

Medical Policy



Title: **Positron Emission Tomography (PET) Scanning: Cardiac Applications**

*See also: Positron Emission Tomography (PET) Scanning: Oncologic Applications
Positron Emission Tomography (PET) Scanning: Miscellaneous (Non-cardiac, Non-oncologic) Applications
Positron Emission Tomography (PET) Scanning: In Oncology to Detect Early Response during Treatment*

Professional

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Institutional

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DESCRIPTION

Cardiac positron emission tomography (PET) scanning is used in 2 key clinical situations: 1) myocardial perfusion scanning as a technique of identifying perfusion defects, which in turn reflect coronary artery disease (CAD); and 2) assessment of myocardial viability in patients with left ventricular (LV) dysfunction as a technique to determine candidacy for a revascularization procedure. A third potential clinical use related to CAD is being evaluated, use of cardiac PET in the measurement of myocardial blood flow and blood flow reserve. Cardiac PET is also being studied in the evaluation of coronary artery inflammation.

Positron emission tomography (PET) scans are based on the use of positron-emitting radionuclide tracers, which simultaneously emit 2 high energy photons in opposite directions. These photons can be simultaneously detected (referred to as coincidence detection) by a PET scanner, consisting of multiple stationary detectors that encircle the thorax. Compared to single-photon emission computed tomography (SPECT) scans, coincidence detection offers greater spatial resolution.

A variety of tracers are used for PET scanning, including fluorine-18, rubidium-82, oxygen-15, nitrogen-13, and carbon-11. Most tracers have a short half-life and must be manufactured with an on-site cyclotron. Rubidium-82 is produced by a strontium-82/rubidium-82 generator. The half-life of fluorine-18 is long enough that it can be manufactured commercially at offsite locations and shipped to imaging centers. The radionuclides may be coupled to a variety of physiologically active molecules, including oxygen, water and ammonia. Fluorine-18 is often coupled with fluorodeoxyglucose (FDG) as a means of detecting glucose metabolism, which in turn reflects the metabolic activity, and thus viability, of the target tissue. Tracers that target the mitochondrial complex are also being developed.

Regulatory Status

The U.S. Food and Drug Administration (FDA) issued a Federal Register notice on March 10, 2000, summarizing the regulatory history of PET radiotracers and highlighting its decisions on safety and effectiveness for certain uses of certain PET radiotracers. With regard to PET radiotracers used for cardiac indications, the FDA has approved the following uses:

- ¹⁸F-FDG for evaluation of myocardial hibernation. The FDA concluded that “a 10-mCi dose (for adults) of FDG F 18 injection produced under conditions specified in an approved application can be found to be safe and effective in PET imaging of patients with CAD and left ventricular dysfunction, when used together with myocardial perfusion imaging, for the identification of left ventricular myocardium with residual glucose metabolism and reversible loss of systolic function.”
- ¹³N-ammonia for evaluation of myocardial blood flow/perfusion. The FDA concluded that “a 10-mCi dose (for adults) of ammonia N 13 injection produced under conditions specified in an approved application can be found to be safe and effective in PET imaging of the myocardium under rest or pharmacological stress conditions to evaluate myocardial perfusion in patients with suspected or existing CAD.”
- In addition, 82-rubidium chloride injection for evaluation of myocardial perfusion (NDA-19-414) was previously approved in 1989 “for assessing regional myocardial perfusion in the diagnosis and localization of myocardial infarction.”

Furthermore, the Federal Register notice stipulates that due to safety concerns stemming from various manufacturing practices, “the agency cannot conclude that these PET drugs are generally recognized as safe and effective for the above-noted indications and therefore needs to review information on how each drug product is formulated and produced at each manufacturing site. Because these PET drugs are not generally recognized as safe and effective, they are new drugs for which approved NDA’s [New Drug Application] or ANDA’s [Abbreviated New Drug Application] are required for marketing.”

A draft guidance document for Current Good Manufacturing Practice (CGMP) requirements was issued on April 1, 2002; although, as of October 2003, regulatory procedures had not yet been finalized. Manufacturers are not required to submit NDAs or ANDAs for a period of 4 years after enactment of the FDA Modernization Act (FDAMA) or “2 years after the date that the agency adopts special approval procedures and CGMP requirements for PET drugs, whichever is longer.” Nevertheless, many PET facilities operate without specific FDA approval.

An FDA website page includes various PET-related documents: Available online at: <http://www.fda.gov/Drugs/DevelopmentApprovalProcess/Manufacturing/ucm085783.htm>. Last accessed June 2013.

Therefore, as the new regulations are implemented and the FDA reviews the safety and effectiveness of radiotracers, implementation of Plan policies regarding PET scans may need to focus on the following:

- whether or not the individual PET radiotracer manufacturer facility meets the current good manufacturing practices (CGMP) for PET scanning as established by FDA;
- whether or not the radiotracer is FDA-approved and is being used for a specific indication that has been FDA-approved; and
- whether or not the clinical indication for individual patients meets medical necessity criteria.

Note: This policy only addresses the use of radiotracers detected with the use of dedicated PET scanners. Radiotracers such as fluorodeoxyglucose (FDG) may be detected using SPECT cameras, a hybrid PET/SPECT procedure that may be referred to as FDG-SPECT or molecular coincidence detection. This technique is not discussed in this document.

POLICY

- A. Cardiac PET scanning may be considered **medically necessary** to assess myocardial perfusion and thus diagnose coronary artery disease in patients with indeterminate SPECT scan; or in patients for whom SPECT could be reasonably expected to be suboptimal in quality on the basis of body habitus (e.g., obesity).
- B. Cardiac PET scanning may be considered **medically necessary** to assess the myocardial viability in patients with severe left ventricular dysfunction as a technique to determine candidacy for a revascularization procedure.
- C. Cardiac PET scanning may be considered **medically necessary** for the diagnosis of cardiac sarcoidosis in patients who are unable to undergo magnetic resonance imaging (MRI) scanning. Examples of patients who are unable to undergo MRI include, but are not limited to, patients with pacemakers, automatic implanted cardioverter-defibrillators (AICDs), or other metal implants.

Myocardial Perfusion

For myocardial perfusion studies, patient selection criteria for PET scans involve an individual assessment of the pretest probability of coronary artery disease (CAD), based both on patient symptoms and risk factors. Patients at low risk for CAD may be adequately evaluated with exercise electrocardiography. Patients at high risk for CAD will typically not benefit from non-invasive assessment of myocardial perfusion; a negative test will not alter disease probability sufficiently to avoid invasive angiography. Accordingly, myocardial perfusion imaging is potentially beneficial for patients at intermediate risk of CAD (approximately 25% to 75% disease prevalence).^{*} This risk can be estimated using the patient’s age, sex, and chest pain quality. For example, the following table summarizes a characterization of patient populations at intermediate risk for CAD. (1)

^{*}The range for intermediate risk used by different authors can vary from that used here. These pretest probability risk groups are based on the previous TEC Assessment and take into account spectrum effect. American College of Cardiology (ACC) guidelines define low risk as less than 10%, intermediate risk as 10–90%, and high risk as greater than 90%.

Individuals at Intermediate Risk for CAD According to Chest Pain Quality

Typical Angina [*]	Atypical Angina ^{**}	Nonanginal Chest Pain ^{***}
Men ages 30-39	Men ages 30-70 years	Men ages 50 years and older
Woman ages 30-60	Woman ages 50 years and older	Women ages 60 years and older

^{*} Chest pain with all of the following characteristics: 1) substernal chest discomfort with characteristic quality and duration, 2) provoked by exertion or emotional stress, and 3) relieved by rest or nitroglycerin

^{**} Chest pain that lacks one of the characteristics of typical angina

^{***} Chest pain that meets one or none of the typical angina characteristics

SPECT scanning can be limited by body habitus, in particular for patients with moderate to severe obesity, which can cause attenuation of tissue tracer leading to inaccurate images. In patients for whom body habitus is expected to lead to suboptimal SPECT scans, PET scanning is preferred.

Myocardial Viability

Patients selected to undergo PET scans for myocardial viability are typically those with severe left ventricular dysfunction being considered for revascularization. A PET scan may determine whether the left ventricular dysfunction is related to viable or non-viable myocardium. Patients with viable myocardium may benefit from revascularization, while those with non-viable myocardium will not. As an example, PET scans are commonly performed in potential heart transplant candidates to rule out the presence of viable myocardium.

For both of these indications, a variety of studies have suggested that PET scans are only marginally more sensitive or specific than SPECT scans. Therefore, the choice between a PET scan (which may not be available locally) and a SPECT scan represents another clinical issue. PET scans may provide the greatest advantage over SPECT scans in moderately to severely obese patients for whom tissue attenuation of tracer is of greater concern.

RATIONALE

Myocardial Perfusion Imaging

In a patient with symptoms suggestive of coronary artery disease (CAD), an important clinical decision point is to determine whether invasive coronary angiography is necessary. A variety of noninvasive imaging tests, including positron emission tomography (PET, using rubidium-82) and single-photon emission computed tomography (SPECT) scans have been investigated as a means of identifying reversible perfusion defects, which may reflect CAD and thus identify patients appropriately referred for angiography.

The sensitivity and specificity of PET may be slightly better than SPECT. For example, the performance characteristics for PET and SPECT based on the Canadian Joint Position Statement (2) is shown in the table below.

Test Characteristics for PET and SPECT scanning based on the Canadian Joint Position Statement (2)

	PET	SPECT
Sensitivity	0.91	0.88
Specificity	0.89	0.77
Estimated likelihood ratio positive	8.27	3.83
Estimated likelihood ratio negative	0.10	0.16

However, their diagnostic utilities may be similar in terms of altering disease risk in a manner affecting subsequent decision making among patients with intermediate pretest probability of CAD. For example, a patient with a 50% pretest probability of CAD would have a 9% post-test probability of CAD following a negative PET scan compared to 13% after a negative SPECT. In either case, further testing would not likely be pursued.

	Post-Test Probability			
	Positive Test		Negative Test	
Pretest Probability	PET	SPECT	PET	SPECT
30%	78%	62%	4%	6%
50%	89%	79%	9%	13%
70%	95%	90%	19%	27%

Estimated positive likelihood ratio= Sensitivity / (1-Specificity)
 Estimated negative likelihood ration= (1-Sensitivity)/ Specificity)
 Post-test probability = post-test odds/(post-test odds +1)
 Post-test odds = pre-test x Likelihood Ratio

In 2012, Jaarsma et al. reported a meta-analysis comparing the diagnostic performance of noninvasive myocardial perfusion imaging with SPECT, cardiac magnetic resonance imaging (MRI) or PET. (3) The comparison standard was coronary artery disease identified with coronary angiography. A total of 166 articles (17,901 patients) met the inclusion criteria, with 114 articles on SPECT, 37 on cardiac MRI, and 15 on PET. Sensitivity with patient level analysis was similar for the 3 tests, with a pooled sensitivity of 88% for SPECT, 89% for MRI, and 84% for PET. Pooled specificity was lower for SPECT (61%), compared to MRI (76%), and PET (81%). The pooled diagnostic odds ratio was 15.31 for SPECT, 26.42 for MRI, and 36.47 for PET. Meta-regression indicated that MRI and PET have a significantly higher diagnostic accuracy than SPECT. Although this analysis is limited by potential publication bias for SPECT and significant heterogeneity in the MRI and SPECT studies, most subgroup analyses showed a relative superiority of MRI and PET over SPECT.

A second 2012 meta-analysis by Parker et al. (4) compared SPECT and PET stress myocardial perfusion imaging, using coronary angiography as the reference standard. A total of 117 articles met selection criteria. SPECT was addressed by 113 studies (11,212 patients), while PET was examined in 9 studies (650 patients). Patient-level diagnostic accuracy data were pooled in a bivariate meta-analysis, showing significantly better sensitivity for PET (92.6%) compared with SPECT (88.3%). There was no significant difference in specificity between PET (81.3%) and SPECT (76.0%). The pattern of higher sensitivity for PET over SPECT and similar specificity was also found among higher quality studies.

Another consideration is that there are fewer indeterminate results with PET than SPECT. A retrospective study by Bateman et al. (5) matched 112 SPECT and 112 PET studies by gender, body mass index (BMI), and presence and extent of CAD and compared for diagnostic accuracy and degree of interpretative certainty (age 65 years; 52% male; mean BMI: 32 kg/m²; 76% with CAD diagnosed on angiography). Eighteen of 112 (16%) SPECT studies were classified as indeterminate compared to 4 of 112 (4%) PET studies. Liver and bowel uptake were believed to affect 6 of 112 (5%) PET studies, compared to 46 of 112 (41%) SPECT studies. In obese patients (BMI > 30), the accuracy of SPECT was 67% versus 85% for PET; accuracy in nonobese patients was reported to be 70% for SPECT and 87% for PET. (5) Therefore, for patients with intermediate pretest probability of CAD, one should start with SPECT testing and only proceed to PET in indeterminate cases. In addition, since obese patients are more prone to liver and bowel artifact, PET testing is advantageous over SPECT in severely obese patients.

Merhige and colleagues reported on outcomes of non-contemporaneous patients with similar probabilities of CAD that were evaluated by SPECT or PET. (6) In this study involving PET scans done at one center compared to those evaluated by SPECT, those receiving PET evaluations had lower rates of angiography (13% vs. 31%) and revascularization (6% and 11% - both respectively) with similar rates of death and myocardial infarction at 1-year follow-up. These results are viewed as preliminary, and additional comparative studies showing impact on outcomes are needed.

Conclusions. Evidence on the diagnostic accuracy of PET for myocardial perfusion imaging establishes that PET is at least as good as SPECT in terms of sensitivity and specificity. However, the modest difference in accuracy may not translate to clinically meaningful differences in diagnosis or management, and SPECT remains the first line test in most instances. There are some patients in which SPECT is indeterminate due to body habitus or other anatomic factors, PET can be performed successfully in most of these patients.

Myocardial Viability

PET has perhaps been most thoroughly researched as a technique to assess myocardial viability to determine candidacy for a coronary revascularization procedure. For example, a patient with a severe stenosis identified by coronary angiography may not benefit from revascularization if the surrounding myocardium is non-viable. A fixed perfusion defect, as imaged on SPECT scanning or stress thallium echocardiography, may suggest nonviable myocardium. However, a PET scan may reveal metabolically active myocardium, suggesting areas of “hibernating” myocardium that would indeed benefit from revascularization. The most common PET technique for this application consists of N-13 ammonia as a perfusion tracer and fluorine-18 fluorodeoxyglucose (FDG) as a metabolic marker of glucose utilization. A pattern FDG uptake in areas of hypoperfusion (referred to as FDG/blood flow mismatch) suggests viable, but hibernating myocardium. The ultimate clinical validation of this diagnostic test is the percentage of patients who experience improvement in left ventricular (LV) dysfunction after revascularization of hibernating myocardium, as identified by PET scanning.

SPECT scanning may also be used to assess myocardial viability. While initial myocardial uptake of thallium-201 reflects myocardial perfusion, redistribution after prolonged periods can be used as a marker of myocardial viability. Initial protocols required redistribution imaging after 24 to 72 hours. While this technique was associated with a strong positive predictive value (PPV), there was a low negative predictive value (NPV); i.e., 40% of patients without redistribution nevertheless showed clinical improvement after revascularization. The NPV has improved with the practice of thallium reinjection. Twenty-four to 72 hours after initial imaging, patients receive a reinjection of thallium and undergo redistribution imaging.

Further supporting the equivalency of these 2 testing modalities, Siebelink and colleagues performed a prospective randomized study comparing management decisions and outcomes based on either PET imaging or SPECT imaging in 103 patients with chronic coronary artery disease (CAD) and LV dysfunction who were being evaluated for myocardial viability. (7) Management decisions included drug therapy or revascularization with either angioplasty or coronary artery bypass grafting. This study is unique in that the diagnostic performance of the 2 studies was tied to the actual patient outcomes. No difference in patient management or cardiac event-free survival was demonstrated between management based on the 2 imaging techniques. The authors concluded that either technique could be used for management of patients considered for revascularization with suspicion of jeopardized myocardium.

Studies identified in literature updates continue to show the equivalence of SPECT and PET. The comparative studies reported on test accuracy and did not address impact on clinical outcomes. As one example, Slart and colleagues (8) concluded that there was overall good agreement between SPECT and PET for the assessment of myocardial viability in patients with severe LV dysfunction. Using a thorax-cardiac phantom, Knesaurek and Machac concluded that PET was

better at detecting smaller defects. (9) In this study, a 1-cm insert was not detectable by SPECT, yet it was detectable using PET.

Conclusions. PET and SPECT can both be used to assess myocardial viability. The available evidence supports that both have roughly similar accuracy for this purpose. PET may be more sensitive for small defects, but the clinical significance of identifying small defects is uncertain.

Myocardial Blood Flow Reserve

In 2011, Ziadi and colleagues reported a prospective study of the prognostic value of myocardial flow reserve (MFR) with ⁸²Rb PET in 704 consecutive patients. (10) Follow-up at a median of 387 days was conducted for 677 patients (96%), the majority (90%) were by phone. The hypothesis was that patients with reduced flow reserve would have higher cardiac event rates and that ⁸²Rb MFR would be an independent predictor of adverse outcomes. The primary outcome was the prevalence of hard cardiac events (myocardial infarction and cardiac death), the secondary outcome was prevalence of a major adverse cardiac event (MACE: cardiac death, myocardial infarction, later revascularization, and cardiac hospitalization). For patients with a normal summed stress score (SSS) and impaired MFR, there was a significantly higher incidence of hard events (2% vs. 1.3%) and MACE (9% vs. 3.8%) compared to patients with a preserved MFR. Patients with an abnormal SSS and MFR less than 2 had a higher incidence of hard events (11.4% vs. 1.1%) and MACE (24% vs. 9%) compared to patients with a preserved MFR. ⁸²Rb MFR was an independent predictor of cardiac hard events (hazard ratio: 3.3) and MACE (hazard ratio: 2.4) over the SSS. Three patients (0.4%) were classified up and 0 classified down with MFR in the multivariate model ($p=0.092$).

A retrospective study published in 2011 by Murthy et al. (11) examined the prognostic value of ⁸²Rb PET coronary flow reserve (CFR) in a series of 2,783 patients referred for rest/stress PET myocardial perfusion imaging. CFR was calculated as the ratio of stress to rest myocardial blood flow using semi-quantitative PET interpretation. The primary outcome was cardiac death over a median follow-up of 1.4 years. Prognostic modeling was done with the Cox proportional hazards model. Adding CFR to a multivariate model significantly improved model fit and improved the c index, a measure of discrimination performance, from 0.82 to 0.84 ($p=0.02$). CFR was a significant independent predictor of cardiac mortality and resulted in improved risk reclassification. A 2012 article by these authors (12) found that the added value of PET CFR was observed in both diabetic and nondiabetic patients.

Other publications describe the use of PET imaging to quantify both myocardial blood flow and MFR. (13, 14) However, as noted in an accompanying editorial, larger prospective clinical trials are needed to understand the clinical utility. (15)

Cardiac Sarcoidosis

Based on clinical input received in 2011, an additional indication was added to the policy on the workup of cardiac sarcoidosis. Published evidence on the utility of PET scanning for cardiac sarcoidosis is limited due to the relatively small numbers of patients with this condition. A 2009 review article (16) concluded that imaging studies had incremental value when combined with clinical evaluation and/or myocardial biopsy in the diagnosis of cardiac sarcoidosis. This review reported that cardiac magnetic resonance imaging (MRI) was the more established imaging

modality in diagnosing sarcoidosis, with an estimated sensitivity of 100% and specificity of 80%. A meta-analysis published in 2012 by Youssef et al. (17) identified 7 studies with 164 patients. Studies were selected if they used fluorodeoxyglucose (FDG) PET for diagnosis of cardiac sarcoidosis and used the criteria of the Ministry of Health, Labor and Welfare (MHLW) of Japan as the reference standard. Pooled sensitivity of PET by random effects meta-analysis was 89% and pooled specificity was 78%. Area under the summary receiver operating characteristic curve was 93%, suggesting a good level of diagnostic discrimination.

Clinical Input Received through Physician Specialty Societies and Academic Medical Centers

While the various physician specialty societies and academic medical centers may collaborate with and make recommendations during this process through the provision of appropriate reviewers, input received does not represent an endorsement or position statement by the physician specialty societies or academic medical centers, unless otherwise noted.

Clinical input received in June 2011 was generally in agreement on the medical necessity of PET for myocardial viability or for patients with an indeterminate SPECT scan. However, input from reviewers disagreed on using a strict BMI cutoff to define patients in whom a SPECT scan would be expected to be suboptimal. Therefore, the language of the policy statement was changed to "Cardiac PET scanning may be considered medically necessary to assess myocardial perfusion and thus diagnose coronary artery disease in patients with indeterminate SPECT scan; or in patients for whom SPECT could be reasonably expected to be suboptimal in quality on the basis of body habitus."

Three reviewers responded to the question of whether PET scanning was medically necessary in the workup of patients with suspected cardiac sarcoidosis. All three were in agreement that PET scanning was medically necessary in this patient group. Two of the three reviewers offered that MRI scanning was the preferred test in the workup of cardiac sarcoidosis but that PET scanning was medically necessary in patients who were unable to undergo MRI. As a result of this input, an additional indication was added to the policy statement for workup of cardiac sarcoidosis: "Cardiac PET scanning may be considered medically necessary for the diagnosis of cardiac sarcoidosis in patients who are unable to undergo MRI scanning. Examples of patients who are unable to undergo MRI include, but are not limited to, patients with pacemakers, automatic implanted cardioverter-defibrillators (AICDs) or other metal implants."

Summary

Evidence from the medical literature supports the use of positron emission tomography (PET) scanning to assess myocardial viability in patients with severe left ventricular (LV) dysfunction who are being considered for revascularization. Results of primary studies and recommendations from specialty societies conclude that PET scanning is at least as good as, and likely superior, to single-photon emission computed tomography (SPECT) scanning for this purpose. For assessing myocardial perfusion in patients with suspected coronary artery disease, PET scanning is less likely than SPECT scanning to provide indeterminate results. Therefore, PET scanning is also useful in patients with an indeterminate SPECT scan. It is also useful in patients whose body habitus is likely to result in indeterminate SPECT scans, for example patients with moderate to severe obesity. For patients who are undergoing a workup for cardiac sarcoidosis, magnetic

resonance imaging (MRI) is the preferred initial test. However, for patients who are unable to undergo MRI, such as patients with a metal implant, PET scanning is the preferred test.

Practice Guidelines and Position Statements

In 2003, the American College of Cardiology (ACC) and the American Heart Association (AHA) published updated guidelines for cardiac radionuclide imaging. (18) Cardiac applications of positron emission tomography (PET) scanning were included in these guidelines. The following table summarizes the guidelines for myocardial reperfusion for both SPECT and PET scans in patients with an intermediate risk of CAD. (18) Class I is defined as conditions for which there is evidence and/or general agreement that a given procedure or treatment is useful and effective. Class IIa is defined as conditions for which there is conflicting evidence or a divergence of opinion, but the weight of evidence/opinion is in favor of usefulness/efficacy. Class IIb is similar to Class II except that the usefulness/efficacy is less well-established by evidence/opinion.

Indication	SPECT Class	PET Class
Identify extent, severity, and location of ischemia (SPECT protocols vary according to whether patient can exercise)	I	IIa
Repeat test after 3-5 years after revascularization in selected high-risk asymptomatic patients (SPECT protocols vary according to whether patients can exercise)	IIa	
As initial test in patients who are considered to be high risk (i.e., patient with diabetes or those with a more than 20% 10-year risk of a coronary disease event) (SPECT protocols vary according to whether patients can exercise).	IIa	
Myocardial perfusion PET when prior SPECT study has been found to be equivocal for diagnostic or risk stratification purposes.	N/A	I

These guidelines also conclude that PET imaging “appears to have slightly better overall accuracy for predicting recovery of regional function after revascularization in patients with left ventricular (LV) dysfunction than single photon techniques (i.e., SPECT scans).” (18) However, the guidelines indicate that either PET or SPECT scans are Class I indications for predicting improvement in regional and global LV function and natural history after revascularization and thus do not indicate a clear preference for either PET or SPECT scans in this situation.

In 2005, a joint statement from the Canadian Cardiovascular Society, Canadian Association of Radiologists, Canadian Association of Nuclear Medicine, Canadian Nuclear Cardiology Society, Canadian Society of Cardiac Magnetic Resonance recommends (Class I recommendation, level B evidence) PET scanning for patients with intermediate pretest probability of CAD who have nondiagnostic noninvasive imaging tests or where such a test does not agree with clinical diagnosis, or may be prone to artifact that could lead to an equivocal other test, such as obese patients. (2)

2011 Appropriateness Criteria from the American College of Radiology (ACR) considers both SPECT and PET to be appropriate for the evaluation of patients with a high probability of coronary artery disease. (19) ACR states that PET perfusion imaging has advantages over SPECT, including higher spatial and temporal resolution. Routine performance of both PET and SPECT are not necessary.

CODING

The following codes for treatment and procedures applicable to this policy are included below for informational purposes. Inclusion or exclusion of a procedure, diagnosis or device code(s) does not constitute or imply member coverage or provider reimbursement. Please refer to the member's contract benefits in effect at the time of service to determine coverage or non-coverage of these services as it applies to an individual member.

CPT/HCPCS

- 78459 Myocardial imaging, positron emission tomography (PET), metabolic evaluation
- 78491 Myocardial imaging, positron emission tomography (PET), perfusion; single study at rest or stress
- 78492 Myocardial imaging, positron emission tomography (PET), perfusion; multiple studies at rest and / or stress
- 78399 Unlisted musculoskeletal procedure, diagnostic nuclear medicine
- A9526 Nitrogen N-13 ammonia, diagnostic, per study dose, up to 40 millicuries
- A9552 Fluorodeoxyglucose F-18 FDG, diagnostic, per study dose, up to 45 millicuries

DIAGNOSES

- 414.00 Other forms of chronic ischemic heart disease; Coronary atherosclerosis; Of unspecified type of vessel, native or graft
- 414.01 Other forms of chronic ischemic heart disease; Coronary atherosclerosis; Of native coronary artery
- 414.02 Other forms of chronic ischemic heart disease; Coronary atherosclerosis; Of autologous vein bypass graft
- 414.03 Other forms of chronic ischemic heart disease; Coronary atherosclerosis; Of nonautologous biological bypass graft
- 414.04 Other forms of chronic ischemic heart disease; Coronary atherosclerosis; Of artery bypass graft
- 414.05 Other forms of chronic ischemic heart disease; Coronary atherosclerosis; Of unspecified type of bypass graft
- 429.9 Other ill-defined heard diseases; heard disease, unspecified
- 410.10 Acute myocardial infarction; Of other anterior wall; episode of care unspecified
- 410.11 Acute myocardial infarction; Of other anterior wall; initial episode of care
- 410.12 Acute myocardial infarction; Of other anterior wall; subsequent episode of care
- 410.20 Acute myocardial infarction; Of inferolateral wall; episode of care unspecified
- 410.21 Acute myocardial infarction; Of inferolateral wall; initial episode of care
- 410.22 Acute myocardial infarction; Of inferolateral wall; subsequent episode of care
- 410.30 Acute myocardial infarction; Of inferoposterior wall; episode of care unspecified
- 410.31 Acute myocardial infarction; Of inferoposterior wall; initial episode of care
- 410.32 Acute myocardial infarction; Of inferoposterior wall; subsequent episode of care
- 410.40 Acute myocardial infarction; Of other inferior wall; episode of care unspecified

- 410.41 Acute myocardial infarction; Of other inferior wall; initial episode of care
- 410.42 Acute myocardial infarction; Of other inferior wall; subsequent episode of care
- 410.50 Acute myocardial infarction; Of other lateral wall; episode of care unspecified
- 410.51 Acute myocardial infarction; Of other lateral wall; initial episode of care
- 410.52 Acute myocardial infarction; Of other lateral wall; subsequent episode of care
- 410.60 Acute myocardial infarction; True posterior wall infarction; episode of care unspecified
- 410.61 Acute myocardial infarction; True posterior wall infarction; initial episode of care
- 410.62 Acute myocardial infarction; True posterior wall infarction; subsequent episode of care
- 410.70 Acute myocardial infarction; Subendocardial infarction; episode of care unspecified
- 410.71 Acute myocardial infarction; Subendocardial infarction; initial episode of care
- 410.72 Acute myocardial infarction; Subendocardial infarction; subsequent episode of care
- 410.80 Acute myocardial infarction; Of other specified sites; episode of care unspecified
- 410.81 Acute myocardial infarction; Of other specified sites; initial episode of care
- 410.82 Acute myocardial infarction; Of other specified sites; subsequent episode of care
- 410.90 Acute myocardial infarction; Unspecified site; episode of care unspecified
- 410.91 Acute myocardial infarction; Unspecified site; initial episode of care
- 410.92 Acute myocardial infarction; Unspecified site; subsequent episode of care
- 411.0 Other acute and subacute forms of ischemic heart disease; Postmyocardial infarction syndrome
- 411.1 Other acute and subacute forms of ischemic heart disease; Intermediate coronary syndrome
- 411.81 Acute coronary occlusion without myocardial infarction
- 411.89 Other acute and subacute forms of ischemic heart disease, other
- 412 Old myocardial infarction
- 413.0 Angina pectoris; Angina decubitus
- 413.1 Angina pectoris; Prinzmetal angina
- 413.9 Angina pectoris; Other and unspecified angina pectoris
- 414.06 Coronary atherosclerosis of native coronary artery of transplanted heart
- 414.07 Coronary atherosclerosis of native coronary artery of bypass graft (artery) (vein) of transplanted heart
- 414.10 Aneurysm and dissection of heart; aneurysm of heart (wall)
- 414.11 Aneurysm and dissection of heart; aneurysm of coronary vessels
- 414.12 Aneurysm and dissection of heart; dissection of coronary artery
- 414.19 Aneurysm and dissection of heart; other aneurysm of heart
- 414.8 Other forms of chronic ischemic heart disease; Other specified forms of chronic ischemic heart disease
- 414.9 Other forms of chronic ischemic heart disease; Chronic ischemic heart disease, unspecified
- 425.0 Endomyocardial fibrosis
- 425.1 Hypertrophic obstructive cardiomyopathy
- 425.2 Obscure cardiomyopathy of Africa
- 425.3 Endocardial fibroelastosis
- 425.4 Other primary cardiomyopathies
- 425.5 Alcoholic cardiomyopathy
- 425.7 Nutritional and metabolic cardiomyopathy
- 425.8 Cardiomyopathy in other diseases classified elsewhere
- 425.9 Secondary cardiomyopathy, unspecified
- 427.0 Paroxysmal supraventricular tachycardia

- 427.1 Paroxysmal ventricular tachycardia
- 428.0 Congestive heart failure, unspecified
- 428.1 Left heart failure
- 429.1 Myocardial degeneration
- 429.3 Cardiomegaly
- 429.82 Hyperkinetic heart disease

ICD-10 Diagnosis (*Effective October 1, 2014*)

- A18.84 Tuberculosis of heart
- I20.0 Unstable angina
- I20.1 Angina pectoris with documented spasm
- I20.8 Other forms of angina pectoris
- I20.9 Angina pectoris, unspecified
- I21.01 ST elevation (STEMI) myocardial infarction involving left main coronary artery
- I21.02 ST elevation (STEMI) myocardial infarction involving left anterior descending coronary artery
- I21.09 ST elevation (STEMI) myocardial infarction involving other coronary artery of anterior wall
- I21.11 ST elevation (STEMI) myocardial infarction involving right coronary artery
- I21.19 ST elevation (STEMI) myocardial infarction involving other coronary artery of inferior wall
- I21.21 ST elevation (STEMI) myocardial infarction involving left circumflex coronary artery
- I21.29 ST elevation (STEMI) myocardial infarction involving other sites
- I21.3 ST elevation (STEMI) myocardial infarction of unspecified site
- I21.4 Non-ST elevation (NSTEMI) myocardial infarction
- I22.0 Subsequent ST elevation (STEMI) myocardial infarction of anterior wall
- I22.1 Subsequent ST elevation (STEMI) myocardial infarction of inferior wall
- I22.2 Subsequent non-ST elevation (NSTEMI) myocardial infarction
- I22.8 Subsequent ST elevation (STEMI) myocardial infarction of other sites
- I22.9 Subsequent ST elevation (STEMI) myocardial infarction of unspecified site
- I24.0 Acute coronary thrombosis not resulting in myocardial infarction
- I24.1 Dressler's syndrome
- I24.8 Other forms of acute ischemic heart disease
- I24.9 Acute ischemic heart disease, unspecified
- I25.10 Atherosclerotic heart disease of native coronary artery without angina pectoris
- I25.110 Atherosclerotic heart disease of native coronary artery with unstable angina pectoris
- I25.111 Atherosclerotic heart disease of native coronary artery with angina pectoris with documented spasm
- I25.118 Atherosclerotic heart disease of native coronary artery with other forms of angina pectoris
- I25.119 Atherosclerotic heart disease of native coronary artery with unspecified angina pectoris
- I25.2 Old myocardial infarction
- I25.3 Aneurysm of heart
- I25.41 Coronary artery aneurysm
- I25.42 Coronary artery dissection
- I25.5 Ischemic cardiomyopathy
- I25.6 Silent myocardial ischemia

- I25.700 Atherosclerosis of coronary artery bypass graft(s), unspecified, with unstable angina pectoris
- I25.701 Atherosclerosis of coronary artery bypass graft(s), unspecified, with angina pectoris with documented spasm
- I25.708 Atherosclerosis of coronary artery bypass graft(s), unspecified, with other forms of angina pectoris
- I25.709 Atherosclerosis of coronary artery bypass graft(s), unspecified, with unspecified angina pectoris
- I25.710 Atherosclerosis of autologous vein coronary artery bypass graft(s) with unstable angina pectoris
- I25.711 Atherosclerosis of autologous vein coronary artery bypass graft(s) with angina pectoris with documented spasm
- I25.718 Atherosclerosis of autologous vein coronary artery bypass graft(s) with other forms of angina pectoris
- I25.719 Atherosclerosis of autologous vein coronary artery bypass graft(s) with unspecified angina pectoris
- I25.720 Atherosclerosis of autologous artery coronary artery bypass graft(s) with unstable angina pectoris
- I25.721 Atherosclerosis of autologous artery coronary artery bypass graft(s) with angina pectoris with documented spasm
- I25.728 Atherosclerosis of autologous artery coronary artery bypass graft(s) with other forms of angina pectoris
- I25.729 Atherosclerosis of autologous artery coronary artery bypass graft(s) with unspecified angina pectoris
- I25.730 Atherosclerosis of nonautologous biological coronary artery bypass graft(s) with unstable angina pectoris
- I25.731 Atherosclerosis of nonautologous biological coronary artery bypass graft(s) with angina pectoris with documented spasm
- I25.738 Atherosclerosis of nonautologous biological coronary artery bypass graft(s) with other forms of angina pectoris
- I25.739 Atherosclerosis of nonautologous biological coronary artery bypass graft(s) with unspecified angina pectoris
- I25.750 Atherosclerosis of native coronary artery of transplanted heart with unstable angina
- I25.751 Atherosclerosis of native coronary artery of transplanted heart with angina pectoris with documented spasm
- I25.758 Atherosclerosis of native coronary artery of transplanted heart with other forms of angina pectoris
- I25.759 Atherosclerosis of native coronary artery of transplanted heart with unspecified angina pectoris
- I25.760 Atherosclerosis of bypass graft of coronary artery of transplanted heart with unstable angina
- I25.761 Atherosclerosis of bypass graft of coronary artery of transplanted heart with angina pectoris with documented spasm
- I25.768 Atherosclerosis of bypass graft of coronary artery of transplanted heart with other forms of angina pectoris
- I25.769 Atherosclerosis of bypass graft of coronary artery of transplanted heart with unspecified angina pectoris

- I25.790 Atherosclerosis of other coronary artery bypass graft(s) with unstable angina pectoris
- I25.791 Atherosclerosis of other coronary artery bypass graft(s) with angina pectoris with documented spasm
- I25.798 Atherosclerosis of other coronary artery bypass graft(s) with other forms of angina pectoris
- I25.799 Atherosclerosis of other coronary artery bypass graft(s) with unspecified angina pectoris
- I25.810 Atherosclerosis of coronary artery bypass graft(s) without angina pectoris
- I25.811 Atherosclerosis of native coronary artery of transplanted heart without angina pectoris
- I25.812 Atherosclerosis of bypass graft of coronary artery of transplanted heart without angina pectoris
- I25.89 Other forms of chronic ischemic heart disease
- I25.9 Chronic ischemic heart disease, unspecified
- I42.0 Dilated cardiomyopathy
- I42.3 Endomyocardial (eosinophilic) disease
- I42.4 Endocardial fibroelastosis
- I42.5 Other restrictive cardiomyopathy
- I42.6 Alcoholic cardiomyopathy
- I42.7 Cardiomyopathy due to drug and external agent
- I42.8 Other cardiomyopathies
- I42.9 Cardiomyopathy, unspecified
- I43 Cardiomyopathy in diseases classified elsewhere
- I47.0 Re-entry ventricular arrhythmia
- I47.1 Supraventricular tachycardia
- I49.2 Junctional premature depolarization
- I50.1 Left ventricular failure
- I50.9 Heart failure, unspecified
- I51.5 Myocardial degeneration
- I51.7 Cardiomegaly
- I51.89 Other ill-defined heart diseases
- I51.9 Heart disease, unspecified

REVISIONS

10-30-2013	Cardiac Applications was originally part of the Positron Emission Tomography (PET) medical policy. Cardiac Applications was pulled out and placed into a separate medical policy, Positron Emission Tomography (PET) Scanning: Cardiac Applications. The medical policy language was unchanged.
	Updated Description section.
	Updated Rationale section.
	In Coding section: <ul style="list-style-type: none"> ▪ Added ICD-10 Diagnosis codes (<i>Effective October 1,2014</i>)
	Updated Reference section.

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