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

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

Professional
Original Effective Date: October 1, 1997
Revision Date(s): October 30, 2013; October 22, 2015
Current Effective Date: October 22, 2015

Institutional
Original Effective Date: September 11, 2004
Revision Date(s): October 30, 2013; October 22, 2015
Current Effective Date: October 22, 2015

State and Federal mandates and health plan member contract language, including specific provisions/exclusions, take precedence over Medical Policy and must be considered first in determining eligibility for coverage. To verify a member’s benefits, contact Blue Cross and Blue Shield of Kansas Customer Service.

The BCBSKS Medical Policies contained herein are for informational purposes and apply only to members who have health insurance through BCBSKS or who are covered by a self-insured group plan administered by BCBSKS. Medical Policy for FEP members is subject to FEP medical policy which may differ from BCBSKS Medical Policy.

The medical policies do not constitute medical advice or medical care. Treating health care providers are independent contractors and are neither employees nor agents of Blue Cross and Blue Shield of Kansas and are solely responsible for diagnosis, treatment and medical advice.

If your patient is covered under a different Blue Cross and Blue Shield plan, please refer to the Medical Policies of that plan.
<table>
<thead>
<tr>
<th>Populations</th>
<th>Interventions</th>
<th>Comparators</th>
<th>Outcomes</th>
</tr>
</thead>
</table>
| Patients/individuals with:  
- Suspected CAD with an indeterminate SPECT scan | Interventions of interest are:  
- Cardiac PET perfusion imaging | Comparators of interest are:  
- Coronary angiography  
- Other noninvasive tests for CAD (eg, stress echocardiography, exercise electrocardiography) | Relevant outcomes include:  
- Test accuracy |
| Patients/individuals with:  
- Severe left ventricular dysfunction considering revascularization | Interventions of interest are:  
- Cardiac PET scanning for myocardial viability | Comparators of interest are:  
- Cardiac magnetic resonance imaging  
- Cardiac SPECT scanning | Relevant outcomes include:  
- Test accuracy  
- Morbid events |
| Patients/individuals with:  
- CAD | Interventions of interest are:  
- Quantitative cardiac PET perfusion imaging | Comparators of interest are:  
- Coronary angiography with fractional flow reserve  
- Clinical risk models | Relevant outcomes include:  
- Morbid events |
| Patients/individuals with:  
- Cardiac sarcoidosis | Interventions of interest are:  
- Cardiac PET scanning | Comparators of interest are:  
- Clinical evaluation  
- Myocardial biopsy | Relevant outcomes include:  
- Test accuracy |

**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. Cardiac PET also is being studied in the measurement of myocardial blood flow and blood flow reserve and for evaluation of coronary artery inflammation.

**Background**

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, comprising multiple stationary detectors that encircle the thorax. Compared with single-photon emission computed tomography (SPECT) scans, coincidence detection offers greater spatial resolution.

A variety of radionuclide 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 with a variety of physiologically active molecules, such as oxygen, water, or ammonia. Fluorine-18 is often coupled with fluorodeoxyglucose (FDG) to detect 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, FDA has approved the following uses:
- **F-18-FDG for evaluation of myocardial hibernation.** 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 [coronary artery disease] 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.”

- **N-13-ammonia for evaluation of myocardial blood flow/perfusion.** 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, **rubidium-82- 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.”

On December 10, 2009, FDA issued guidance for Current Good Manufacturing Practice (CGMP) for PET drug manufacturers,3 and in August 2011, FDA issued similar CGMP guidance for small businesses.4 Compliance with PET CGMP regulations is required 2 years from the date of the earlier guidance, that is, beginning December 10, 2011. As FDA develops new regulations, and reviews radiotracer safety and effectiveness, implementation of Plan policies regarding PET scans may need to focus on the following:

- whether or not an individual PET radiotracer manufacturer facility meets current good manufacturing practices (CGMP) 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 evidence demonstrates improvement in net health outcome with PET scanning for the clinical indication for an individual.

**Note:** This policy only addresses the use of radiotracers detected with the use of dedicated PET scanners. Radiotracers such as 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.

B. Cardiac PET scanning may be considered **medically necessary** to assess myocardial viability in patients with severe left ventricular dysfunction as a technique to determine candidacy for a revascularization procedure. (See the Policy Guidelines section regarding the relative effectiveness of PET and SPECT scanning.)

C. Cardiac PET scanning may be considered **medically necessary** for diagnosing 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.

D. Cardiac PET scanning is **experimental / investigational** for quantification of myocardial blood flow in patients diagnosed with CAD.

Policy Guidelines

Myocardial Perfusion Imaging

For myocardial perfusion studies, patient selection criteria for PET scans include 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 typically will not benefit from noninvasive 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 (25%-75% disease prevalence).* This risk can be estimated using the patient’s age, sex, and chest pain quality. For example, Table 1 summarizes a characterization of patient populations at intermediate risk for CAD.\(^1\)

* Intermediate-risk ranges used by different authors may differ from the range used here. These pretest probability risk groups are based on a 1995 TEC Assessment\(^2\) and take into account spectrum effect. American College of Cardiology (ACC) guidelines define low risk as less than 10%, intermediate risk as 10 to 90%, and high risk as greater than 90%.

**Table 1  Individuals at Intermediate Risk for CAD According to Chest Pain Quality**

<table>
<thead>
<tr>
<th></th>
<th>Typical Angina(^a)</th>
<th>Atypical Angina(^b)</th>
<th>Nonanginal Chest Pain(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men ages 30-39 y</td>
<td>Men ages 30-70 y</td>
<td>Men ages ≥50 y</td>
<td></td>
</tr>
<tr>
<td>Woman ages 30-60 y</td>
<td>Woman ages ≥50 y</td>
<td>Women ages ≥60 y</td>
<td></td>
</tr>
</tbody>
</table>

CAD: coronary artery disease
\(^a\) 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
\(^b\) Chest pain that lacks 1 of the characteristics of typical angina
\(^c\) Chest pain that has 1 or none of the typical angina characteristics
SPECT scanning can be limited by body habitus, particularly by 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 nonviable myocardium. Patients with viable myocardium may benefit from revascularization, but those with nonviable 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 the above 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**

This policy has been updated periodically using the MEDLINE database. The most recent literature review was performed for the period through June 24, 2015. Following is a summary of the key literature to date.

**Myocardial Perfusion Imaging**

In a patient with symptoms suggesting 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), have been investigated for identifying reversible perfusion defects, which may reflect CAD and thus identify patients appropriately referred for angiography.

Sensitivity and specificity of PET may be slightly better than for SPECT. For example, performance characteristics for PET and SPECT based on the 2007 Canadian Joint Position Statement\(^5\) is shown in 2.

**Table 2. Performance Characteristics of PET and SPECT Scanning Based on the 2007 Canadian Joint Position Statement\(^5\)**

<table>
<thead>
<tr>
<th></th>
<th>PET</th>
<th>SPECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>0.91</td>
<td>0.88</td>
</tr>
<tr>
<td>Specificity</td>
<td>0.89</td>
<td>0.77</td>
</tr>
<tr>
<td>Estimated positive likelihood ratio(^a)</td>
<td>8.27</td>
<td>3.83</td>
</tr>
<tr>
<td>Estimated negative likelihood ratio(^b)</td>
<td>0.10</td>
<td>0.16</td>
</tr>
</tbody>
</table>

**PET:** positron emission tomography; **SPECT:** single-photon emission computed tomography.

\(^{a}\) Estimated positive likelihood ratio = sensitivity/(1 – specificity).

\(^{b}\) Estimated negative likelihood ratio = (1 – sensitivity)/specificity.
However, diagnostic utilities of PET and SPECT may be similar, ie, in terms of modifying disease risk assessment in a manner that affects subsequent decision making in patients with intermediate pretest probability of CAD. For example, as shown in Table, a patient with a 50% pretest probability of CAD would have a 9% posttest probability of CAD after a negative PET scan compared with 13% after a negative SPECT. In either case, further testing likely would not be pursued.

<table>
<thead>
<tr>
<th>Pretest Probability</th>
<th>Post-test Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive Test</td>
</tr>
<tr>
<td></td>
<td>PET</td>
</tr>
<tr>
<td>30%</td>
<td>78%</td>
</tr>
<tr>
<td>50%</td>
<td>89%</td>
</tr>
<tr>
<td>70%</td>
<td>95%</td>
</tr>
</tbody>
</table>

CAD: coronary artery disease; PET: positron emission tomography; SPECT: single-photon emission computed tomography.

In 2012, Jaarsma et al reported a meta-analysis comparing the diagnostic performance of noninvasive myocardial perfusion imaging using SPECT, cardiac magnetic resonance imaging (MRI) or PET. The comparison standard was CAD identified with coronary angiography. A total of 166 articles (17,901 patients) met inclusion criteria, with 114 articles on SPECT, 37 on cardiac MRI, and 15 on PET. Sensitivity by 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 with MRI (76%) and PET (81%). 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 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 assessed in 113 studies (11,212 patients), and PET was assessed 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 also was found among higher quality studies.

Takx et al (2014) reported a meta-analysis of studies that compared noninvasive myocardial perfusion imaging modalities (MRI, CT, PET, SPECT, echocardiography) with coronary angiography plus fractional flow reserve (FFR). Literature was searched to May 2014, and 37 studies met inclusion criteria (4698 vessels). Three PET studies of moderate to high quality were included (870 vessels); pretest probability of CAD was intermediate to intermediate-high in these studies. Negative likelihood ratio (NLR) was chosen as the primary outcome of interest because ruling out hemodynamically significant CAD is a primary purpose of noninvasive imaging. At the vessel level, pooled NLRs for PET, MRI, and CT were similar and were lower (better) than the pooled NLR for SPECT (PET pooled NLR=0.15 [95% CI, 0.05 to 0.44]; SPECT pooled NLR=0.47 [95% CI, 0.37 to 0.59]). Similarly, at the patient level, pooled NLRs for PET, MRI, and CT were better than the pooled NLRs for SPECT and echocardiography (PET pooled NLR=0.14 [95% CI, 0.02 to 0.87]; SPECT pooled NLR=0.39 [95% CI, 0.27 to 0.55]). Area under the receiver
operating characteristic (AUC) analyses were similar at both the vessel level (PET, 0.95 vs SPECT, 0.83) and the patient level (PET, 0.93 vs SPECT, 0.82).

Another consideration is that there are fewer indeterminate results with PET than SPECT. Bateman et al (2006) retrospectively matched 112 SPECT and 112 PET studies by gender, body mass index (BMI), and presence and extent of CAD, and compared diagnostic accuracy and degree of interpretative certainty (age, 65 years; 52% male; mean BMI = 32 kg/m²; 76% with CAD diagnosed on angiography). Eighteen (16%) of 112 SPECT studies were classified as indeterminate compared with 4 (4%) of 112 PET studies. Liver and bowel uptake were believed to affect 46 (41%) of 112 SPECT studies, compared with 6 (5%) of 112 PET studies. In obese patients (BMI > 30 kg/m²), accuracy of SPECT was 67% versus 85% for PET; accuracy in nonobese patients was 70% for SPECT and 87% for PET. 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, because obese patients are more prone to liver and bowel artifact, PET testing is advantageous over SPECT in severely obese patients.

Merhige et al (2007) reported on noncontemporaneous patients who had similar probabilities of CAD and were evaluated by SPECT or PET. In this single-center study comparing PET with SPECT, patients who received PET scans had lower rates of angiography (13% PET vs 31% SPECT) and revascularization (6% PET vs 11% SPECT) 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.

**Section Summary**

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. For some patients in whom SPECT may be indeterminate due to body habitus or other anatomic factors, PET often can be performed successfully.

**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 nonviable. 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. 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 proportion of patients who experience improvement in left ventricular (LV) dysfunction after revascularization of hibernating myocardium, as identified by PET scanning.

SPECT scanning also may be used to assess myocardial viability. Initial myocardial uptake of thallium-201 reflects myocardial perfusion, and redistribution after prolonged periods can be a
marker of myocardial viability. Initial protocols required redistribution imaging after 24 to 72 hours. Although this technique was associated with a strong positive predictive value (PPV), there was a low negative predictive value (NPV); ie, 40% of patients without redistribution nevertheless showed clinical improvement after revascularization. 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 et al (2001) performed a prospective randomized study comparing management decisions and outcomes based on either PET imaging or SPECT imaging in 103 patients who had chronic CAD and LV dysfunction and were being evaluated for myocardial viability. Management decisions included drug therapy or revascularization with either angioplasty or coronary artery bypass grafting. This study is unique in that diagnostic performance of PET and SPECT was tied to 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 who have suspicion of jeopardized myocardium.

Studies identified in literature updates continued to show the equivalence of SPECT and PET. Comparative studies reported on test accuracy and did not address impact on clinical outcomes. As 1 example, Slart et al (2005) 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 (2006) concluded that PET was better at detecting smaller defects. In this study, a 1-cm insert was not detectable by SPECT, yet it was detectable by PET.

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

Quantified Myocardial Blood Flow
Several publications describe the use of PET imaging to quantify both myocardial blood flow and MFR. However, as noted in an accompanying editorial and by subsequent reviewers, larger prospective clinical trials are needed to understand the clinical utility of these approaches. For example, Stuijfzand et al (2015) used 15-O[H2O] PET imaging in 92 patients with 1-2 vessel disease to quantify myocardial blood flow, myocardial flow reserve (MFR, defined as stress myocardial blood flow/rest myocardial blood flow), and “relative flow reserve” (defined as stress myocardial blood flow in a stenotic area/stress myocardial blood flow in a normal perfused area). Relative flow reserve was evaluated as a potential noninvasive alternative to FFR on coronary angiography. Using optimized cut points for PET detection of hemodynamically significant CAD (FFR as reference standard), AUC analysis showed similar diagnostic performance for all 3 measures (0.76 [95% CI, 0.66 to 0.86] for myocardial blood flow; 0.72 for MFR [95% CI, 0.61 to 0.83]; and 0.82 [95% CI, 0.72 to 0.91] for relative flow reserve; p>0.05 for all comparisons).

Taqueti et al (2015) evaluated the association between MFR (called coronary flow reserve in this study) and cardiovascular outcomes in 329 consecutive patients referred for invasive coronary
angiography after stress PET perfusion imaging. Patients with a prior history of coronary artery bypass grafting (CABG) or heart failure, or with left ventricular ejection fraction (LVEF) less than 40%, were excluded. Patients underwent rubidium-82 (Rb-82) or N-13 ammonia PET imaging and selective coronary angiography. MFR was calculated as the ratio of stress to rest myocardial blood flow for the whole left ventricle. The primary outcome was a composite of cardiovascular death and hospitalization for heart failure. These outcomes were chosen because they are thought to be related to microvascular dysfunction, which impacts PET myocardial blood flow measures, as opposed to obstructive CAD, which characteristically presents with myocardial infarction and/or revascularization. Patients were followed for a median of 3.1 years (interquartile range, 1.7-4.3) for the occurrence of major adverse cardiovascular events (MACE, comprising death, cardiovascular death, and hospitalization for heart failure or myocardial infarction). During follow-up, 64 patients (19%) met the primary composite end point. In a multivariate model that included pretest clinical score (to determine the pretest probability of obstructive, angiographic CAD), LVEF, left ventricular ischemia, early revascularization (within 90 days of PET imaging), and Coronary Artery Disease Prognostic Index, MFR was statistically associated with the primary outcome (hazard ratio [HR] per 1 unit decrease in continuous MFR score, 2.02 [95% CI, 1.20 to 3.40]). Using binary classification defined by median MFR, incidence of the primary outcome was 50% in patients with low or high CFR. A statistically significant interaction between CFR and early revascularization by CABG was observed: Event-free survival for patients with high CFR who underwent early revascularization was similar in groups who received CABG (n=17) or percutaneous coronary intervention (PCI; n=72) or no revascularization (n=79); among patients with low CFR who underwent early revascularization, event-free survival was significantly better in the CABG group (n=22) compared with the PCI group (n=85; adjusted log-rank test, p=0.006) and the no-revascularization group (n=57; adjusted log-rank test, p=0.001).

In 2011, Ziadi et al reported a prospective study of the prognostic value of myocardial flow reserve (MFR) with Rb-82 PET in 704 consecutive patients assessed for ischemia. Ninety-six percent of patients (n=677) were followed for a median of 387 days; most (90%) were followed up by telephone. The hypothesis tested was that patients with reduced flow reserve would have higher cardiac event rates and that Rb-82 MFR would be an independent predictor of adverse outcomes. Primary outcome was the prevalence of hard cardiac events (myocardial infarction and cardiac death); secondary outcome was prevalence of MACE (comprising cardiac death, myocardial infarction, later revascularization, and cardiac hospitalization). Patients with a normal summed stress score (SSS) but impaired MFR had a significantly higher incidence of hard events (2% vs 1.3%) and MACE (9% vs 3.8%) compared with patients who had preserved MFR. Patients with abnormal SSS and impaired MFR had a higher incidence of hard events (11.4% vs 1.1%) and MACE (24% vs 9%) compared with patients who had preserved MFR. Rb-82 MFR was an independent predictor of cardiac hard events (HR: 3.3) and MACE (HR=2.4) over SSS. Three patients (0.4%) were classified up and 0 classified down with MFR in the multivariate model (p=0.092).

Murthy et al (2011) examined the prognostic value of Rb-82 PET MFR (called coronary flow reserve in this study) in a retrospective series of 2783 patients referred for rest/stress PET myocardial perfusion imaging. Coronary flow reserve was calculated as the ratio of stress to rest myocardial blood flow using semiquantitative PET interpretation. Primary outcome was cardiac death over a median follow-up of 1.4 years. Prognostic modeling was done with a Cox proportional hazards model. Adding MFR to a multivariate model containing clinical covariates (eg, CAD risk factors and CAD history) significantly improved model fit and improved the c index,
a measure of discrimination performance, from 0.82 to 0.84 (p=0.02). MFR was a significant independent predictor of cardiac mortality and resulted in improved risk reclassification. In 2012, these authors reported that the added value of PET MFR was observed in both diabetic and non-diabetic patients.22

**Section Summary**
Evidence for the association of quantitative myocardial blood flow and myocardial flow reserve with cardiovascular outcomes is growing. Some but not all prospective studies have shown improvements over prognostic models based on clinical risk factors for cardiac events. Editorialists have commented on the potential utility of quantitative perfusion for understanding cardiac physiology and for informing future research.23,24 However, because some studies used data-driven cut points and did not include healthy volunteers to verify discriminative ability (spectrum bias), these methods are considered to be in a developmental stage for clinical use.

**Cardiac Sarcoidosis**
Based on clinical input received in 2011, an additional indication for the workup of cardiac sarcoidosis was added to the policy. Published evidence on utility of PET scanning for cardiac sarcoidosis is limited due to the relatively small number of patients with this condition. A 2009 review by Sharma et al concluded that imaging studies had incremental value when combined with clinical evaluation and/or myocardial biopsy in the diagnosis of cardiac sarcoidosis.25 The authors reported that cardiac MRI was the more established imaging modality in diagnosing sarcoidosis, with an estimated sensitivity of 100% and specificity of 80%. A 2012 meta-analysis by Youssef et al identified 7 studies with 164 patients.26 Studies were selected if they used FDG PET for diagnosis of cardiac sarcoidosis and used criteria of the Japanese Ministry of Health, Labor and Welfare 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 (AUC) was 93%, suggesting a good level of diagnostic discrimination. Yokoyama et al (2015) reported an AUC of 0.96 for identifying patients with cardiac sarcoidosis using optimized cut points for the maximum standardized uptake value on FDG PET/CT.27

**Ongoing and Unpublished Clinical Trials**
Some currently unpublished trials that might influence this policy are listed in Table 1.

**Table 1. Summary of Key Trials**

<table>
<thead>
<tr>
<th>NCT No.</th>
<th>Trial Name</th>
<th>Planned Enrollment</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ongoing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCT01934985</td>
<td>Dynamic Cardiac SPECT Imaging</td>
<td>160</td>
<td>Sep 2015</td>
</tr>
<tr>
<td>NCT01943903</td>
<td>Prospective Longitudinal Trial of FFRct: Outcome and Resource Impacts</td>
<td>580</td>
<td>Dec 2015</td>
</tr>
<tr>
<td>NCT01288560</td>
<td>Alternative Imaging Modalities in Ischemic Heart Failure (AIMI-HF) Project I-A of Imaging Modalities to Assist With Guiding Therapy and the Evaluation of Patients With Heart Failure (IMAGE-HF)</td>
<td>1511</td>
<td>Jun 2017</td>
</tr>
<tr>
<td>NCT00756379</td>
<td>Randomized Trial of Comprehensive Lifestyle Modifications, Optimal Pharmacological Treatment and PET Imaging for Detection and Management of Stable Coronary Artery Disease</td>
<td>1300</td>
<td>Jan 2019</td>
</tr>
</tbody>
</table>

NCT: national clinical trial.
Summary of Evidence
For assessing myocardial perfusion in patients with suspected coronary artery disease, positron emission tomography (PET) scanning is less likely than single-photon emission computed tomography (SPECT) scanning to provide indeterminate results. Therefore, PET scanning also is useful in patients with an indeterminate SPECT scan. It also is useful in patients whose body habitus is likely to result in indeterminate SPECT scans, eg, patients with moderate to severe obesity.

Evidence from the medical literature supports the use of PET scanning to assess myocardial viability in patients with severe left ventricular dysfunction who are being considered for revascularization. Results of primary studies and evidence-based recommendations from specialty societies conclude that PET scanning is at least as good as, and likely superior, to SPECT scanning for this purpose.

Studies of quantitative myocardial blood flow and myocardial flow reserve in patients with CAD indicates that these methods are in a developmental stage for clinical use. Current evidence is insufficient to permit conclusions about the impact on net health outcome in these patients.

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, evidence supports PET scanning as the preferred test.

Clinical Input Received From 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.

2011 Input
Clinical input received in June 2011 was in general agreement with the medical necessity of PET for myocardial viability or for patients with an indeterminate SPECT scan. However, reviewers disagreed on using a strict body mass index 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 whether PET scanning was medically necessary in the workup of patients with suspected cardiac sarcoidosis. All 3 were in agreement that PET scanning was medically necessary in this patient group. Two of the 3 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."

**Practice Guidelines and Position Statements**

**American College of Cardiology and American Heart Association**

In 2003, the American College of Cardiology and American Heart Association published updated guidelines for cardiac radionuclide imaging, including cardiac applications of PET. Table 5 summarizes the guidelines for PET and SPECT imaging in patients with an intermediate risk of coronary artery disease (CAD). 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.

<table>
<thead>
<tr>
<th>Indication</th>
<th>SPECT Class</th>
<th>PET Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify extent, severity, and location of ischemia (SPECT protocols vary according to whether patient can exercise)</td>
<td>I</td>
<td>IIa</td>
</tr>
<tr>
<td>Repeat test after 3-5 y after revascularization in selected high-risk asymptomatic patients (SPECT protocols vary according to whether patients can exercise)</td>
<td>IIa</td>
<td>–</td>
</tr>
<tr>
<td>As initial test in patients who are considered to be at high risk (ie, patients with diabetes or those with a &gt;20% 10-y risk of a coronary disease event) (SPECT protocols vary according to whether patients can exercise)</td>
<td>IIa</td>
<td>–</td>
</tr>
<tr>
<td>Myocardial perfusion PET when prior SPECT study has been found to be equivocal for diagnostic or risk stratification purposes</td>
<td>NA</td>
<td>I</td>
</tr>
</tbody>
</table>

PET: positron emission tomography; SPECT: single-photon emission computed tomography.

These guidelines concluded that PET imaging “appears to have slightly better overall accuracy for predicting recovery of regional function after revascularization in patients with left ventricular dysfunction than single photon techniques (ie, SPECT scans).” 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.

**Canadian Cardiovascular Society et al**

In 2007, Canadian Cardiovascular Society, Canadian Association of Radiologists, Canadian Association of Nuclear Medicine, Canadian Nuclear Cardiology Society, and Canadian Society of Cardiac Magnetic Resonance recommended 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, eg, obesity (class I recommendation, level B evidence).

**American College of Radiology**

2011 American College of Radiology (ACR) Appropriateness Criteria consider both SPECT and PET to be appropriate for the evaluation of patients with a high probability of CAD. ACR states that
PET perfusion imaging has advantages over SPECT, including higher spatial and temporal resolution. Routine performance of both PET and SPECT are unnecessary.

**European Society of Cardiology**

European Society of Cardiology published evidence-based consensus guidelines for the diagnosis and treatment of acute and chronic heart failure in 2012. Guideline authors concluded that myocardial perfusion/ischemia imaging should be considered in patients thought to have CAD, who are considered suitable for coronary revascularization, to determine whether there is reversible myocardial ischemia and viable myocardium. Recommended imaging modalities are echocardiography, cardiac MRI, SPECT, and PET. (Class 2a recommendation [weight of evidence/opinion is in favor of usefulness/efficacy]; level C evidence [based on consensus expert opinion and/or small or retrospective studies or registries].)

**Japanese Society of Nuclear Cardiology**

In 2014, the Japanese Society of Nuclear Cardiology published recommendations for PET imaging for cardiac sarcoidosis. In Japan, F-18-FDG PET is approved only for detecting sites of inflammation in cardiac sarcoidosis. In patients with cardiac sarcoidosis diagnosed by established guidelines (eg, 2006 update of JMHW guidelines), FDG PET may be used to assess lesion distribution. However, use of FDG PET to diagnose patients with suspected cardiac sarcoidosis is not covered by the health ministry’s insurance reimbursement.

**U.S. Preventive Services Task Force Recommendations**

No U.S. Preventive Services Task Force recommendations for use of PET in cardiac imaging have been identified.

**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**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>78459</td>
<td>Myocardial imaging, positron emission tomography (PET), metabolic evaluation</td>
</tr>
<tr>
<td>78491</td>
<td>Myocardial imaging, positron emission tomography (PET), perfusion; single study at rest or stress</td>
</tr>
<tr>
<td>78492</td>
<td>Myocardial imaging, positron emission tomography (PET), perfusion; multiple studies at rest and / or stress</td>
</tr>
<tr>
<td>A9526</td>
<td>Nitrogen N-13 ammonia, diagnostic, per study dose, up to 40 millicuries</td>
</tr>
<tr>
<td>A9552</td>
<td>Fluorodeoxyglucose F-18 FDG, diagnostic, per study does, up to 45 millicuries</td>
</tr>
<tr>
<td>A9555</td>
<td>Rubidium Rb-82, diagnostic, per study dose, up to 60 millicuries</td>
</tr>
</tbody>
</table>

- A PET scan essentially involves 3 separate activities:
  1. manufacture of the radiopharmaceutical, which may be manufactured on site or manufactured at a regional delivery center with delivery to the institution performing PET;
  2. actual performance of the PET scan; and
  3. interpretation of the results.
The following CPT codes and HCPCS codes are available to code for PET scans:
  - This CPT code describes the use of FDG to evaluate myocardial viability: 78459
  - These 2 CPT codes describe the use of rubidium to evaluate myocardial perfusion: 78491, 78492
  - Effective in 2006, there are HCPCS codes for FDG, rubidium, and N-13 ammonia: A9552, A9555, A9526.

ICD-9 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 heart diseases; Heart 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 Diagnoses (Effective October 1, 2015)
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
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I43</td>
<td>Cardiomyopathy in diseases classified elsewhere</td>
</tr>
<tr>
<td>I47.0</td>
<td>Re-entry ventricular arrhythmia</td>
</tr>
<tr>
<td>I47.1</td>
<td>Supraventricular tachycardia</td>
</tr>
<tr>
<td>I49.2</td>
<td>Junctional premature depolarization</td>
</tr>
<tr>
<td>I50.1</td>
<td>Left ventricular failure</td>
</tr>
<tr>
<td>I50.9</td>
<td>Heart failure, unspecified</td>
</tr>
<tr>
<td>I51.5</td>
<td>Myocardial degeneration</td>
</tr>
<tr>
<td>I51.7</td>
<td>Cardiomegaly</td>
</tr>
<tr>
<td>I51.89</td>
<td>Other ill-defined heart diseases</td>
</tr>
<tr>
<td>I51.9</td>
<td>Heart disease, unspecified</td>
</tr>
</tbody>
</table>

**REVISIONS**

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
</table>
| 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:  
  - Added ICD-10 Diagnosis codes (**Effective October 1, 2014**) Updated Reference section. |
| 10-22-2015 | Description section updated  
  In Policy section:  
  - In Item A removed the example in the policy statement, “(e.g., obesity)”  
  - In Item B added “(See the Policy Guidelines section regarding the relative effectiveness of PET and SPECT scanning.)”  
  - In Item C revised wording by removing “the diagnosis of” and adding “diagnosing” to read “Cardiac PET scanning may be considered medically necessary for diagnosing cardiac sarcoidosis in patients…”  
  - Added Item D “Cardiac PET scanning is experimental / investigational for quantification of myocardial blood flow in patients diagnosed with CAD.”  
  - Policy Guidelines updated to reflect current information on relative effectiveness of PET and SPECT scanning. Rationale section updated  
  In Coding section:  
  - Removed CPT Code: 78399  
  - Added HCPCS Code: A9555  
  - Updated Coding notations  
  References updated |

**REFERENCES**


30. Members ATF, McMurray JJV, Adamopoulos S, et al. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012: The Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC. European Heart Journal. July 1, 2012;33(14):1787-1847. PMID


Other References

1. Blue Cross and Blue Shield of Kansas, Medical Advisory Committee meeting, April 24, 2003 (see Blue Cross and Blue Shield of Kansas Newsletter, Blue Shield Report MAC–02-03).

2. Blue Cross and Blue Shield of Kansas, Oncology Liaison Committee meeting, February 18, 2003 (see Blue Cross and Blue Shield of Kansas Newsletter, Blue Shield Report MAC–02-03).

3. Blue Cross and Blue Shield of Kansas, Radiology Liaison Committee meeting, February 11, 2003 (see Blue Cross and Blue Shield of Kansas Newsletter, Blue Shield Report MAC–02-03).

4. MCMC, Medical Care Ombudsman Program (MCOP), August 11, 2006, MCOP ID 1071-0720.


6. Blue Cross and Blue Shield of Kansas Radiology Liaison Committee, February 2009.