Procedure Guideline for Myocardial Perfusion Imaging

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PART 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.

PART II: BACKGROUND INFORMATION AND DEFINITIONS

Myocardial perfusion imaging is a procedure that utilizes an intravenously administered radiopharmaceutical to depict the distribution of nutritional blood flow in the myocardium. Perfusion imaging is useful to identify areas of relatively or absolutely reduced myocardial blood flow associated with ischemia or scar. The distribution of perfusion following radiopharmaceutical injection can be assessed at rest, cardiovascular stress or both. These images can be recorded with either single-photon or positron imaging techniques utilizing radiopharmaceuticals that are extracted and retained for a variable period of time by the myocardium. The relative regional distribution and clearance of a radiopharmaceutical in the myocardium can be recorded with planar or tomographic single-photon techniques or quantitated using positron imaging techniques. The data can be analyzed utilizing visual inspection and/or by quantitative techniques. Some Food and Drug Administration-(FDA-)approved radiopharmaceuticals employed for myocardial perfusion imaging include (a) single-photon tracers ^{201}Tl and the ^{99m}Tc-labeled radiopharmaceuticals such as sestamibi, tetrofosmin and teboroxime and (b) the positron-emitting tracer ^{82}Rb.

Patients with significant coronary artery stenosis due to abnormal coronary vasoreactivity or obstructive coronary artery disease (CAD) have a zone of diminished radiopharmaceutical concentration in the area of decreased perfusion. If this area of decreased tracer concentration is worse when the tracer is administered during stress than when the tracer is administered at rest, the zone of decreased tracer concentration is most likely due to ischemia. If the area of diminished tracer concentration remains unchanged, even after injection at rest, the lesion most likely represents scar.* Recording data with both SPECT and electrocardiogram (ECG) gating permits evaluation of the relationship of perfusion to regional function.

PART III: COMMON INDICATIONS (TABLE 1)

A. Assessment of the (i) presence, (ii) location, (iii) extent and (iv) severity of myocardial ischemia and scar.†
B. Determination of the significance of anatomic lesions detected by angiography.
C. Assessment of myocardial viability.

PART IV: COMMON CLINICAL SETTINGS FOR MYOCARDIAL PERFUSION IMAGING

A. Known or suspected CAD.
   1. Diagnose acute or chronic CAD (presence and severity).
   2. Determine prognosis (risk stratification based on extent of myocardium in jeopardy, cavitary dilatation and lung uptake).

TABLE 1
Summary of Clinical Indications for Myocardial Perfusion Imaging

- Diagnosis of coronary artery disease
  - -presence
  - -location (coronary territory)
  - -extent (number of vascular territories involved)
- Assessment of the degree of coronary stenosis and impact on regional perfusion
- Assessment of myocardial viability
  - -ischemia versus scar
  - -prediction of improvement in function following revascularization
- Risk assessment (prognosis) in patients
  - -after myocardial infarction
  - -preoperative for major surgery who may be at risk for coronary events
- Monitoring of treatment effect
  - -after coronary revascularization
  - -medical therapy for congestive heart failure or angina
  - -lifestyle modification

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Note: All 26 SNM-approved procedure guidelines are available on the Society's home page. We encourage you to download these documents via the Internet at www.snm.org. If you would like information on the development process of this guideline or to order a compendium of all 26 procedure guidelines for $20.00, contact Marie Davis, Society of Nuclear Medicine, at (703) 708-9000, ext. 250, or by e-mail at mdavis@snm.org.

*Depending on the clinical circumstance, such fixed abnormalities may represent high-grade obstruction to zones of viable, hibernating myocardium. When ^{201}Tl is used as the radiopharmaceutical, delayed imaging may be useful to distinguish these lesions from scar. When ^{99m}Tc-sestamibi is used as the radiopharmaceutical, administering nitroglycerin prior to injection at rest may help make this distinction.

†Scar (fibrosis) is often due to infarction. However, similar fixed abnormalities may be seen in patients with cardiomyopathy.

3. Differentiate between coronary and noncoronary etiologies in patients with acute chest pain syndromes seen in the emergency room.

B. Follow-up of patients with known CAD.
Evaluate the immediate and long-term effects of:
1. Revascularization procedures (such as coronary artery bypass grafting, angioplasty, etc.) in patients with recurrent symptoms.
2. Medical or drug therapy.
3. Dietary and lifestyle modifications.

C. Known or suspected congestive heart failure.
Differentiate ischemic from idiopathic cardiomyopathy.

PART V: PROCEDURE

A. Patient Preparation

1. Rest Injected Myocardial Perfusion Imaging
A fasting state is generally preferred (but not necessary) prior to rest myocardial perfusion imaging. It is not generally necessary to withhold medications prior to perfusion imaging. Good intravenous access is required for the administration of the radiopharmaceutical. Radiopaque objects in the area of the thorax should be removed prior to imaging; implanted radiopaque objects (metal, silicone, etc.) should be noted as potential attenuators of cardiac activity.

2. Exercise (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 hr prior to the stress study. In general, patients undergoing a stress study should be hemodynamically and clinically stable for a minimum of 48 hr prior to testing. Patients who are unable to exercise for noncardiac reasons (e.g., severe pulmonary disease, arthritis, amputation, neurological disease, etc.) may be stressed pharmacologically with drugs designed to cause coronary hyperemia or increased cardiac work. In patients who are capable of performing adequate exercise stress, exercise is generally preferred. If not medically contraindicated, it is recommended that medications such as beta-blocking drugs that may alter the heart rate and blood pressure (BP) response to exercise be withheld for diagnostic studies. A secure intravenous line should be established for the administration of the radiopharmaceutical during stress. Patients undergoing exercise stress should wear comfortable clothing and walking shoes.

3. Pharmacologic Stress (see Table 2.)
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 that may interfere with the coronary hyperemia produced by vasodilator stress agents should be discontinued for at least 12 hr prior to pharmacologic stress imaging (or 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 following administration of the radiopharmaceutical to reverse the effects of the vasodilator. This is not required for adenosine due to its short duration of action.
b. Ino/chronotropic adrenergic agents may be administered to increase myocardial oxygen demand (i.e., dobutamine, arbutamine). Drugs that may blunt the chronotropic response to adrenergic stimulant stress with dobutamine or arbutamine should be noted (i.e., beta-adrenergic blocking agents). In some patients atropine may be required to increase the heart rate response from dobutamine. Patients should be fasting for a minimum of 4 hr prior to pharmacologic stress testing. Although these agents are in routine clinical use for this indication, they have not received FDA approval for this specific purpose.

TABLE 2
Modalities for Stress Myocardial Perfusion Imaging

• Exercise Stress
-submaximal
-symptom limited
-maximal
• Pharmacologic Stress
-vasodilators
adenosine
dipyridamole
-Ino/chronotopic
arbutamine
dobutamine
dobutamine + atropine

B. Information Pertinent to Performing the Procedure
A cardiovascular medical history and cardiorespiratory examination, including baseline vital signs, should be obtained prior to 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. A 12-lead ECG should be reviewed for evidence of acute ischemia, arrhythmia or conduction disturbances (i.e., left bundle branch block) prior to stress myocardial perfusion imaging. 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.

C. Precautions/Contraindications

1. Exercise Stress
The relative contraindications to exercise testing are unstable angina with recent (<48 hr) 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 disease, orthopedic disease, arthritic disease, severe pulmonary disease, peripheral vascular disease, severe deconditioning or inability to comprehend the exercise protocol.

2. Pharmacologic Stress

Patients with a history of bronchospasm, pulmonary disease (i.e., asthma or pulmonary hypertension), prior intubation for severe pulmonary disease, systemic hypotension (BP systolic <90 mmHg), severe mitral valve disease and 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 advanced (second- or third-degree) atrioventricular block or sick sinus syndrome should not be tested with adenosine due to its negative dromotropic (SA + AV node) effect. Additional contraindications to vasodilator agents include MI within 2 days, unstable angina within 48 hr, 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

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 and early following 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 electrocardiographic monitoring must be performed during the stress and recovery phases. Vital signs (heart rate and BP) 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 or 2 min) for symptoms of myocardial ischemia or 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 equipment is an absolute indication to stop exercise.

4. OSHA, NRC 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 (see Table 3.)

The following single-photon-emitting radiopharmaceuticals are FDA approved for use as myocardial perfusion tracers: ^{201}Tl, ^{99m}Tc-sestamibi, ^{99m}Tc-teboroxime and ^{99m}Tc-tetrofosmin. The following positron-emitting radiopharmaceutical is approved for use as a myocardial perfusion tracer: ^{82}Rb. Under most circumstances, the dosimetry of these radiopharmaceuticals limits the maximum administered dose for a combined rest and stress study (performed on the same day) to a total of 4 mCi of ^{201}Tl, 40 mCi of ^{99m}Tc-labeled radiopharmaceuticals and 50 mCi of ^{82}Rb. When rest and stress studies are performed on separate days, the dose of ^{201}Tl may be 4mCi/injection and the dose of the ^{99m}Tc-labeled agents may be 30mCi/injection. A secure intravenous line is required for the safe administration of these radiopharmaceuticals.

TABLE 3
Radiation Dosimetry for Adults*

Radiopharmaceutical	Administered activity MBq (mCi)	Organ receiving the largest radiation dose† mGy (rad)	Effective dose† mSv (rem)
^{201}Tl-chloride	75–150 i.v.	0.54 Kidneys	0.23
	(2–4)	(2.0)	(0.85)
^{99m}Tc-sestamibi	750–1100 i.v.	0.036 Gallbladder	0.0085
	(20–30)	(0.13)	(0.032)
^{99m}Tc-teboroxime	1100–1850 i.v.	0.034 ULI	0.011
	(30–50)	(0.13)	(0.039)
^{99m}Tc-tetrofosmin	750–1500 i.v.	0.031 Gallbladder	0.0067
	(20–40)	(0.11)	(0.025)
^{82}Rb	1100–1850 i.v.	0.018 Kidneys	0.0048
	(30–50)	(0.067)	(0.018)

*See package insert for full prescribing information and complete radiation dosimetry.
†Per MBq (per mCi).
ULI = Upper large intestine.

E. Image Acquisition

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

1. Planar Imaging

Images should be recorded in at least three standard views: anterior view, left anterior oblique 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). 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 in a fashion so that the heart occupies approximately 35%–50% of the usable field of view. Efforts should be made to ensure that the rest and stress views are oriented in a comparable fashion. Images of diagnostic quality can be obtained if a minimum of 500,000 counts are recorded in each view (a minimum of 400 cts/cm^2 of normal myocardium). The timing of imaging following injection of the radiopharmaceutical will vary with the radiopharmaceutical (immediate images are required for ^{99m}Tc-teboroxime, within 10 min of injection for ^{201}Tl, and within 30 min–60 min for ^{99m}Tc-sestamibi and ^{99m}Tc-tetrofosmin). Anatomic structures that may attenuate myocardial activity (i.e., breast tissue) should be positioned in identical fashion for the rest and stress studies.

2. SPECT

Depending on available instrumentation, SPECT im-

ages can be recorded with either a 180° or 360° collection. 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, prone imaging may produce a better result. 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 that is utilized (generally 40 sec/image for ^{201}Tl and low-dose ^{99m}Tc-sestamibi/tetrofosmin, and 25 sec/image for high-dose ^{99m}Tc-sestamibi/tetrofosmin). ECG gating for the acquisition of cardiac function on ^{99m}Tc radiopharmaceutical perfusion studies may be accomplished with the placement of nonradiopaque electrodes and a gating device. SPECT images are acquired using either a general all-purpose or high-resolution collimator. A planar anterior view image may be acquired prior to the initiation of the SPECT acquisition to measure lung radiopharmaceutical uptake (i.e., lung-to-heart activity ratio). Transmission images may be acquired with certain tomographic SPECT imaging systems to enhance attenuation correction during processing. Appropriate filtering and smoothing algorithms should be applied, based on recommendations for the radiopharmaceutical that is utilized.

3. PET

   To minimize misalignment between emission and transmission images, pharmacologic stress is preferred in these patients. After recording the transmission images, the relative distribution of perfusion is evaluated at rest followed by evaluation at stress. Image acquisition usually commences at about 90 sec after the intravenous administration of ^{82}Rb and continues for 6 min–9 min.

4. Image Evaluation

   The interpreting physician should initially assess the overall quality of the myocardial perfusion study for possible artifacts, image processing problems, patient motion and image quality prior to visual analysis or quantitative interpretation. Planar and SPECT images should be viewed on a computer display to permit adjustment of contrast and brightness. Prior to 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. The data should be reconstructed using either a filtered backprojection or iterative reconstruction algorithm.

   Initially the reconstructed studies should be assessed for patient positioning and adequacy of processing. Rest and stress images should be appropriately aligned and presented in a format that permits direct comparison. Rest and stress images should be normalized to ensure the comparability of background and target activity for interpretation following visual review of raw data and reconstructed tomographic views. Computer-generated image displays can be viewed in either gray scale or color. Excess contrast, which can make small differences in perfusion appear as lesions, should be avoided. In general, images should be displayed in a standardized format, as recommended by the American Heart Association/American College of Cardiology, Society of Nuclear Medicine and American Society of Nuclear Cardiology. Computer-assisted quantitative analysis can be used to measure regional myocardial activity, to evaluate the size and severity of perfusion abnormalities and to measure regional clearance of the radiopharmaceutical from the myocardium on serial images. When ECG gated myocardial perfusion studies are recorded, these data should be evaluated both as summed, ungated data (as described above) and in a cinematic format to evaluate regional wall motion and thickening.

F. Interventions

   Stress tests are described above.

G. Processing

   Data processing is described in the guideline on SPECT imaging (see *Society of Nuclear Medicine Procedure Guideline for General Imaging*). The myocardial perfusion images can be analyzed for the relative activity in each section of myocardium and that result compared to the information in a normal database. Prior to quantifying the data, the images should be reviewed for artifacts due to 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, these data are useful to supplement the interpretation of an experienced observer.

H. Interpretation/Reporting

   Prior to interpreting the images, the data should be reviewed for artifacts due to 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 at rest are usually associated with myocardial scar. Lesions seen at stress that improve on the rest injected study are usually due to ischemia. Additional parameters that are particularly useful on planar ^{201}Tl images are increased lung uptake or left ventricular cavitary dilatation, as markers of severe left ventricular dysfunction. In patients injected with ^{201}Tl at rest to detect decreased perfusion to areas of viable myocardium, the initial images are compared to those recorded several hours later. An increase in the relative concentration of tracer seen initially to that recorded later indicates viable myocardium.

I. Quality Control

   (See general guidelines and American Society of Nuclear Cardiology guidelines on myocardial perfusion imaging.)

J. Sources of Error

   1. *Radiopharmaceutical Dose Delivery*—Interstitial (nonintravenous) injection of the radiopharmaceutical due to 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 artificial defects in the myocardium. Careful attention to patient comfort and stability during the acquisition may prevent major motion artifacts. Minor motion artifacts can often be corrected by reprocessing of data.
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. 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 due to breast, obesity, abdominal structures, etc.) can hamper accurate image analysis by creating false-positive lesions on the rest and/or stress images.
6. *Standardization of Nomenclature*—Society of Nuclear Medicine-approved nomenclature should be used to describe anatomic areas in each of the three reconstructed orthogonal tomographic views and on each of the three planar images to avoid diagnostic inconsistencies and render comparisons to previous studies easier. Prior studies should be reviewed for comparison to the current study in order to note differences (i.e., new findings) in comparison to any prior study.
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*—Prior to 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 (ROI) Placement*—For quantitative analysis of regional myocardial and lung activity, it is necessary to ensure that ROIs do not include activity from adjacent structures. Calculation of the lung-to-heart activity ratio should include a similar-sized ROI 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 ROIs utilized for quantitative analysis of radiopharmaceutical uptake and clearance.

PART VI: 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.

PART VII: ISSUES REQUIRING FURTHER CLARIFICATION

None

PART VIII: CONCISE BIBLIOGRAPHY

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PART IX: LAST HOUSE OF DELEGATES APPROVAL DATE

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PART X: NEXT ANTICIPATED APPROVAL DATE

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Procedure Guideline for Brain Perfusion SPECT Using Technetium-99m Radiopharmaceuticals

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Key Words: SPECT; brain perfusion scintigraphy; practice guideline; cerebrovascular circulation

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PART I: PURPOSE

The purpose of this guideline is to assist nuclear medicine practitioners in recommending, performing, interpreting and reporting the results of brain perfusion SPECT studies using ^{99m}Tc radiopharmaceuticals.

PART II: BACKGROUND INFORMATION AND DEFINITIONS

SPECT of the brain is a technique for obtaining tomographic images of the three-dimensional distribution of a radiopharmaceutical that reflects regional cerebral perfusion (*1–4*).

PART III: COMMON INDICATIONS

A. Detection and evaluation of cerebrovascular disease.
B. Evaluation of patients with suspected dementia.
C. Presurgical localization of epileptic foci.

Additional indications, not listed here, are under active evaluation, many of which appear promising at this time.

PART IV: PROCEDURE

A. Patient Preparation
1. Prearrival
   No special preparation required.
2. Preinjection
   The most important aspect of patient preparation is to achieve a consistent environment at the time of injection and uptake.
   a. Evaluate patient for ability to cooperate.
   b. Place patient in quiet, dimly lit room.
   c. Keep patient's eyes and ears open.
   d. Ensure that patient is seated or reclining comfortably.
   e. Place intravenous access at least 10 min prior to injection to permit accommodation.
   f. Explain importance of no head motion.
   g. Instruct patient not to speak or read.
   h. Have no interaction with patient prior to, during or up to 5 min postinjection.

B. Information Pertinent to Performing the Procedure
Relevant patient data suggested for optimal interpretation of scans include patient history (including any past drug use or trauma), neurologic exam, psychiatric exam, mental status exam (e.g., Folstein mini-mental status examination or other neuropsychological test), recent morphologic imaging studies (e.g., CT, MRI) and current medications and when last taken.

C. Precautions
1. Demented patients must be closely monitored at all times.
2. Patients with neurologic deficits may require special care and monitoring.
3. Sedation should be given after injection of radiopharmaceutical when possible.

D. Radiopharmaceutical
1. Radiopharmaceuticals (See Tables 1 and 2.)
   a. Technetium-99m-HMPAO (exametazime [unstabilized]).
   b. Technetium-99m-HMPAO (exametazime [stabilized]).
   c. Technetium-99m-bicisate (ethyl cystine dimer [ECD]).
2. Radiopharmaceutical Preparation
   a. Use fresh generator eluate (<2 hr old) for optimal results with ^{99m}Tc-HMPAO.
   b. Do not use pertechnetate obtained from a generator that has not been eluted for 24 hr or more.

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