3. Blood pool activity:
   a. Increased blood pool activity is commonly seen due to low ejection fraction.
   b. Reconstruction of the images with an appropriate pre-scan delay may improve blood pool activity and image resolution (Table 2).

INTERPRETATION AND REPORTING

Image interpretation and reporting is outlined in the ASNC Imaging Guidelines for Nuclear Cardiology Procedures. The essential elements of a PET MPI report are shown in Table 3.

1. MPI and gated PET:
   a. The relative PET myocardial perfusion images are interpreted semi-quantitatively.
   b. The quantitation of myocardial blood flow enables the identification of balanced ischemia or microvascular flow reserve abnormalities but is presently a research application.
2. Calcium scoring:
   a. If a gated calcium score is performed, those findings must be incorporated into the report.
   b. A review of the transmission CT scan for the presence or absence of coronary artery calcium is not recommended. The slice thickness (~5 mm) and motion blurring from cardiac and breathing motion can render coronary calcium estimates erroneous, especially if there is no coronary artery calcium detected.
3. Non-cardiac findings:
   a. Transaxial perfusion images should be routinely inspected for pathological extracardiac uptake.
   b. Review of the low resolution transmission CT scan is helpful in identifying extracardiac pathology (pleural or pericardial effusions, coronary or aortic/aortic valve calcifications, mediastinal masses, lung nodules, etc.).

SUGGESTED READING

Dilsizian V, Bacharach SL, Beanlands RS, et al. Imaging guidelines for nuclear cardiology procedures: PET myocardial perfusion and metabolism clinical imaging. J Nucl Cardiol 2009;16:doi: 10.1007/s12350-009-9094-9.
ASNC thanks the following members for their contributions to this document: Writing Group: Sharmila Dorbala, MD (Chair); Karthik Ananthasubramaniam, MD; Mouaz H. Al-Mallah, MD; and Rupa Mehta, MD. Reviewers:

Table 3. **Elements of a comprehensive PET MPI report**

Imaging	Parameters
Demographics	Patient demographics Indications for the study
Methods	Technique and radiotracer dose Stress test information Technique for attenuation correction and calcium scoring (when applicable)
Findings - MPI	Qualitative/semi-quantitative estimates of rest, stress and reversible perfusion defects
- Gated MPI	Left ventricular volumes Regional wall motion Rest and peak stress left ventricular ejection fraction
- Calcium score	Agatston calcium score Percentile values based on age and gender
- Ancillary findings	Ancillary findings on the transmission and emission imaging
Conclusions	An overall interpretation of the findings (ischemia, scar, or combined findings) in a vascular distribution. The final impression should include a comprehensive interpretation of MPI results in conjunction with stress ECG changes, rest and peak stress ejection fraction, presence or absence of transient ischemic dilation of the left ventricle as well as calcium scoring. Discordant findings should be interpreted

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PET Myocardial Perfusion Imaging (MPI)

OVERVIEW

The purpose of this document is to specifically identify the critical components involved in performing myocardial perfusion imaging (MPI) with positron emission tomography (PET). This document will cover **advantages, disadvantages, patient selection, test preparation, procedural details, and image interpretation and reporting of PET MPI.**

INDICATIONS

PET MPI is indicated for the diagnosis of patients with suspected coronary artery disease (CAD) and risk stratification of patients with known CAD, when they are unable to exercise, have a left bundle branch block pattern, paced rhythm on electrocardiogram (ECG), or an equivocal single photon emission computed tomography (SPECT) MPI. PET MPI is also indicated for the detection of the co-presence of CAD and for the assessment of resting myocardial perfusion in patients undergoing the assessment of myocardial viability with F-18-Fluorodeoxyglucose (FDG) PET.

CONTRAINDICATIONS

Contraindication to stress testing:

- Standard contraindications to exercise stress testing or to pharmacological stress

Contraindications to PET imaging:

- Inability to lie flat or lie still for the duration of the scan
- Claustrophobia (occasionally)

ADVANTAGES

As compared to SPECT MPI, PET MPI provides:

- Rapid imaging protocols and faster laboratory throughput
- Increased diagnostic accuracy
- More accurate attenuation correction
- Higher spatial and temporal resolution
- Excellent myocardial viability assessment
- Peak-stress regional myocardial wall motion abnormalities and ejection fraction during dipyridamole or dobutamine stress with Rubidium-82 (Rb-82) MPI
- Potential for absolute quantification of myocardial blood flow
- Lower radiation dose

DISADVANTAGES

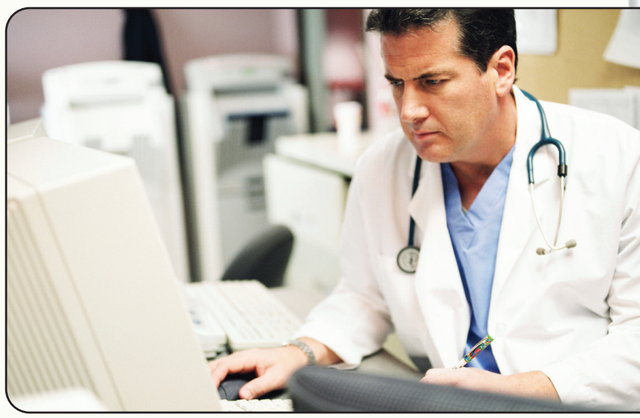
As compared to SPECT MPI, PET MPI's drawbacks include:

- Limited availability
- More expensive equipment and associated costs
- Difficult to use with exercise stress
- Lack of experienced/trained staff

PATIENT SELECTION

Patients who benefit from PET MPI include those who:

- Have an equivocal SPECT MPI for diagnosis or risk stratification of known or suspected CAD



- Require pharmacologic stress imaging
- Are more prone to attenuation artifacts (obese patients, female patients, arms down imaging)
- Require myocardial viability assessment

Table 1. **Pharmacologic stress procedures for PET MPI**

	Adenosine*	Dipyridamole*	Dobutamine
Number of Peripheral IV lines recommended	2	1	2
Radiotracer Injection	Mid infusion	3 minutes after completion of infusion	When target heart rate is reached

Note: Patients should not eat or drink for 6 hours before the procedure. Anti-anginal therapies (beta blockers, nitrates) should be held in patients without a known diagnosis of coronary artery disease (diagnostic test).

*Avoid caffeine intake for >12 hours and avoid theophylline intake for > 48 hours

TEST PREPARATION

1. Patient preparation is similar to that of pharmacologic SPECT (Table 1).
2. Patient height, weight, chest circumference (to ensure patients will fit on the scanner), ejection fraction (as it will affect pre-scan delay, see Table 2), and history of claustrophobia are assessed.

STRESS PROCEDURES

1. Most PET stress scans are performed using pharmacological stress with vasodilator stress being the most common.
2. The radiotracer is injected during peak hyperemia using the same or a separate intravenous line (Table 1).
3. Exercise stress is feasible but may be cumbersome due to high radiation dose to personnel, coordination with the cyclotron, and patient motion.

IMAGING PROCEDURE

Commonly used imaging parameters for PET MPI are shown in Table 2. There are three steps in acquiring a PET MPI study (Figure 1):

1. Topogram/Scout scan: This is a computed tomography (CT) or a low-dose radionuclide-based image to localize the heart position.
2. Transmission scan: After obtaining the topogram, a radionuclide scan or a low-dose CT transmission scan is obtained for attenuation correction.
3. Emission scan: The emission image acquisition starts with the bolus injection of the radionuclide (list mode) or after a pre-scan delay as static or gated images (Table 2). In a list mode (images are acquired with a time signal as well as an ECG signal), a single radiotracer injection and image acquisition allows multiple image reconstructions (i.e., summed static images, multi-frame ECG gated images, and multi-frame dynamic images). A list mode or rest- and stress-gated acquisition is recommended.

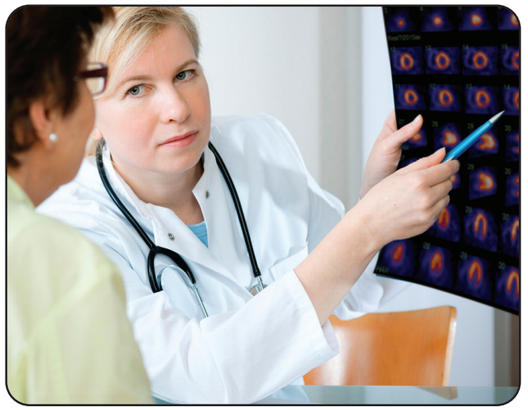
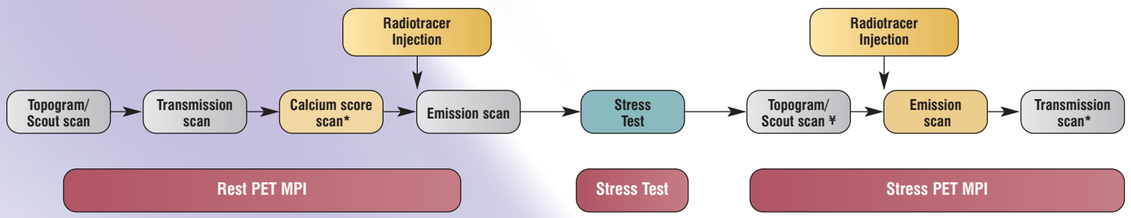


Figure 1. **Acquisition of PET MPI**



* Optional; ¥, a repositioning scan may be necessary if the patient has been moved out of the gantry after the rest scan (eg., N-13 ammonia PET scans)

* If equal doses of ammonia are used for rest and stress, then due to its 10 minute half-life, one must wait at least 50 minutes between the two injections (to ensure decay of the first dose).

¥ A pre-scan delay is used (during acquisition or reconstruction) to allow for clearing of the radiotracer activity from the left ventricular cavity.

OSEM, ordered subset expectation maximization

RADIOTRACERS

1. Rubidium-82 (76-second half-life) is produced by a generator (does not require a cyclotron on site) and is the most widely used radiotracer for clinical PET MPI. The Strontium-82 (Sr-82) generator that produces Rb-82 is replaced every 28 days, reflecting the physical half-life of Sr-82.
2. The use of N-13 ammonia (9.96-minute half-life) is limited to institutions that have a cyclotron on site. The longer half-life permits exercise stress.

QUALITY CONTROL, INTERPRETATION AND REPORTING

Physicians interpreting perfusion PET need to have a thorough understanding of coronary physiology and myocardial perfusion imaging with nuclear techniques (PET and SPECT).

QUALITY CONTROL

Quality control of PET MPI is important and includes the evaluation of the following:

1. Patient motion:
   a. Is more difficult to recognize with PET (due to simultaneous acquisition of counts, not step and shoot) and can degrade images.
   b. Can be minimized by ensuring proper patient instruction and positioning.
2. Attenuation correction:
   a. Interpret only attenuation-corrected PET MPI.
   b. Review an overlay of the transmission and emission images to ensure appropriate registration because misregistration of transmission and emission images can result in artifactual defects (most common in the antero-lateral walls from under-correction by emission images overlying lung tissue).
   c. Software programs are available for the appropriate registration of the PET and CT images.

Table 2. **Imaging parameters for PET MPI**

Imaging	Parameters
Patient positioning	Supine with arms raised above shoulders and supported
Topogram/Scout	Computed Tomography (CT) Scout or 10-20 mCi (370-740 MBq) Rb-82 or 1-2 mCi (37-74 MBq) N-13 ammonia to localize the heart position
Transmission scan	Measured attenuation correction before or after emission
	Radionuclide scan (3-5 minutes)
	CT scan (10-30 seconds) CT parameters: 80-140 kVp, 10-20 mA, shallow tidal breathing, field of view carina to 2 cm below the heart, 4-5 mm slice thickness
Emission scan	
- Radiotracer dose	2D: 40-60 (1480-2220 MBq) Rb-82, or 10-20 mCi (370-740 MBq) N-13 ammonia
	3D: 10-20 mCi (370-740 MBq) Rb-82, or 10-20 mCi (370-740 MBq) N-13 ammonia*
- Mode of acquisition	2D or 3D List mode (start imaging with injection of radiotracer), gated or static imaging
- Scan duration	3-7 minutes (Rb-82), 10-15 minutes (N-13 ammonia)
- Prescan delay ¥	70-90 seconds (Rb-82 left ventricular ejection fraction (LVEF) >50%) 90-120 seconds (Rb-82 LVEF <50%) 90-180 seconds (N-13 ammonia)
- Reconstruction	Filtered back projection or iterative reconstruction (OSEM)

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