Society of Nuclear Medicine Procedure Guideline for Myocardial Perfusion Imaging

version 3.0, approved June 15, 2002

Authors: H. William Strauss, MD (Memorial Sloan Kettering Cancer Center, New York, NY); D. Douglas Miller, MD (Saint Louis University Health Sciences Center, St. Louis, MO); Mark D. Wittry, MD (Saint Louis University Health Sciences Center, St. Louis, MO); Manuel D. Cerqueira, MD (Georgetown University Medical Center, Washington, DC); Ernest V. Garcia, PhD (Emory University Hospital, Atlanta, GA); Abdulmassi S. Iskandrian, MD (Allegheny University of the Health Sciences, Philadelphia, PA); Heinrich R. Schelbert, MD, PhD (UCLA School of Medicine, Los Angeles, CA); Frans J. Wackers, MD, PhD (Yale University School of Medicine, New Haven, CT); Helena R. Balon, MD (William Beaumont Hospital, Royal Oak, MI); Otto Lang, MD (Third Medical School, Charles University, Prague, Czech Republic); and Josef Machac, MD (Mount Sinai School of Medicine, New York University, NY).

I. Purpose

The purpose of this guideline is to assist nuclear medicine practitioners in recommending, performing, interpreting, and reporting the results of myocardial perfusion imaging studies.

II. Background Information and Definitions

Myocardial perfusion imaging (MPI) utilizes an intravenously administered radiopharmaceutical to depict the distribution of nutritional blood flow in the myocardium. Perfusion imaging identifies areas of reduced myocardial blood flow associated with ischemia or scar. The relative regional distribution of perfusion can be assessed at rest, cardiovascular stress, or both. Imaging can also be performed during acute events (e.g., chest pain of unknown etiology, such as in the coronary care unit or emergency department). Perfusion images can be recorded with planar or tomographic single-photon or tomographic positron imaging techniques, utilizing radiopharmaceuticals that are extracted and retained for a variable period of time by the myocardium. The data can be analyzed by visual inspection and/or by quantitative techniques. Some radiopharmaceuticals employed for MPI and approved by the U.S. Food and Drug Administration (FDA) include: Tl-201 and the Tc-99m–labeled radiopharmaceuticals, such as sestamibi, tetrofosmin, and teboroxime, for single-photon imaging and Rb-82 for PET imaging.

Patients with significant coronary artery narrowing as a result of coronary artery disease (CAD) and/or abnormal coronary flow reserve will have a zone of diminished radiopharmaceutical concentration in the area of decreased perfusion. If either the area or severity of decreased tracer concentration is worse when the tracer is administered during stress than rest, the zone of decreased tracer concentration most likely represents ischemia. If the area of diminished tracer concentration remains unchanged, even after injection at rest, the defect most likely represents scar, although in a significant number of cases, it may represent viable, underperfused myocardium.*In addition to regional perfusion, recording the data with both SPECT and ECG gating permits calculation of global and regional ventricular function and assessment of the relationship of perfusion to regional function.

III. Common Indications (see Table 1)

A. Assess the presence, location, extent, and severity of myocardial perfusion abnormalities.
B. Determine the significance of anatomic lesions detected by angiography
C. Detect viable ischemic myocardium

IV. Common Clinical Settings for Myocardial Perfusion Imaging

A. Known or Suspected CAD
   1. Diagnosis of physiologically significant CAD (presence and severity)

* Such fixed abnormalities may also represent high-grade obstruction in zones of viable, hibernating myocardium. When Tl-201 is used as the radiopharmaceutical, redistribution of tracer on delayed images may be useful to distinguish these lesions from scar. When Tc-99m–labeled radiopharmaceuticals are used, administering nitroglycerin before injection at rest may help make this distinction by improving perfusion (and tracer uptake) in the severely ischemic but viable region. Patients who fail to demonstrate myocardial viability with conventional SPECT imaging techniques may benefit from F-18 FDG PET imaging, especially those patients with marked left ventricular dysfunction.

2. Determine prognosis (risk stratification based on extent and severity of myocardial perfusion abnormalities and left ventricular function
3. Differentiate between coronary and noncoronary causes in patients with acute chest pain syndromes seen in the emergency room

B. Follow-Up of Patients with Known CAD
1. Evaluate the immediate and long-term effects of:
   a. Revascularization procedures (such as coronary artery bypass grafting, angioplasty, stent placement, use of angiogenic growth factors, etc.).
   b. Medical or drug therapy, whether designed to prevent ischemia (e.g., drugs that alter myocardial metabolic oxygen supply / demand relationship) or modify lipids and other features of atherosclerotic plaque (e.g., statin drugs).

C. Known or Suspected Congestive Heart Failure
1. Differentiate ischemic from idiopathic cardiomyopathy
2. Help assess whether patient has sufficient viable myocardium overlying the infarction to consider revascularization

V. Procedure

A. Patient Preparation
1. Rest-injected MPI
   Patients should be fasting for at least 4 hours (preferably for 12 hours) before MPI. Cardiac medications should be withheld if the examination is performed to detect coronary disease (see additional information later in this guideline). Cardiac medication should be taken as usual when the examination is performed to determine the effectiveness of medical therapy. Radiopaque objects in the area of the thorax should be removed before imaging; implanted radiopaque objects (metal, silicone, etc.) should be noted as potential attenuators of cardiac activity. In patients with severe coronary disease, it may be advisable to administer nitroglycerin sublingually about 3 minutes before rest injection of the radiopharmaceutical.
2. Exercise stress MPI
   Graded exercise stress is usually performed with a treadmill or bicycle ergometer with continuous patient monitoring. All stress procedures must be supervised by a qualified health care professional and performed in accordance with American Heart Association / American College of Cardiology guidelines. A fasting state is recommended for a minimum of 4 hours before the stress study. In general, patients undergoing a stress study should be hemodynamically and clinically stable for a minimum of 48 hours before testing. Although patients who are unable to exercise for noncardiac reasons (e.g., severe pulmonary disease, arthritis, amputation, neurological disease, etc.) may be stressed

Table 1

Summary of Clinical Indications for Myocardial Perfusion Imaging

- Diagnosis of coronary artery disease
  - -Presence
  - -Location (coronary territory)
  - -Severity
- Assessment of the impact of coronary stenosis on regional perfusion
- Help distinguish viable ischemic myocardium from scar
- Risk assessment and stratification
  - -Postmyocardial infarction
  - -Pre-operative for major surgery in patients who may be at risk for coronary events
- Monitor treatment effect
  - -After coronary revascularization
  - -Medical therapy for congestive heart failure or angina
  - -Lifestyle modification

pharmacologically with drugs designed to cause coronary hyperemia or increased cardiac work (see Table 2), exercise stress is preferred because it provides additional prognostic information.

If not medically contraindicated, it is recommended that medications such as calcium channel blocking drugs and beta-blocking drugs that may alter the heart rate and blood pressure response to exercise should be withheld on the day of diagnostic studies. A secure intravenous line should be established for the administration of the radiopharmaceutical during stress. Patients undergoing exercise stress should wear suitable clothing and shoes.

3. Pharmacologic stress
   Two types of pharmacologic stress are useful to evaluate myocardial perfusion:
   a. Vasodilator stress agents may be administered to create coronary hyperemia (i.e., dipyridamole, adenosine). Caffeine-containing beverages and methylxanthine-containing medications, which interfere with the coronary hyperemia produced by these drugs, should be discontinued for at least 12 hours before pharmacologic stress imaging (longer for long-acting methylxanthine preparations). When possible, patients may also undergo low-level exercise to minimize symptoms associated with the vasodilators and to minimize subdiaphragmatic tracer uptake. When dipyridamole is employed as the vasodilator, aminophylline (or a caffeinated beverage) may be administered after administration of the radiopharmaceutical to reverse the effects of the vasodilator. This is usually not required for adenosine, because of its short duration of action, but aminophylline may be necessary when symptoms persist even after cessation of adenosine.
   b. Ino/chronotropic adrenergic agents (i.e., dobutamine) be administered to increase myocardial oxygen demand. Drugs that may blunt the chronotropic response to adrenergic stimulant stress with dobutamine (i.e., beta-adrenergic blocking agents) should be discontinued before the procedure, if possible. Atropine may be required in some patients to increase the heart rate response, although increasing the heart rate by atropine does not cause the same increment in coronary blood flow as does a similar increment in heart rate induced by exercise. Patients should be fasting for a minimum of 4 hours before pharmacologic stress testing. Although dobutamine is in routine clinical use for pharmacologic stress, it is not an FDA-approved indication for the drug.

B. Information Pertinent to Performing the Procedure
   A cardiovascular medical history and cardiorespiratory examination, including baseline vital signs, should be obtained before stress studies. Specific areas in the medical history requiring attention are the indication for the examination, medications, symptoms, cardiac risk factors, and prior diagnostic or therapeutic procedures. Special attention must be directed to determine whether the patient may have an unstable coro-

Table 2
Modalities for Stress Testing

- Exercise
  - -Submaximal
  - -Symptom limited
  - -Maximal
- Pharmacological stress
  - -Vasodilators
    - Adenosine
    - Dipyridamole
  - -Inotropic
    - Dobutamine
    - Dobutamine + atropine

nary syndrome or aortic valve stenosis that could increase the risk of stress. Patients should also be assessed for obstructive airway disease that could increase the risk of bronchospasm with infusion of dipyridamole or adenosine. A 12-lead electrocardiogram (ECG) should be reviewed for evidence of acute ischemia, arrhythmia or conduction disturbances (i.e., left bundle branch block [LBBB]), before stress MPI. Diabetic patients requiring insulin should be evaluated on a case-by-case basis to optimize diet and insulin-dosing on the day of the examination. In patients with LBBB. it is useful to use vasodilator stress to minimize the effect of the abnormal septal wall motion on the myocardial image of "perfusion."

C. Precautions / Contraindications

1. Exercise stress

   Contraindications to exercise testing are unstable angina with recent (<48 hours) angina or congestive heart failure, documented acute myocardial infarction (MI) within 2–4 days of testing, uncontrolled systemic (systolic >220 mmHg, diastolic >120 mmHg) or pulmonary hypertension, untreated life-threatening arrhythmias, uncompensated congestive heart failure, advanced atrioventricular block (without a pacemaker), acute myocarditis, acute pericarditis, severe mitral or aortic stenosis, severe obstructive cardiomyopathy, and acute systemic illness. Relative contraindications to exercise stress include conditions that may interfere with exercise, such as neurologic, orthopedic, arthritic, or severe pulmonary disease or peripheral vascular disease, severe deconditioning, or inability to comprehend the exercise protocol.

2. Pharmacologic stress

   Patients with a history of severe bronchospasm, pulmonary disease (i.e., asthma or pulmonary hypertension), prior intubation for severe pulmonary disease, systemic hypotension (systolic <90 mmHg), severe mitral valve disease, or prior hypersensitivity to dipyridamole or adenosine should not undergo vasodilator stress with dipyridamole or adenosine. Patients requiring methylxanthine-containing medications to control their bronchospasm should not be tested with vasodilator agents. Ino / chronotropic agents may be employed in these patients. Patients with mild bronchospasm may undergo vasodilator stress testing, particularly after pretreatment with an albuterol inhaler.

   Patients with advanced (second- or third-degree) atrioventricular block or sick sinus syndrome should not be tested with adenosine because of its negative dromotropic (SA + AV node) effect. Additional contraindications to vasodilator agents include severe aortic stenosis, severe obstructive hypertrophic cardiomyopathy, and severe orthostatic hypotension. The use of dipyridamole or adenosine is not recommended in pregnant or lactating females.

   Ino / chronotropic agents are contraindicated in patients with ventricular tachyarrhythmias. These agents should be used with caution in patients with unstable angina, obstructive or hypertrophic myopathy, or soon after acute infarction.

3. Cardiac emergency precautions

   Life support instrumentation and emergency drugs must be available in the immediate vicinity of the stress laboratory. A physician or other trained medical personnel currently certified in advanced cardiac life support (ACLS) must be immediately available during the stress and recovery phases. Continuous ECG monitoring must be performed during the stress and recovery phases. Vital signs (heart rate and blood pressure) and a 12-lead ECG should be recorded at regular intervals throughout the stress and recovery phases. The patient should be questioned at regular intervals (e.g., every 1–2 minutes) for symptoms of myocardial ischemia or the side effects of pharmacologic stress agents using a standardized scale (e.g., 1 = very light to 10 = most severe). Patients with implanted defibrillator devices may require temporary adjustment of their device to prevent stress-induced triggering. Failure of monitoring equipment is an absolute indication to stop exercise.

4. Occupational Safety and Health Administration (OSHA), Nuclear Regulatory Commission, and state regulatory guidelines

   It is mandatory that all regulatory guidelines for the safe handling of syringes, needles, radioactive materials, and patient waste be followed at all times.

D. Radiopharmaceuticals

The following single-photon–emitting radiopharmaceuticals are FDA approved for use as myocardial perfusion tracers: Tl-201, Tc-99m sestamibi, Tc-99m teboroxime, and Tc-99m tetrofosmin. The following positron-emitting radiopharmaceutical is approved for use as a myocardial perfusion tracer: Rb-82. FDA recommendations for the maximum administered dose for a combined rest and stress study (performed on the

Radiation Dosimetry for Adults*

Radiopharmaceutical	Administered Activity MBq (mCi)	Organ Receiving the Largest Radiation Dose+ mGy per MBq (rad per mCi)	Effective Dose+ mdose mSv per MBq (rem per mCi)
T1-201 chloride[1]	75 – 150 i.v. (2 – 4)	0.46 Kidneys (1.7)	0.23 (0.85)
Tc-99m sestamibi[2]	750 – 1100 i.v. (20 – 30)	0.039 Gallbladder (0.14)	0.0085 (0.031)
Tc-99m teboroxime	1100 – 1850 i.v. (30 – 50)	0.034 ULI (0.13)	0.011 (0.041)
Tc-99m tetrofosmin	750 – 1500 i.v. (20 – 40)	0.031 Gallbladder (0.11)	0.0067 (0.025)
Rb-82[3]	1100 – 1850 i.v. (30 – 50)	0.018 Kidneys (0.067)	0.0048 (0.018)

* See package insert for full prescribing information and complete radiation Dosimetrydosimetry.
[1]ICRP 53, page p. 373.
[2]ICRP 62, page p. 23.
[3]ICRP 53, page p. 162.

same day) are a total of 4 mCi of Tl-201, 40 mCi of Tc-99m–labeled radiopharmaceuticals, and 120 mCi of Rb-82. When rest and stress studies are performed on separate days, the dose of thallium may be 4 mCi/injection and the dose of the technetium-labeled agents may be 30 mCi/injection. Doses may be adjusted at the discretion of the prescribing physician.

E. Image Acquisition: Single Photon

Data can be acquired using planar, SPECT, or a combination of both techniques. SPECT imaging is strongly preferred.

1. Planar imaging

Images are usually recorded with the patient supine on the imaging table in at least 3 standard views: anterior view, a left anterior oblique (LAO) view to optimize visualization of the septum (usually 45°), and left lateral view (preferably recorded with the patient in the right lateral decubitus position to minimize attenuation from the abdomen). Image acquisition should commence as soon as the patient's heart rate has recovered to near baseline values (preferably within 10 minutes of injection). Additional views may be required to account for unusual cardiac orientation within the thorax. Acquisition is performed with a gamma camera equipped with either a low-energy all-purpose or high-resolution parallel-hole collimator, with the camera as close to the chest as possible. Images should be acquired so that the heart occupies ~35%–50% of the usable field of view (using magnification during image acquisition if a large-field-of-view camera is employed to record the data). Images of diagnostic quality can be obtained if a minimum of 500,000 counts are recorded in each view (a minimum of 400 cts/cm2 of normal myocardium). The timing of imaging after injection of the radiopharmaceutical will vary with the radiopharmaceutical (immediate images are required for teboroxime, within minutes of injection for thallium, and 30–60 minutes for sestamibi and tetrofosmin). Anatomic structures that may attenuate myocardial activity (e.g., breast tissue) should be positioned in identical fashion for the rest and stress studies.

2. SPECT

SPECT images can be recorded with either a 180° or 360° collection, but a 180° acquisition is preferred because of better resolution and contrast and less attenuation. Imaging with Tl-201 should commence 5–10 minutes after injection, as soon as the patient's heart rate has returned to near baseline levels, to maximize the ability to detect transient left ventricular dysfunction. Imaging with Tc-99m ses-

tamibi or tetrofosmin should commence after liver activity has sufficiently cleared, usually 15–30 minutes after a stress injection and 45–60 minutes after a rest injection. The patient should be placed in a comfortable position on the SPECT table. The left arm should be positioned away from the field of acquisition. Data are usually recorded with the patient in the supine position; however, in patients likely to have significant diaphragmatic (abdominal) attenuation, imaging in the prone or left lateral position may produce a better result. To reduce artifacts from attenuation, a scintillation camera with attenuation correction hardware and software may be used. Either a step-and-shoot acquisition with 32 or 64 stops separated by 3–6° or continuous acquisition may be used. The duration of acquisition at each stop varies with the protocol and radiopharmaceutical (generally 40 seconds/image for thallium and low-dose Tc-99m sestamibi/tetrofosmin, and 25 seconds/image for high-dose Tc-99m sestamibi/tetrofosmin). ECG gating for the acquisition of cardiac function should be used whenever possible (particularly when the studies are recorded with Tc-99m radiopharmaceuticals) and may be accomplished with the placement of nonradiopaque electrodes and a gating device. SPECT images are acquired using a high-resolution collimator. Planar images may be acquired before the initiation of SPECT acquisition to measure lung radiopharmaceutical uptake (i.e., lung-to-heart activity ratio) and to evaluate the pattern of myocardial perfusion in the event of patient movement during SPECT acquisition.

Data may be recorded with attenuation correction, using either an x-ray or radionuclide source. The attenuation correction information reduces the influence of photon attenuation as a cause of decreased myocardial activity. Although this approach is attractive, some available hardware and software result in artifacts. As a result, both uncorrected and corrected data should be reviewed to minimize the likelihood of misinterpretation. Attenuation correction methodology is still under development and evaluation.

3. PET

Positron images are generally corrected for attenuation. Because of the short physical half-life of Rb-82 (~75 sec) and to minimize misalignment between emission and transmission images, pharmacologic stress is used in these patients. In many PET systems, the initial acquisition is performed as a "scout," with 15–20 mCi Rb-82 to help positioning and determine timing for start of image acquisition (longer delay in patients with slow circulation times, usually as a result of heart failure). The resting study can be performed first, because of the short half-life of Rb-82. Image acquisition usually begins 65–95 seconds after the intravenous administration of Rb-82 (longer times in patients with slow circulation times, indicated on the "scout" images) and continues for 5–10 minutes. Next,

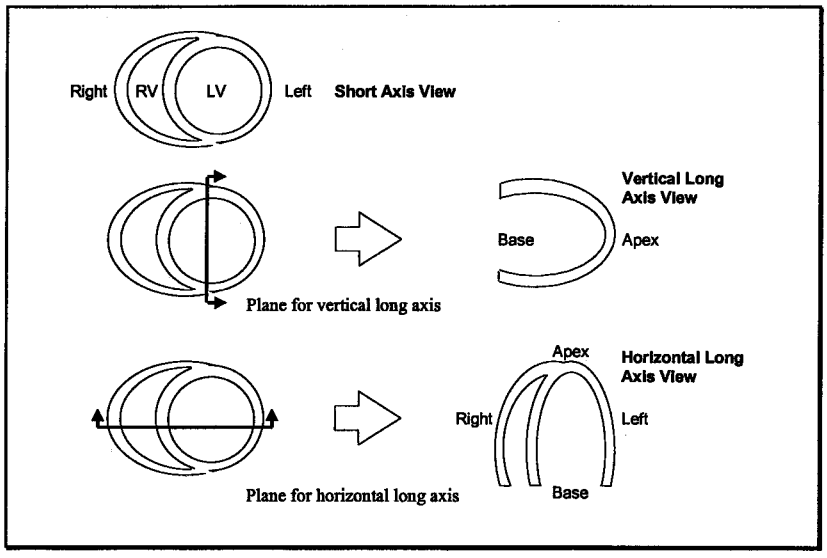

Figure 1. Orientation for display of tomographic myocardial perfusion data.

the transmission images are recorded to acquire 30–40 million counts, beginning about 9–10 minutes after injection of rubidium for the "scout" scan. Finally, dipyridamole or adenosine is administered intravenously, followed by a Rb-82 injection and PET acquisition during maximal pharmacological stress. The relative distribution of perfusion is evaluated at rest, followed by evaluation at stress.

4. Image evaluation
   The study is initially reviewed for possible artifacts, image processing problems, patient motion, and overall image quality before visual analysis or quantitative interpretation. Planar and SPECT images should be viewed on a computer display to permit adjustment of contrast and brightness, optimized to the myocardium. Before reconstruction, the SPECT projection data should be reviewed as a cine display to detect patient motion. Significant patient motion during image acquisition may necessitate the reprocessing or reacquisition of these studies. Data should be reconstructed using either a filtered backprojection or iterative reconstruction algorithm.

   Perfusion PET images should be carefully reviewed to detect cardiac displacement between rest and stress.

F. Interventions
   Stress tests were described previously in this guideline.

G. Processing
   Approaches to data processing and study quality control are described in the guideline on SPECT imaging (see Society of Nuclear Medicine Procedure Guideline for General Imaging). After reconstruction, the myocardial perfusion images can be analyzed for the relative activity in each section of myocardium. That result can be compared with a normal database. Before quantifying the data, the images should be reviewed for artifacts resulting from attenuation or zones of unexpected increased activity. In the absence of artifacts, the zones of myocardium for quantification are selected, the myocardial borders are defined, and the programs then calculate and display the relative distribution of activity. As with other forms of quantitation, this data is useful to supplement the interpretation of an experienced observer.

H. Interpretation Criteria
   Before interpreting the images, the data should be reviewed for artifacts resulting from attenuation or zones of unexpected increased activity that may alter the appearance of the myocardium. In the absence of artifacts, the images are evaluated for areas of decreased radiopharmaceutical concentration in the stress or rest images and for changes in regional count density when gated data are recorded. Zones of myocardium with tracer concentration below normal with injection at rest are usually associated with myocardial scar, but fixed defects with uptake >50% of normal regions are often viable. Defects seen at stress that improve on the resting study usually indicate ischemia. Additional parameters that are particularly useful on planar thallium images are increased lung uptake or left ventricular cavity dilatation as markers of severe left ventricular dysfunction.

   1. Viability
      Tl-201 can be injected at rest to detect decreased perfusion to areas of viable myocardium. Images recorded 10–15 minutes after injection (initial images) are compared with those recorded at least 3–24 hours later. An increase in the relative concentration of tracer seen initially to that recorded later indicates viable myocardium.

I. Reporting
   The report should contain information about the indication for the study, condition of the patient at the time of injection, the specific radiopharmaceutical, dose and route of administration, distribution of radiopharmaceutical in the myocardium, relative size and shape of the left ventricle, and, if a gated scan is performed, regional thickening of the myocardium and left ventricular ejection fraction. The report should conclude with a concise impression.

   Information about the condition of the patient at the time of injection should include: the type of stress (e.g., treadmill, bicycle), exercise level achieved (preferably expressed in mets), heart rate, blood pressure, symptoms, and a brief description of the ECG at rest and changes induced by stress. The duration of exercise should also be stated. With pharmacologic stress, the type and dose of drug and duration of infusion should be noted, in addition to the changes in heart rate, blood pressure, ECG, and symptoms.

   Information about the distribution of radiopharmaceutical should include the site and extent of reduced perfusion, likely vascular territory, and relationship of regional wall thickening to abnormal perfusion.

J. Quality Control
   (See Society of Nuclear Medicine Procedure Guideline on General Imaging.)

K. Sources of Error
   1. Radiopharmaceutical dose delivery
      Interstitial (nonintravenous) injection of the

radiopharmaceutical as a result of a malfunctioning intravenous catheter will reduce delivery of the radiopharmaceutical to the myocardium and alter radiopharmaceutical uptake and clearance kinetics. A low count image should raise concern regarding adequate delivery of the radiopharmaceutical and prompt imaging of the injection site for confirmation of the infiltrated dose.

2. Patient motion
   Voluntary or involuntary patient motion during image acquisition will create image blurring and artifacts that may appear as irregularities or zones of decreased uptake in the myocardium. Careful attention to patient comfort and stability during the acquisition may prevent major motion artifacts. Minor motion artifacts often can be corrected by reprocessing of data, using a motion-correction algorithm. Patients should not be released before review of raw data for patient motion.
3. Suboptimal stress level
   Failure to achieve the gender- and age-predicted 85% peak maximal heart rate will reduce the sensitivity of this procedure for detection of CAD. Patients who cannot achieve 85% of maximal predicted heart rate should be considered for pharmacologic stress before stress injection. Concomitant medications that attenuate or block the action of pharmacologic stress agents may have a similar effect.
4. Inappropriate image processing
   Inappropriate filtering of raw backprojected tomographic data may significantly degrade image quality. Recommended filters and cutoff limits should be applied to the processing of tomographic myocardial perfusion data. Inappropriate count normalization of stress and rest images may cause noncomparability of images for diagnostic analysis.
5. Attenuation artifacts
   Failure to recognize and account for the presence of soft tissue attenuation (often in breast, obesity, abdominal structures, etc.) can hamper accurate image analysis by creating false-positive lesions on the rest and/or stress images. Prone imaging or the use of attenuation-correction hardware and software can reduce this artifact.
6. Standardization of nomenclature
   Society of Nuclear Medicine–approved nomenclature should be used to describe anatomic areas in each of the 3 reconstructed orthogonal tomographic views and on each of the 3 planar images to avoid diagnostic inconsistencies and render comparisons to previous studies easier. Prior studies should be reviewed for comparison to the current study to note differences (i.e., new findings).
7. Noncomparability of views/tomographic slices
   Comparable views and tomographic slices should be displayed for comparison of the rest and stress (or redistribution) data.
8. Review of raw data
   Before examination of reconstructed tomographic cuts, the raw tomographic data acquisition should be reviewed in a rotational cinematic format for the presence of attenuation artifacts and zones of increased activity (e.g., lung, liver, bowel, or renal activity and other lesions) that may alter the appearance of the myocardium on the reconstructed data. If possible, steps should be taken to compensate for these problems, or the acquisition may have to be repeated.
9. Region of interest placement
   For quantitative analysis of regional myocardial and lung activity, it is necessary to assure that regions of interest do not include activity from adjacent structures. Calculation of the lung-to-heart activity ratio should include a similarly sized region of interest in lung and myocardium, not including the anterior and anterolateral wall, where lung and myocardium activity overlap. Attempts should be made to include only cardiac activity in regions of interest utilized for quantitative analysis of radiopharmaceutical uptake and clearance.
10. Compatibility with normal database
    For quantitative analysis, the SPECT data must be processed in an identical fashion to the normal data file, including filtering, reorientation, and quantitative analysis.

VI. Issues Requiring Further Clarification

None

I. Concise Bibliography

American Society of Nuclear Cardiology. Imaging guidelines for nuclear cardiology procedures, part 1. Myocardial perfusion stress protocols. *J Nucl Cardiol*. 1996;3(3):G11–15.

American Society of Nuclear Cardiology. Imaging guidelines for nuclear cardiology procedures, part 2. Myocardial perfusion stress protocols. *J Nucl Cardiol*. 1999;6(2):G47–84.

Cardiovascular Imaging Committee, American College of Cardiology. Standardization of cardiac tomo-

graphic imaging. *J Am Coll Cardiol.* 1992;20:255–256.

Committee on Advanced Cardiac Imaging and Technology, Council of Clinical Cardiology, American Heart Association, Cardiovascular Imaging Committee, American College of Cardiology, and the Board of Directors of the Cardiovascular Committee, Society of Nuclear Medicine. Standardization of cardiac tomographic imaging. *J Nucl Med.* 1992;33:1434–1435.

Ritchie J, Bateman TM, Bonow RO, et al. Guidelines for clinical use of cardiac radionuclide imaging. A report of the AHA / ACC Task Force on Assessment of Diagnostic and Therapeutic Cardiovascular Procedures, Committee on Radionuclide Imaging, developed in collaboration with the American Society of Nuclear Cardiology. *Circulation.* 1995;91:1278–1303.

Schlant RC, Friesinger GC, Leonard JJ. Clinical competence in exercise testing. A statement for physicians from the ACP / ACC / AHA Task Force on Clinical Privileges in Cardiology. *J Am Coll Cardiol.* 1990;16:1061–1065.

Updated imaging guidelines for nuclear cardiology procedures, part 1. *J Nucl Cardiol.* 2001;8(1):G5–G58.

VIII. Disclaimer

The Society of Nuclear Medicine has written and approved guidelines to promote the cost-effective use of high quality nuclear medicine procedures. These generic recommendations cannot be applied to all patients in all practice settings. The guidelines should not be deemed inclusive of all proper procedures or exclusive of other procedures reasonably directed to obtaining the same results. The spectrum of patients seen in a specialized practice setting may be quite different than the spectrum of patients seen in a more general practice setting. The appropriateness of a procedure will depend in part on the prevalence of disease in the patient population. In addition, the resources available to care for patients may vary greatly from one medical facility to another. For these reasons, guidelines cannot be rigidly applied.

Advances in medicine occur at a rapid rate. The date of a guideline should always be considered in determining its current applicability.