or nitroglycerin.
- Atypical angina (probable): Chest pain or discomfort that lacks one of the characteristics of definite or typical angina.
- Non-anginal chest pain: Chest pain or discomfort that meets one or none of the typical angina characteristics.

For patients who do not present with chest pain syndrome, Framingham risk score was used. An online Framingham risk score calculator that was used can be found at URL: <http://www.mcw.edu/calculators/CoronaryHeartDiseaseRisk.htm>. For this analysis, cholesterol levels

were excluded. Only the history of dyslipidemia was obtained and not the actual cholesterol values. Because of this, the Framingham risk score may be underestimated. Based on the score, coronary heart disease risk may be derived.⁴

- CHD risk – low. Defined by the age-specific risk level that is below average. In general, low risk will correlate with a 10-year absolute CHD risk less than 10%.
- CHD risk – moderate. Defined by the age-specific risk level that is average or above average. In general, moderate risk will correlate with a 10-year absolute CHD risk between 10% to 20%.
- CHD risk – high. Defined as the presence of diabetes mellitus or the 10-year absolute CHD risk of greater than 20%.

Perioperative risk was determined for the appropriateness criteria report using a “Stepwise Approach to Preoperative Cardiac Assessment,” found in ACC/AHA 2002 Guideline Update for Perioperative Cardiovascular Evaluation for Noncardiac Surgery.¹⁰ Perioperative risk predictors were identified after the clinician determines that the patient does not require urgent surgery and that there has not been revascularization within the last five years. If major risk predictors were present, coronary angiography and the postponement or cancellation of non-cardiac surgery should be considered. Once perioperative risk predictors were assessed based on the algorithm, then the surgical risk and patient’s functional status should be used to establish the need for noninvasive testing.⁴ The perioperative risk predictors were as follows:¹⁰

- Major risk predictors. Unstable coronary syndromes, decompensated heart failure (HF), significant arrhythmias, and severe valve disease.
- Intermediate risk predictors. Mild angina, prior myocardial infarction (MI), compensated or prior HF, diabetes, or renal insufficiency.
- Minor risk predictors. Advanced age, abnormal electrocardiogram (ECG), rhythm other than sinus, low functional capacity, history of cardiovascular accident (CVA), and uncontrolled hypertension.

The surgical risk categories were as follows:¹⁰

- High-risk surgery - cardiac death or MI greater than 5%. Emergent major operations (particularly in the elderly), aortic and peripheral vascular surgery, prolonged surgical procedures associated with large fluid shifts and/or blood loss.
- Intermediate-risk surgery - cardiac death or MI = 1% to 5%. Carotid endarterectomy, head and neck surgery, surgery of the chest or abdomen, orthopedic surgery, prostate surgery.
- Low-risk surgery - cardiac death or MI less than 1%. Endoscopic procedures, superficial procedures, cataract surgery, breast surgery.

An ECG that was uninterpretable refers to ECGs with resting ST-segment depression (greater than or equal to 0.10 mV), complete left bundle branch block, pre-excitation (Wolf-Parkinson-White Syndrome), or paced rhythm.

The variables were obtained from the data bases of the patients and tabulated. The appropriateness classification (appropriate, inappropriate and uncertain) of the indications for performing myocardial perfusion imaging was determined for each patient using the appropriateness criteria (Appendix B).

Sample size and basis for the calculation. The sensitivity of the test range between 71% to 97% with an average of 87% and the specificity is between 36 to 92% with an average of 74%.³ Based on an 87% sensitivity, the calculated sample size is equal to or more than 695 with a 5% relative error and a 95% level of confidence.

Statistical Analysis. The demographic profile characteristics of patients were presented in terms of means, standard deviations, frequency and percent distribution. All data were entered in Microsoft Office Excel and analyzed using Epi Info version 6 and SPSS. Chi-square test was used to compare categorized variables. A p-value of less than 0.05 was considered statistically significant.

Table 1. Baseline Characteristics of Patients in the Study (PHC, 2010)

Characteristics	Mean	SD
Age	55	8.78
LVEF	54.36%	18.87
	Frequency	%
Gender		
Male	461	65.9
Female	239	34.1
Chestpain	406	58.0
Hypertension	562	80.3
Diabetes Mellitus	219	31.3
Smoking	270	38.6
Post-ACS	147	21.0
Post-revascularization	88	12.6

Table 2. Distribution of Patients by Appropriateness Category (PHC, 2010)

Category	No.	%
Appropriate	504	72.0
Inappropriate	105	15.0
Uncertain	91	13.0

RESULTS

Seven hundred (700) subjects who underwent myocardial perfusion imaging from January 2008 to December 2009 were included. The mean age of the patients seen is 55 years old and is mostly male (Table 1).

Majority of the subjects complained of experiencing chest pain, were hypertensive, non-diabetic and non-smoker, had no history of acute coronary syndrome and have not undergone a coronary revascularization procedure. Among the cases included in the study, most of them are in the appropriate category (Table 2).

Among patients who are classified as to having an appropriate indication for myocardial perfusion imaging, majority of them have abnormal myocardial perfusion imaging results (Table 3). Majority had normal results among those who were classified as having an inappropriate or uncertain indication for myocardial perfusion

imaging. There is a highly significant association between appropriateness category and myocardial perfusion imaging findings (p-value of 0.000).

The left ventricular ejection fraction (expressed in means) is 50.92% in the appropriate category. This is significantly lower (p-value of 0.000) than the left ventricular ejection fraction of the inappropriate and uncertain categories (64.08% and 62.21%, respectively). However the left ventricular ejection fractions in the inappropriate and uncertain categories do not differ significantly from each other. This is significantly lower (p-value of 0.000) than the left ventricular ejection fraction of the inappropriate and uncertain categories (64.08% and 62.21%, respectively). However the left ventricular ejection fractions in the inappropriate and uncertain categories do not differ significantly from each other.

The referring physicians were mostly cardiologists (Table 4). There is no association between myocardial perfusion imaging results and specialty of referring physicians among appropriateness categories.

DISCUSSION

As part of a hospital who caters mainly to patients with cardiovascular diseases, it is expected that majority of the procedures being done in the Division of Nuclear Medicine is for the evaluation of suspected or known coronary artery disease. This is the first study done in this institution to evaluate the indications for referral of patients who underwent myocardial perfusion imaging.

In the study done by Mehta et al which was done in the United States,⁹ the mean age of the

patients was 61 years old and majority were female (55%). The majority of the patients in this study are male (66%) and younger at 55 years old. Most of the patients referred to our division for myocardial perfusion imaging are classified to have appropriate indications (72%). This is slightly lower than the 80% reported as having appropriate indications in the study by Mehta. Normal myocardial perfusion imaging results were obtained significantly more frequently in the inappropriate group than in the appropriate group in both Mehta's study and in this paper. Mehta's study also showed that left ventricular ejection fraction was significantly lower in the appropriate group than in the inappropriate group but was not significantly lower than in the uncertain group; the uncertain

group was not significantly different from the inappropriate group. These findings are also comparable to the present study.

There is a highly significant association between appropriateness category and myocardial perfusion imaging findings. Those whose indication for referral was classified as appropriate were more likely to have an abnormal result. Even though majority of those with inappropriate and uncertain indications were normal, there were still some patients whose results turned out positive for coronary artery disease. In these instances, the attending physicians also relied on their clinical judgment, experience and expertise. These will have an impact on the management and treatment of the patients.

Table 3. Comparison of Appropriateness Category with SPECT MPI Results (PHC, 2010)

Category	SPECT MPI Results				
	Normal SPECT MPI n = 238		Abnormal SPECT MPI n = 417		Total
	No.	%	No	%	
Appropriate	150	29.8	354	70.2	504
Inappropriate	78	74.3	27	25.7	105
Uncertain	55	60.4	36	39.6	91
p-value			0.000		

Table 4. Comparison of Appropriateness Category with Specialty of Referring Physicians (PHC, 2010)

Category / SPECT MPI	CARDIOLOGIST n = 666		Non-CARDIOLOGIST n = 34		P-Value
	No.	%	No.	%	
Appropriate	485		19		0.305
Normal	142	29.3	8	42.1	
Abnormal	343	70.7	11	57.9	
Inappropriate	95		10		0.276
Normal	72	75.8	6		
Abnormal	23	24.2	4		
Uncertain	95		5		1.000
Normal	72	60.5	3	60.0	
Abnormal	23	39.5	2	40.0	

CONCLUSION

Majority of the physicians who send their patients to the Division of Nuclear Medicine for myocardial perfusion imaging have appropriately done so based on the indications for referral. There were more abnormal myocardial perfusion imaging results in the appropriate category as compared with inappropriate and uncertain categories. The specialty of the referring physician did not affect the result of the myocardial perfusion imaging. The ACCF/ASNC Appropriateness Criteria for Single-Photon Emission Computed Tomography Myocardial Perfusion Imaging may serve as a guide for attending physicians in the management of their patients with suspected or known coronary artery disease.

REFERENCES

1. Fact sheet on cardiovascular diseases [Online]. Available from: URL: <http://www.who.int/mediacentre/factsheets/fs317/en/index.html>
2. Mortality country fact sheet 2006: Philippines [Online]. Available from: URL: http://www.who.int/whosis/mort/profiles/mort_wpro_phl_philippines.pdf
3. Klocke F, Baird M, Bateman T, Berman D, Carabello B, Cerqueira M et al. ACC/AHA/ASNC guidelines for the clinical use of cardiac radionuclide imaging: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASNC Committee to Revise the 1995 Guidelines for the Clinical Use of Radionuclide Imaging) [Online]. 2003. Available from URL: <http://www.americanheart.org/downloadable/heart/1061222494555RNIFullTextFinal.pdf>
4. Bateman T, Cerqueira M, Gibbons R, Gillam L, Gillespie J, Hendel R et al. ACCF/ASNC appropriateness criteria for single-photon emission computed tomography myocardial perfusion imaging (SPECT MPI). *J Am Coll Cardiol.* 2005 ;46(8):1587-605.
5. World Health Organization: Health System Philippines [Online]. Available from: URL: <http://www.wpro.who.int/NR/rdonlyres/AD39B24B-B3C8-48DD-9B1D-E229CFCCC3C0/0/30Philippines07.pdf>
6. Mehta R, Ward R, Chandra S, Agarwal R, Williams K. Evaluation of the American college of cardiology foundation/American society of nuclear cardiology appropriateness criteria for SPECT myocardial perfusion imaging. *J Nucl Cardiol.* 2008 May/June;15:337-44.
7. Diamond GA, Forrester JS. Analysis of probability as an aid in the clinical diagnosis of Coronary artery disease. *NEJM.* 1979;300:1350-1358.
8. Gibbons RJ, Balady GJ, Bricker JT et al. ACC/AHA 2002 guideline update for exercise testing: summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guideline (Committee to Update the 1997 Exercise Testing Guidelines). *Circulation.* 2002;106:1883-18892.
9. Gibbons RJ, Abrams J, Chatterjee K et al. ACC/AHA 2002 guideline update for the management of patients with chronic stable angina – summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on the Management of Patients With Chronic Stable Angina). *Circulation* 2003;107:149-158.
10. Eagle KA, Berger PB, Calkins H et al. ACC/AHA guideline update for perioperative cardiovascular evaluation for noncardiac surgery – executive summary a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1996 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery). *Circulation* 2002;105:1257-1267.

Note: Appendices available in electronic version
<http://www.phc.gov.ph/about-phc/phc-journals.php>