

Utilization of radionuclide myocardial perfusion imaging in two health care systems: Assessment with the 2009 ACCF/ASNC/AHA appropriateness use criteria

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Background. Although differences in the rate of utilization of invasive cardiac procedures between Veterans Affairs (VA) hospitals and other health care systems are present, noninvasive cardiac imaging use pattern has not been well studied. We evaluated the ability of the updated appropriateness use criteria (AUC) to determine utilization patterns of myocardial perfusion imaging (MPI) and compare use between an academic practice and a VA.

Methods. One-hundred fifty stress/rest MPI studies in an academic practice and 150 at a VA hospital were retrospectively reviewed using the hierarchical approach published in the 2009 AUC.

Results. Less than 1% of studies were unclassified. A higher percentage of MPI were requested for inappropriate reason at the VA, although this difference was not statistically significant ($P = .248$). In the VA, non-physicians requested significantly more inappropriate studies than physicians (26.8% vs 20.1%; $P < .048$). Within the academic practice non-cardiologists referred more patients for inappropriate indications than cardiologists (23.9% vs 10.1%; $P = .001$). Five most common inappropriate indications accounted for the vast majority of inappropriately requested MPI (77%).

Conclusions. The revised 2009 AUC allow for near complete categorization of appropriateness in testing. Differences between institutions and provider types were noted and areas for improved utilization were identified. (J Nucl Cardiol 2012;19:37–42.)

Key Words: SPECT • diagnostic and prognostic application • cost-effectiveness

INTRODUCTION

Cardiac imaging has well-documented applications for diagnosis, risk assessment, and patient management decisions. However, imaging has come under scrutiny because of its rapid growth and financial burden to the health care system.^{1,2} Although the rate of increase for MPI has declined in recent years, there remains a 6.1% average annual increase in cardiovascular imaging stress tests. Furthermore, substantial geographic variability is present suggesting the possibility of overuse/misuse.¹

Inappropriate use of cardiac radionuclide imaging (RNI) may be harmful to patients and generate unwarranted cost to the healthcare system whereas appropriate procedures aid in clinical decision making and may impact on patients' outcome. In response to these concerns several specialty and subspecialty societies developed appropriate use criteria (AUC) to facilitate rational use of imaging services. ACCF/ASNC recently published an updated AUC for cardiac radionuclide imaging.³ Application of the original AUC published in 2005 was described in publications and quality improvements projects were suggested.^{4,5} However, limited data is available on the utilization of the updated criteria.^{6,7} Therefore, we evaluated the ability of the updated (2009) AUC to assess the appropriateness of performing RNI in clinical practice.

In the United States, medical services are supplied by several different health care systems that differ from each other with regard to payer reimbursement policies, oversight of practitioner performance⁸, and medico-legal pressures.⁹ In addition to different systems, health

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care is also being provided by an increasingly diverse group of practitioners, including physician assistants and nurse practitioners whose type and level of training differ from that of physicians.¹⁰ The advantage of using physician extenders in other cardiology services like cardiac catheterization and outpatient services has been described.^{11,12} However, it is questionable whether it can be generalized to other cardiology subspecialties like cardiac imaging where clinical decision making might play a role in progressive growth of these services. Therefore, we sought to compare differences in the utilization patterns and appropriate use of RNI between a VA hospital and an academic practice and among various health care providers.

METHODS

Study Groups and Data Collection

The nuclear laboratory in Miami VA Medical Center (VAMC) performs all the myocardial perfusion imaging (MPI) for inpatients at the VAMC and outpatients from the facility's on-site and affiliated off-site clinics. The nuclear laboratory of the University of Miami Medical Group (UMMG) performs all the outpatients MPI for the academic practice, including those requested at on-site and at off-site clinics. We retrospectively reviewed 150 consecutive stress/rest MPI performed at UMMG between January and August 2009. For the VAMC, 150 stress/rest MPI were selected from among the group of studies performed between January and August 2009, based on last name alphabetical order starting with letter "a" until 150 studies were collected.

Chart audits were performed by a single physician using electronic medical records and each study was assigned an indication and appropriateness score whenever possible in accordance with AUC based on hierarchical approach; the auditor was blinded to the results of the MPI studies. Healthcare providers were classified as physicians and non-physicians. Physicians were further classified as cardiologists (trainees and attendings in specialties other than cardiology) and non-cardiologists (trainees and attendings in specialties other than cardiology). Non-physicians (nurse practitioners and physicians assistants) function as primary care providers in some of VAMC clinics while in UMMG only physicians were ordering MPI. The protocol was approved by the institutional review board of each facility.

Statistical Methods

Categorical numbers are reported as numbers and percentages. Chi-square tests were used to compare ordering patterns of UMMG and VAMC physicians, and within the VAMC physicians and non-physicians. A two-sided *P* value less than .05 was considered statistically significant. Analyses were performed with Statistix, version 9.0. Correlation between appropriateness scores and study results was analyzed using Pearson Chi-square (SPSS).

Rating of Indications for MPI

MPI were rated using the revised 2009 AUC based on a combined analysis of the indication stated by the ordering provider and a detailed review of the clinical data in the medical records. These criteria consist of 33 appropriate, 9 uncertain and 25 inappropriate indications divided according to clinical category into 8 tables. A hierarchical algorithm described in the revised AUC criteria was used to facilitate classification of the MPI, especially when the true clinical reason might have two or more clinical indications.

The studies with indications addressed in the criteria were assigned a rating of classified, and those requested for indication not described within the criteria were rated as unclassified. Classified indications were further rated as appropriate, uncertain, and inappropriate. To assess the reproducibility of appropriateness rating, 20 randomly selected studies were blindly reviewed by a second reviewer.

Correlation Between Appropriateness Scores and Study Results

The scintigraphic results of the MPI studies were reviewed and labeled as normal, abnormal study/no ischemia (infarction, left ventricular dilatation, abnormal LV function), and abnormal study/ischemia; reviewers were unaware of the appropriateness score at the time of MPI categorization.

RESULTS

Study Sites

A total of 150 MPI performed in the laboratory of the UMMG and 150 MPI performed at the Miami VAMC were reviewed. Among MPI requested at VAMC 12% were requested for hospitalized patients and 88% were performed as outpatients.

Patient Characteristics

Table 1 shows basic demographic characteristics of the patients at both institutions. The major difference between the two hospital sites was sex of the patients as VAMC patients are primarily men. Despite older population at UMMG, the prevalence of risk factors was higher in VAMC, with diabetes, hypertension, hyperlipidemia, and smoking being statistically more frequent at VAMC ($P < .05$).

Appropriate Use Rating

Comparison of overall appropriateness rates is summarized in Figure 1. The majority of the studies were ordered for appropriate indication (67.3% in VAMC vs 74% in UMMG), with a trend for more inappropriate studies at VAMC ($P = .272$). The rate of

Table 1. Patients characteristics

	UMH (n = 150)	VAMC (n = 150)	P value
Age	65 ± 12	61 ± 10	.0054
Men*	86 (57%)	148 (99%)	<.0001
Diabetes*	31 (21%)	52 (35%)	.0096
Hypertension	111 (74%)	130 (87%)	.0086
Hyperlipidemia*	58 (62%)	115 (77%)	<.0001
Smoking*	34 (23%)	64 (43%)	.0003
Prior MI	43 (29%)	57 (38%)	.1111
Prior PCI	34 (23%)	31 (21%)	.7794
Prior CABG	18 (12%)	20 (13%)	.8624

* P < .05.

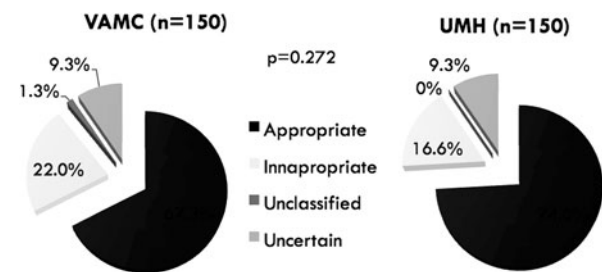


Figure 1. Comparison of appropriate use rates in two health systems. VAMC, Miami VA Medical Center; UMMG, University of Miami Medical Group.

uncertain indication is the same in both institutions. Only 1.3% of the studies requested in VAMC and no study in UMMG were rated as unclassified.

Practitioners

Studies were requested by large number of different level health care providers at both institutions. Figure 2 shows the frequency distribution of providers requesting MPI by practice location. All providers in UMMG were physicians and almost half of MPI was ordered by cardiologists (47%). In VAMC non-physician requests accounted for 27% of all MPI performed.

Indications

The most common indications for testing were (1) evaluation of symptomatic patients with intermediate pretest probability of CAD, interpretable ECG and are able to exercise, (2) evaluation of symptomatic patients with intermediate pretest probability of CAD, unable to exercise or uninterpretable ECG, (3) preoperative evaluation for non-cardiac surgery in patients with one or more clinical risk factor and poor exercise capacity.

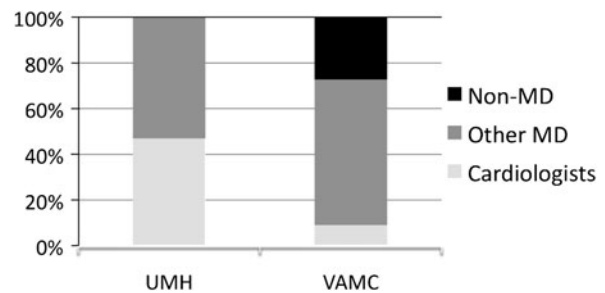


Figure 2. Type of provider based on location. UMH, University of Miami Hospital; VAMC, Miami VA Medical Center.

These three most common indications for MPI were considered appropriate.

Inappropriate Testing Patterns

Table 2 shows the most common inappropriate indications and a comparison between two centers. The five most common indications account for 77% of inappropriate testing. When comparing different health care providers in VAMC, there is a difference of inappropriately ordered studies between physicians and non-physicians (P = .022). In UMMG, non-cardiologists account for higher number of inappropriate testing than cardiologists (P = .001) (Figure 3).

The most common inappropriate indications among cardiology-referred patients were risk assessment in asymptomatic/stable symptoms patients with known CAD on coronary angiography or abnormal stress imaging study <2 years ago. This indication alone accounted for 50% of all inappropriate testing among cardiologists. Non-cardiologists and non-physicians requested the highest number of inappropriate studies for detection of CAD in asymptomatic intermediate risk patients with interpretable ECG (35%) and for

Table 2. Most common inappropriate indications by site, in order of frequency

	UMH (n = 25, 16.6%)	VAMC (n = 33, 22.0%)
1	Asymptomatic or stable symptoms, known CAD on coronary angiography or prior abnormal stress imaging study <2 years ago (20%)	Asymptomatic, intermediate CAD risk, interpretable ECG (48%)
2	Preoperative evaluation for intermediate-risk surgery, no active cardiac conditions, good functional capacity (20%)	Preoperative evaluation for intermediate-risk surgery, no active cardiac conditions, good functional capacity (24%)
3	Symptomatic, low probability of CAD, interpretable ECG, able to exercise (16%)	Asymptomatic patients with low CAD risk (12%)
4	Asymptomatic, low CAD risk (16%)	Asymptomatic or stable symptoms, known CAD on coronary angiography or prior abnormal stress imaging study <2 years ago (6%)
5	Preoperative evaluation for intermediate-risk surgery, no active cardiac conditions, no clinical risk factors (12%)	Preoperative evaluation for low-risk surgery (6%)

UMH, University of Miami Hospital; VAMC, Miami VA Medical Center

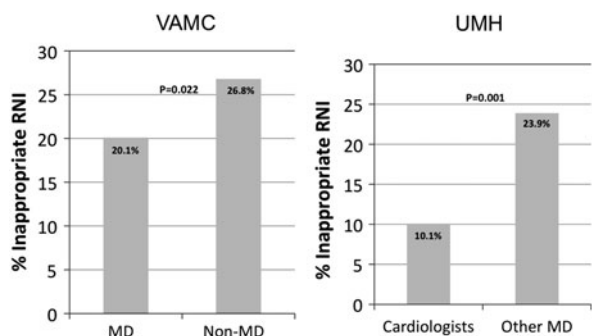


Figure 3. Frequency of inappropriate RNI based on location and type of clinician. RNI, radionuclide imaging; VAMC, Miami VA Medical Center; UMH, University of Miami Hospital.

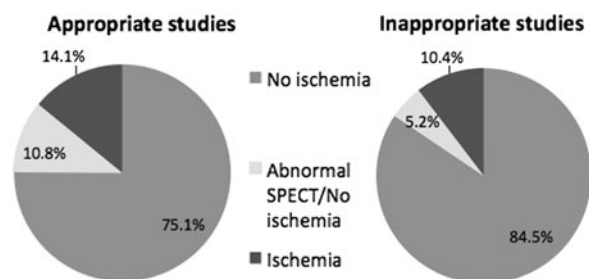


Figure 4. Scintigraphic findings based on appropriate use.

preoperative evaluation for intermediate risk surgery in patients without an active cardiac condition and with moderate-good exercise capacity (23%).

Correlation Between Appropriateness Scores and Study Results

There were fewer negative studies for ischemia within the appropriate group, as compared to the inappropriate group (75.1% vs 84.5%, respectively). Additionally, a higher percentage of studies with ischemia was noted in the appropriate group (14.1% vs 10.4%, respectively, $P = .038$) (Figure 4).

DISCUSSION

The appropriate use criteria were developed as a consequence of the rising concerns about the rate of cardiac imaging and the increased fiscal burden on the health care system.³ Recently, revised AUC were published, based on new clinical data and the addition of clinical scenarios, so as to be more complete and reduce uncertainty. Our study is one of the first reports evaluating the updated AUC for RNI. We have demonstrated that the revised AUC permits evaluation of the vast majority of clinical scenarios. Combined data from both institutions examined in this study show that only 0.66% of the requests could not be classified, reflecting a significant improvement compared to studies using the original criteria, with rate of unclassified tests between 2.9% and 10.0%.^{4,5} The sole unclassified indication in our institution was in both cases a test request prior to prescribing sildenafil. The algorithm-based hierarchical approach advocated in the AUC was followed closely in our study to avoid misclassification.

We sought to examine the RNI ordering patterns in diverse practice settings and by different health care providers. Overall, we found that the majority of the requests for RNI were reasonable (appropriate), although there remains an opportunity for improvement.

Despite significant differences in non-clinical factors that could influence decision making in ordering RNI in VA health care system and academic center, adherence to appropriateness criteria did not differ between the two systems. However, significant differences were observed in the ordering patterns depending on the clinicians' level of training. Non-physicians ordered a higher number of inappropriate studies in VAMC than physicians. In UMMG where all the practitioners were physicians, adherence to appropriateness criteria among non-cardiologists was lower than among cardiologists.

A pattern of similar requests for inappropriate indications was observed among the different health care providers groups. One single indication accounted for 50% of inappropriately ordered studies among cardiologists in UMMG. The five most common inappropriate indications were similar in both institutions and accounted for 77% of inappropriate tests requested. These data suggest a directed approach for educational initiatives, aimed at specific provider groups and focused on key clinical scenarios. We believe that a reasonable approach should include presentations which are directed to all clinicians, including non-physicians and non-cardiologists. Additionally, the incorporation of AUC algorithms into physician order entry systems and decision-support tools is essential, so as to guide an ordering provider through hierarchical algorithms, as has been demonstrated on mobile devices and web-based platforms.¹³ The effectiveness of this model will have to be determined in future studies.

One of the promising tools noted above is web-based initiative developed by ACCF to help providers identify performance gaps and to compare their practice to benchmarks, thereby driving continuous quality improvements.¹⁴ A reduction of one-half of inappropriate test ordering when using an automated on-line tracking system with feedback was recently described.⁶

Several studies have demonstrated that non-physician practitioners provide high quality, cost-effective healthcare.^{10,15} However, our results demonstrate that non-physicians have a lower adherence rate with AUC for RNI. However, none of the prior studies described non-physician providers performance in noninvasive imaging but rather in general primary care settings.^{10,15}

The percentage of negative myocardial perfusion SPECT was high in both appropriate and inappropriate groups (75.1% and 84.5%, respectively). These results are substantially higher than in the report by Mehta et al (45% and 68%, respectively).⁴ Our results show comparable percentage of normal SPECT in the uncertain

group (51.9% vs 53%). We noted abnormal test results commonly and more frequently in the appropriate group than in inappropriate group (24.9% vs 15.6 %, respectively), but with a lower incidence than noted in a recent report where abnormal SPECT studies were noted in 40% for appropriate group and 27% in inappropriate group¹⁶. Ischemia was more frequent in the appropriate group (14.1%), however it should be noted that ischemia was also present in 10.4% of inappropriate studies. These results and data from two other centers^{4,16} demonstrate that substantial number of abnormal test results are present among inappropriate studies, suggesting the need for outcome data and a further evaluation of appropriateness use criteria.

Study Limitations

The population of patients studied within the two institutions differed significantly in regards to patients' sex and we were therefore not able to determine different test ordering patterns between men and women. Additionally, all the patients in UMMG were from outpatient services, potentially reflecting an unequal distribution of patients' morbidity between the two institutions.

CONCLUSION

The revised ACCF/ASNC/AHA 2009 RNI appropriate use criteria permit categorization of appropriateness in testing/patient selection using hierarchical approach in the vast majority of patients. Differences in appropriate use of RNI were noted between two contemporary health care systems. Additionally, the number of inappropriate MPI studies ordered is influenced by the level of the practitioners training, as well as the type of clinician. A small number of inappropriate indications account for the great majority of inappropriate MPI studies.

Our results suggest that broad application of RNI AUC to clinical practice is feasible. Educational efforts should be tailored for different health care providers groups to provide increase awareness of AUC and to reduce inappropriate (unnecessary) testing. However, the confirmation that substantial number of abnormal RNI examinations is present even when performed for inappropriate indications suggests the need for outcome studies and possibly a re-examination of the AUC.

References

1. Lucas FL, DeLorenzo MA, Siewers AE, Wennberg DE. Temporal trends in the utilization of diagnostic testing and treatments for cardiovascular disease in the United States, 1993-2001. *Circulation* 2006;113:374-9.

2. Gibbons R, Eckel R, Jacobs AK. The utilization of cardiac imaging. *Circulation* 2006;113:1715-6.
3. Hendel RC, et al. ACCF/ASNC/ACR/AHA/ASE/SCCT/SCMR/SNM 2009 Appropriate use criteria for cardiac radionuclide imaging: a report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, the American Society of Nuclear Cardiology, the American College of Radiology, the American Heart Association, the American Society of Echocardiography, the Society of Cardiovascular Computed Tomography, the Society for Cardiovascular Magnetic Resonance, and the Society of Nuclear Medicine. *Circulation* 2009;119:e561-e587.
4. Mehta R, et al. Evaluation of the American College of Cardiology Foundation/American Society of Nuclear Cardiology appropriateness criteria for SPECT myocardial perfusion imaging. *J Nucl Cardiol* 2008;15:337-44 (epub 2008 April 16).
5. Gibbons RJ, et al. Application of appropriateness criteria to stress single-photon emission computed tomography sestamibi studies and stress echocardiograms in an academic medical center. *J Am Coll Cardiol* 2008;51:1283-9.
6. Hendel RC, et al. A multicenter assessment of the use of single-photon emission computed tomography myocardial perfusion imaging with appropriateness criteria. *J Am Coll Cardiol* 2010;55:156-62.
7. Carryer DJ, Hodge DO, Miller TD, Askew JW, Gibbons RJ. Application of appropriateness criteria to stress single photon emission computed tomography sestamibi studies: A comparison of the 2009 revised appropriateness criteria to the 2005 original criteria. *Am Heart J* 2010;160:244-9.
8. Jha AK, et al. Effect of the transformation of the Veterans Affairs health care system on the quality of care. *N Engl J Med* 2003;348:2218-27.
9. Elmore JG, et al. Does litigation influence medical practice? The influence of community radiologists' medical malpractice perceptions and experience on screening mammography. *Radiology* 2005;236:37-46.
10. Hooker RS. Physician assistants and nurse practitioners: The United States experience. *Med J Aust* 2006;185:4-7.
11. Albert NM, et al. Outpatient cardiology practices with advanced practice nurses and physician assistants provide similar delivery of recommended therapies (findings from IMPROVE HF). *Am J Cardiol* 2010;105:1773-9.
12. Krasuski RA, et al. Trained and supervised physician assistants can safely perform diagnostic cardiac catheterization with coronary angiography. *Catheter Cardiovasc Interv* 2003;59:157-60.
13. Appropriateness use criteria for radionuclide imaging for i-phones. <http://www.astellasapps.com/>. Accessed September 18, 2010.
14. Imaging in FOCUS: RNI Improvement Tool on Cardiosource. <http://www.cardiosource.org/Science-And-Quality/Quality-Programs/Imaging-in-FOCUS/RNI-Decision-Support-Tool.aspx>.
15. Hooker RS. A cost analysis of physician assistants in primary care. *J Am Acad Phys Assist* 2002;15:39-42.
16. Koh AS, Flores JL, Keng FY, et al. Evaluation of the ACCF/ASNC appropriateness criteria for SPECT myocardial perfusion imaging in an Asian tertiary cardiac center. *J Nucl Cardiol* 2011;18:324-30 (epub 2010 November 24).