



CIGNA MEDICAL COVERAGE POLICY

The following Coverage Policy applies to all plans administered by CIGNA Companies including plans administered by Great-West Healthcare, which is now a part of CIGNA.

**Subject Nuclear Imaging including
Single-Photon Emission
Computed Tomography
(SPECT)**

Effective Date 12/15/2008
Next Review Date.....9/15/2009
Coverage Policy Number 0169

Table of Contents

Coverage Policy	1
General Background	2
Coding/Billing Information	15
References	19
Policy History.....	29

Hyperlink to Related Coverage Policies

AcuTect™
Autism Spectrum Disorders/Pervasive
Developmental Disorders: Assessment
and Treatment
Magnetic Resonance Imaging (MRI) of the
Breast
Mammography
Positron Emission Tomography (PET)
Prostascint®

INSTRUCTIONS FOR USE

Coverage Policies are intended to provide guidance in interpreting certain **standard** CIGNA HealthCare benefit plans as well as benefit plans formerly administered by Great-West Healthcare. Please note, the terms of a participant's particular benefit plan document [Group Service Agreement (GSA), Evidence of Coverage, Certificate of Coverage, Summary Plan Description (SPD) or similar plan document] may differ significantly from the standard benefit plans upon which these Coverage Policies are based. For example, a participant's benefit plan document may contain a specific exclusion related to a topic addressed in a Coverage Policy. In the event of a conflict, a participant's benefit plan document **always supercedes** the information in the Coverage Policies. In the absence of a controlling federal or state coverage mandate, benefits are ultimately determined by the terms of the applicable benefit plan document. Coverage determinations in each specific instance require consideration of 1) the terms of the applicable group benefit plan document in effect on the date of service; 2) any applicable laws/regulations; 3) any relevant collateral source materials including Coverage Policies and; 4) the specific facts of the particular situation. Coverage Policies relate exclusively to the administration of health benefit plans. Coverage Policies are not recommendations for treatment and should never be used as treatment guidelines. Proprietary information of CIGNA. Copyright ©2008 CIGNA

Coverage Policy

CIGNA covers nuclear imaging scintigraphy (including single-photon emission computed tomography (SPECT) and SPECT with concurrently-acquired computed tomography [SPECT/CT]) as medically necessary for ANY of the following when other imaging studies are inconclusive or contraindicated:

- bone and skeletal disorders
- brain disorders (e.g., dementia including Alzheimer's disease [AD], cerebrovascular disease, epilepsy, encephalitis, head injury) and central nervous system disorders
- gastrointestinal disorders
- hepatobiliary and hepatosplenic disorders
- infections and inflammation
- lung disorders
- lymphatic disorders
- parathyroid disorders
- renal and urinary disorders
- acute and subacute scrotal pain due to testicular torsion, epididymitis, or orchitis
- thyroid disorders

- tumors (except as noted below)

CIGNA covers SPECT myocardial perfusion imaging (MPI) OR MUGA scanning (multiple gated acquisition, equilibrium radionuclide angiography/ ventriculography, [ERNA, RVG], or gated blood pool imaging), as medically necessary for ANY of the following:

- detection of obstructive coronary artery disease (CAD) in asymptomatic or symptomatic individuals with either intermediate or high pretest probability¹ for CAD
- detection of CAD in individuals with uninterpretable or equivocal² stress test results
- risk assessment:
 - in asymptomatic or symptomatic individuals with intermediate or high pretest probability¹ for CAD
 - in asymptomatic or symptomatic individuals with known CAD to evaluate suspected worsening disease
 - preoperative individuals with an intermediate perioperative risk predictor³ or poor exercise tolerance (< 4 estimated metabolic equivalents of exercise [METs])
 - following acute coronary syndrome ST-segment elevation myocardial infarction (STEMI) if thrombolytic therapy was administered and there are no immediate plans for cardiac catheterization
 - following acute coronary syndrome and unstable angina or non-ST-segment elevation myocardial infarction (NSTEMI) or acute MI has been excluded but a strong suspicion of ischemia remains and there are no immediate plans for cardiac catheterization
 - in asymptomatic individuals post-revascularization who are ≥ 5 years after coronary artery bypass graft (CABG)
 - in symptomatic individuals post-revascularization
- assessment of viability/ischemia when there is known CAD on cardiac catheterization and revascularization is being considered
- evaluation of ventricular function when echocardiography is nondiagnostic or potentially cardiotoxic therapy has been or will be utilized
- arrhythmias

CIGNA does not cover nuclear imaging scintigraphy including SPECT or SPECT/CT for any of the following because it is considered experimental, investigational or unproven:

- chronic fatigue syndrome
- multiple myeloma
- psychiatric and neuropsychiatric disorders
- scrotal tumors, chronic scrotal inflammation or cryptorchidism
- screening for CAD in asymptomatic, low pretest probability¹ individuals

CIGNA does not cover scintimammography, including breast-specific gamma imaging (BSGI) because it is considered experimental, investigational or unproven.

For additional information refer to CIGNA Coverage Policies on Prostascint[®] and AcuTect[™].

¹physician utilized established methods of determining risk/probability of CAD (i.e., American College of Cardiology [ACC]/American Heart Association [AHA] Multiple-Risk-Factor Assessment [Age, Gender, and Symptoms]; Framingham Risk Score calculation; Duke Treadmill Score calculation).

²equivocal defined according to American College of Cardiology key data elements and definitions for measuring the clinical management and outcomes of individuals with acute coronary syndromes.

³per ACC perioperative risk predictors (Brindis, et al., 2005)

General Background

Nuclear medicine is a subspecialty within the field of radiology. X-ray and nuclear medicine imaging share in common the use of ionizing radiation. X-ray images are produced by recording the differential absorption of x-rays by body tissues. Nuclear medicine images are obtained by mapping the distribution of radioactivity of an administered radiopharmaceutical within the body. Gamma-rays and x-rays are photons, or electromagnetic radiation, that can penetrate matter and be detected by an external detection system. The detectors used are usually some kind of scintillation detector, either a large field of view gamma camera with one to three heads, or a ring detector.

Emission computed tomography (ECT) provides an in vivo three-dimensional distribution of radiopharmaceuticals within the body, generated from a set of two-dimensional projectional images. ECT is considered functional imaging, whereas magnetic resonance imaging (MRI) or computed tomography (CT) are considered anatomical. ECT improves image contrast and quantification and includes single-photon emission computed tomography (SPECT) and positron emission tomography (PET). SPECT is more readily available in practice than PET because it utilizes commercially available isotopes and does not require an on-site cyclotron. SPECT involves the detection of gamma rays emitted singly (single-photon) from radionuclides such as technetium-99m (Tc-99m) and thallium-201 (TI 201).

Conventional planar imaging provides only a two-dimensional projection of a three-dimensional distribution of activity. Planar imaging may be used for individuals who do not tolerate the position that must be maintained during a SPECT acquisition, those who have difficulty coping with the larger SPECT camera being so close to the body, or those with large body habitus that surpasses the weight and size limits of SPECT systems. SPECT scintigrams allow 3-D information to be gained in addition to standard planar views. They are used to give depth information (e.g., in kidney studies) or aid localization of a particular lesion (e.g., for bone scintigrams). Alternatively, SPECT can be used for myocardial studies or various brain imaging techniques (e.g., for diagnosis of dementia and evaluation of cerebral blood flow). More recently, dual-headed cameras have entered the market, and these are capable of automatically acquiring whole-body scintigrams in one pass. They have reduced the acquisition time for many studies when compared with the single-headed cameras, including SPECT sequences, while allowing the simultaneous collection of two or more images (e.g., anterior and posterior or lateral or oblique views). Some of these dual-headed cameras have a fixed geometry of 180° separation between the two heads, whereas the newest that have variable angle gantries are especially useful for the increasing cardiac workload (Grainger, et al., 2003).

Indications

The ultimate goal of nuclear medicine is to provide an accurate, three-dimensional (3-D) map of the distribution of a radiopharmaceutical within a individual, and possibly also to measure changes in distribution with time. Tumors, infection and other disorders can be detected by evaluating organ function. Some applications of nuclear imaging include: analyze kidney function; visualize heart blood flow and function; scan lungs for respiratory and blood flow problems; identify blockage in the gallbladder; evaluate bones for fracture, infection, arthritis and tumors; determine the presence or spread of cancer; identify bleeding into the bowel; locate the presence of infection; measure thyroid function to detect an overactive or underactive thyroid; and investigate abnormalities in the brain (Radiology Society of North America [RSNA], 2008).

U.S. Food and Drug Administration (FDA)

Radiopharmaceuticals and imaging systems are regulated by the U.S. Food and Drug Administration (FDA). Premarket 510(k) notification is required by the FDA for an emission computed tomography diagnostic device or nuclear tomography system, which are Class II medical devices. Radio-pharmaceutical approvals may or may not specify the types of imaging systems they can be used with or the types of conditions or diagnoses they can be used to help detect.

Literature Review

SPECT/CT Imaging

Consistent with trends in PET/CT systems, hybrid SPECT systems have evolved, combining SPECT and CT systems. It is possible to co-register separately acquired cross-sectional and functional imaging data using side-by-side comparison or more sophisticated software to superimpose images. These methods are relatively reliable for rigid structures, but are otherwise limited by the cumbersome and somewhat unreliable nature of the process. Hybrid imaging with sequential acquisition of structural and functional data in the same imaging session without alteration in patient position overcomes many of the shortcomings and enables more accurate

co-registration. Established oncological applications include imaging of neuroendocrine tumors (e.g., pheochromocytoma, paraganglionoma, and neuroblastoma, medullary thyroid cancer and gastroenteropancreatic tumors, including carcinoids and endocrine pancreatic tumors); differentiated (follicular and papillary) thyroid carcinoma; lymphoma; and for early detection of bone metastases in oncology patients. Oncological applications growing in use include prostate cancer; lung cancer and characterization of solitary pulmonary nodules; characterization of the biological features of brain tumors; and use in radionuclide therapy (Chowdhury and Scarsbrook, 2008).

Society of Nuclear Medicine (SNM): SNM Procedure Guideline for SPECT/CT Imaging (May, 2006) states that indications for SPECT/CT include but are not limited to imaging of the following:

- tumors
- thyroid disorders
- parathyroid disorders
- skeleton disorders
- inflammation or infection
- lymphatic system
- heart disorders
- brain disorders
- other organs

The SNM states that combined SPECT/CT devices provide both the functional information from SPECT and the anatomic information from CT in a single examination. Some studies have demonstrated that the information obtained by SPECT/CT is more accurate in evaluating individuals than that obtained from either SPECT or CT alone. Although techniques for registration and fusion of images obtained from separate SPECT and CT scanners have been available for several years, the advantages of having SPECT and CT integrated into a single device have resulted in the development of this technology (SNM, 2006).

American Society of Nuclear Cardiology (ASNC): ASNC Imaging Guidelines for Nuclear Cardiology Procedures: Instrumentation Quality Assurance and Performance (2007) states that in nuclear cardiology, SPECT components are typically large field of view variable angle dual detector systems. These combined systems, in practice, demonstrate a range of capability and integration. CT components range from nondiagnostic units suitable for use in anatomical localization and attenuation correction to 16-slice systems capable of computed tomography angiography. The SPECT detectors in SPECT/CT systems do not differ in any significant way from those of stand-alone SPECT systems. These systems may be viewed from a protocol perspective as stand-alone systems where an emission study is followed or preceded by a CT scan for attenuation correction. The CT and SPECT components may then be analyzed independently or in three-dimensional image registrations, depending on the type of study.

In a 2008 Information Statement, the ASNC states that all diagnostic imaging protocols should be constructed to minimize the radiation exposure to the patient while providing the best possible information for an accurate diagnosis. While there may be a finite risk associated with a diagnostic study using low level ionizing radiation, the typical patient presents a higher risk by not having the imaging study performed. There is considerable uncertainty in dosimetry point estimates for both nuclear and CT imaging protocols. When choosing a diagnostic protocol careful consideration should be given to the incremental diagnostic benefit versus the radiation risk. Reducing radiation dose to the patient should always be a primary consideration in the development or new or modification of existing protocols. However, the reduction should not impact the quality and accuracy of the clinical information from the study. The risk of the study should never be considered without considering the benefit or the risk of not doing the study. While the benefit of a test is difficult to quantify, its estimate likely has comparable uncertainty as the radiation risk.

Bone/Skeletal

Bone or skeletal scintigraphy is performed for numerous indications, including but not limited to detection, evaluation, and/or follow-up of: primary and metastatic bone neoplasms; disease progression or response to therapy; Paget's disease of bone; stress and/or occult fractures; trauma; osteomyelitis; musculoskeletal inflammation or infection; bone viability (grafts, infarcts, osteonecrosis); metabolic bone disease; arthritides; prosthetic joint loosening and infection; pain of suspected musculoskeletal etiology; myositis ossificans; complex regional pain syndrome/reflex sympathetic dystrophy; abnormal radiographic or laboratory findings; distribution

of osteoblastic activity prior to administration of therapeutic radiopharmaceuticals for treating bone pain (ACR, 2007).

Brain

Radionuclide imaging of the brain requires radiopharmaceuticals that cross the blood–brain barrier. Clinical applications include but are not limited to: detecting and evaluating cerebrovascular disease; differentiating lacunar from nonlacunar infarctions; predicting the prognosis of individuals with cerebrovascular accidents; evaluating individuals with transient ischemic attacks; evaluating individuals with suspected dementia; localizing epileptic foci preoperatively; evaluating symptomatic traumatic brain injury, especially in the absence of CT and/or MRI findings; diagnosing encephalitis; monitoring and assessing vascular spasm following subarachnoid hemorrhage; mapping of brain perfusion during interventions; confirming brain death (ACR, 2007).

For other indications (e.g., neuropsychiatric disorders, chronic fatigue syndrome), the findings of SPECT brain perfusion imaging have not been fully characterized (ACR, 2007). SPECT imaging conducted in a research setting provides information on the biology of major psychiatric disorders but is not utilized at this time in the clinical management of psychiatric disorders.

American Psychiatric Association (APA): The APA Practice Guideline for the Treatment of Patients With Alzheimer’s Disease and Other Dementias (2007) states that the use of a structural neuroimaging study, such as CT or MRI scan, is generally recommended as part of an initial evaluation, although clinical practice varies. Imaging is particularly important for those with a subacute onset (less than one year), symptom onset before age 65, vascular risk factors suggesting a higher likelihood of cerebrovascular involvement in their dementia, or a history or neurological examination findings suggesting a possible focal lesion. Nonetheless, clinically important lesions may be found on neuroimaging in the absence of these indications. The value of imaging in individuals with late-stage disease who have not been previously evaluated has not been established (2007).

The APA Psychiatric Evaluation of Adults APA Guideline (2006) states that “neuroimaging techniques are currently used in identifying central nervous system processes such as infection, malformations, cerebrovascular events, and malignancy. Accumulating evidence also suggests other applications of neuroimaging in psychiatric evaluation. In cognitive disorders of late life, such as Alzheimer’s disease, neuroimaging techniques have been evaluated for use as surrogate markers for the microscopic neuropathologies that characterize the illness. Functional neuroimaging with positron emission tomography or single-photon emission computed tomography has demonstrated an association between reduced regional activity (metabolism or perfusion) in temporoparietal regions and the presence and severity of Alzheimer’s disease, whereas other dementing illnesses do not show this temporoparietal feature. The reproducibility of these findings has enhanced the differentiation between Alzheimer’s disease and other dementing illnesses. Ongoing work aims to confirm the clinical utility of such information.”

The APA Psychiatric Evaluation of Adults Guideline (2006) also states “in patients with schizophrenia and mood and anxiety disorders, structural and functional neuroimaging studies have reported differences between patients and healthy control persons as well as differences in some patient subgroups and in responders and nonresponders to some treatments. Nevertheless, the clinical utility of neuroimaging techniques for planning of individualized treatment has not yet been shown. Further research is needed to demonstrate a clinical role for structural and functional neuroimaging in establishing psychiatric diagnoses, monitoring illness progression, and predicting prognoses.”

American Academy of Neurology (AAN): The AAN Summary of Evidence-based Guideline for Clinicians is a summary of two 2006 AAN evidence-based guidelines reviewing all of the evidence for diagnosis, prognosis, and neuroprotective and alternative therapies for Parkinson disease (PD) and one 2002 evidence-based guideline assessing the evidence for initiation of treatment for PD. The Summary states that SPECT “may not be useful in differentiating PD from other parkinsonian syndromes.”

The AAN Practice Parameter Diagnosis and Prognosis of New Onset Parkinson disease states that “ β -CIT and IBZM SPECT are possibly useful in distinguishing PD from essential tremor and subjects. There is insufficient evidence to determine if these modalities are useful in distinguishing PD from other forms of parkinsonism (Suchowersky, et al., 2006).

The AAN Practice Parameter, Screening And Diagnosis Of Autism, states that functional imaging modalities such as functional MRI, SPECT, or PET are currently only research tools in the evaluation of autism and that there is no evidence to support a role for functional neuroimaging studies in the clinical diagnosis of autism at the present time (AAN, reaffirmed 2006).

The AAN Practice Parameter, Neuroimaging of the Neonate, states “near infrared spectroscopy, nuclear medicine (SPECT and PET), and functional MRI are other major imaging technologies not discussed in this neuroimaging of the neonate practice parameter because of lack of data; these technologies are under evaluation for use in the assessment of the developing brain” (Ment, et al., 2002).

The AAN Practice Parameter, Diagnostic Assessment of the Child with Cerebral Palsy, states “there was insufficient evidence to make any recommendations regarding the role of SPECT scans or evoked potentials in children with cerebral palsy” (Ashwal, et al., 2004).

European Federation of Neurological Societies (EFNS): The EFNS Guideline, Recommendations for the Diagnosis and Management of Alzheimer’s disease and Other Disorders Associated with Dementia (2007), states that structural imaging should be used in the evaluation of every patient suspected of dementia. SPECT and PET may be useful in those cases where diagnostic uncertainty remains after clinical and structural imaging workup, and should not be used as the only imaging measure.

American Heart Association: SPECT cerebral blood flow studies can be used to determine the relative risks of hemorrhage following thrombolysis of acute stroke patients, whatever the time after onset of symptoms (Latchaw, et al., 2003).

American Academy of Pediatrics (AAP): Brain imaging studies and electroencephalography do not show reliable differences between children with Attention-Deficit/Hyperactivity Disorder (ADHD) and controls (AAP, 2000).

Breast (See Scintimammography section below in this document)

Gastrointestinal

Gastrointestinal scintigraphy is performed for numerous indications, including but not limited to: demonstration of salivary gland function and tumors; detection of heterotopic functioning gastric mucosa; demonstration of the presence and site of acute gastrointestinal bleeding; verification of aspiration; evaluation and quantification of transit through and reflux into the esophagus; quantification of the rate of emptying of liquid and/or solid meals from the stomach; transit through the small and large intestine; Meckel’s diverticulum; assessment of peritoneovenous shunt patency; detection of congenital or acquired perforation of the pleuroperitoneal diaphragm; demonstration of the presence or absence of peritoneal loculations prior to intraperitoneal chemotherapy or radiopharmaceutical therapy.

Scintigraphy is used to assess motility disorders of the esophagus and in the investigation of gastro-esophageal reflux disease. It is well-established as the gold standard for the assessment of gastric emptying. Radionuclide studies of gastric emptying and motility are the most physiologic studies available for studying gastric motor function (ACR, 2005; SNM, 2004).

Hepatobiliary

Hepatobiliary scintigraphy is performed for numerous indications, including but not limited to: evaluation of acute cholecystitis; evaluation of common bile duct obstruction; evaluation of right upper quadrant pain or mass; detection of enterogastric reflux; postoperative assessment of biliary enteric bypass; evaluation of hepatic transplant function; evaluation of neonatal hyperbilirubinemia (biliary atresia vs. neonatal hepatitis “syndrome”); and assessment of chronic biliary tract disorders. Hepatobiliary scintigraphy evaluates hepatocellular function and patency of the biliary system by tracing the production and flow of bile from the liver through the biliary system into the small intestine (ACR, 2003; SNM, 2001).

Hepatosplenic

Hepatosplenic scintigraphy (e.g., liver/spleen imaging, liver blood pool imaging, hepatic artery perfusion) is performed for numerous indications, including but not limited to: assessing the size, shape, and position of the liver and spleen; detecting, measuring, and monitoring of masses of either organ; differentiating hepatic

hemangiomas and focal nodular hyperplasia from other liver lesions; measuring and evaluating hepatic function in cases of acute or chronic liver disease; confirming the patency and arterial distribution of hepatic arterial perfusion catheters; identifying functional splenic tissue; and evaluating suspected functional asplenia (ACR, 2005; SNM, 2003).

Infections and Inflammation

Infection or inflammation scintigraphy is performed for numerous indications, including but not limited to: fevers of unknown origin (FUO); disk space and joint space infections; potential infections in immunocompromised patients; tuberculosis; sarcoidosis; pulmonary inflammation from therapeutic or environmental agents; inflammatory bowel disease; osteomyelitis; vascular infections; and evaluation of a painful prosthesis (ACR, 2004; SNM, 2004).

Lung

Pulmonary scintigraphy is performed for numerous indications, including but not limited to: assessing the probability of acute or chronic pulmonary thromboembolic disease; establishing the presence of chronic, unresolved pulmonary emboli; quantifying of differential pulmonary function; evaluating lung transplants; evaluating the effects of congenital heart/lung disease; confirming the presence of bronchopleural fistulae; and evaluating the effects of chronic pulmonary parenchymal disorders, such as cystic fibrosis (ACR, 2004; SNM, 2004).

Parathyroid

Parathyroid scintigraphy is performed for numerous indications, including but not limited to: prior to surgery to facilitate identification and removal of abnormal parathyroid tissue; and subsequent to surgery in patients with persistent or recurrent hyperparathyroidism to detect aberrant or ectopic hyperplastic or neoplastic glands (ACR, 2004; SNM, 2004).

Renal / Urinary

Renal or urinary scintigraphy is performed for numerous indications, including but not limited to: detection, evaluation, and quantification of possible urinary tract obstruction; detection and evaluation of renovascular disease; detection of pyelonephritis and parenchymal scarring; detection and evaluation of functional and anatomic abnormalities of transplanted kidneys; qualitative measurement of renal function; detection of congenital and acquired anatomic renal abnormalities; quantification of certain parameters of renal function, such as effective renal plasma flow, excretory index, glomerular filtration rate, and differential renal function; renal cortical scintigraphy for the detection of the cortical defects of acute pyelonephritis and scarring related to chronic pyelonephritis; ad radionuclide cystography for the detection and evaluation of vesicoureteral reflux and quantification of postvoid bladder residual (ACR, 2003, 2005; SNM, 2003).

Scrotum

Scrotal scintigraphy is performed for differentiation of specific causes of acute and subacute scrotal pain, especially testicular torsion and epididymitis/orchitis. The procedure is not indicated in evaluating cryptorchidism, tumors, or chronic inflammation (ACR, 2004).

Thyroid

Thyroid scintigraphy is performed for numerous indications, including but not limited to: detection of focal and/or global abnormalities of thyroid anatomy, correlation of anatomy with function, detection of aberrant or metastatic functioning thyroid tissue or residual normal tissue after therapy, thyroid uptake in hyperthyroidism, and whole-body imaging for thyroid carcinoma (ACR, 2004; SNM, 1999).

American Association of Clinical Endocrinologists (AACE): The AACE Medical Guideline for clinical practice for the diagnosis and management of thyroid nodules (2006) lists the following indications for thyroid scintigraphy:

- single thyroid nodule or MNG and suppressed TSH level; FNA not necessary
- large MNG, especially with substernal extension
- in search of ectopic thyroid tissue (for example, struma ovarii or sublingual thyroid)
- in subclinical hyperthyroidism to identify occult hyperfunctioning tissue

- some investigators suggest evaluation of follicular neoplasms with a scintiscan to identify a functioning cellular adenoma that may be benign; however, most such nodules are cold on a scintiscan (AACE, 2006)

Tumor

Tumor scintigraphy is performed for numerous indications, including but not limited to: detection of certain primary, metastatic, and recurrent tumors, evaluation of abnormal imaging and nonimaging findings in patients with a history of certain tumors, and reassessment of patients for residual tumor burden after therapy. Specific clinical applications depend on the specific radiopharmaceutical used:

- ⁶⁷Gallium citrate (e.g., Hodgkin's lymphoma, non-Hodgkin's lymphoma, melanoma, lung cancer, and hepatoma, sarcoma, testicular tumors, multiple myeloma, head and neck tumors)
- radioiodinated MIBG (i.e., neuroendocrine tumors)
- radiolabeled monoclonal antibodies (e.g., OncoScint[®], ProstaScint[®], and CEA-SCAN[®])
- ¹¹¹In Octreotide (Octreoscan[®]) (e.g., medullary thyroid carcinoma, gastrinoma, pheochromocytoma, neuroblastoma, and carcinoid)
- NeoTect (Tc-99m Detreotide) (i.e., noninvasive characterization of pulmonary masses)
- Thallium-201 (Thallos Chloride) (e.g., glioblastoma, osteosarcoma, lymphoma, thyroid carcinoma, breast tumors)
- Tc-99m sestamibi (e.g., Miraluma[®]) (ACR, 2005; SNM, 2001)

Cardiac

Cardiac nuclear imaging is used to examine the anatomy and function of the heart. Types of cardiac nuclear imaging studies may include:

- SPECT myocardial perfusion imaging (i.e. SPECT MPI):
- equilibrium radionuclide angiography or ventriculography (i.e., gated blood pool imaging, multiple gated acquisition [MUGA] scanning, ERNA, RVG)
- first-pass radionuclide angiography or ventriculography

SPECT MPI: SPECT MPI scanning provides two critical pieces of clinical information—perfusion, by comparing rest and stress images to look for fixed or reversible defects; and function—by evaluating wall motion, including ejection fraction. SPECT is preferable to planar for myocardial perfusion scintigraphy. SPECT MPI can be performed at rest, or under stress caused by exercise or pharmacologically. Exercise or pharmacological stress Tl-201 or Tc-99m sestamibi SPECT MPI in patients with chest pain yields sensitivity of 85–90% for detecting CAD. Specificity for excluding CAD is about 90% when electrocardiography (ECG)-gated SPECT MPI is used. Exercise SPECT MPI and pharmacological SPECT MPI both yield sensitivities and specificities for CAD detection that are superior to those of exercise ECG testing alone. Stress SPECT MPI can be used for assessment of prognosis of CAD. Data reported from the literature demonstrate that patients with normal regional myocardial perfusion and normal left ventricular function on gated SPECT scans have an excellent prognosis, whereas patients with abnormal scans have an increased rate of cardiac death and nonfatal infarction during follow-up. The incorporation of ECG-gated SPECT imaging into a SPECT acquisition is now standard of care in MPI and is recommended as standard by contemporary guidelines. The addition of left ventricular (LV) function data to the perfusion information provides incremental and independent prognostic information as well as being of practical importance in management decisions. Gated SPECT MPI has also been an important advance in helping to differentiate attenuation artifacts from infarct, as regions with persistent low counts that show normal motion and thickening represent soft tissue artifacts rather than scar. Thus, gated SPECT MPI has improved the specificity of perfusion imaging for ruling out CAD, particularly in women (Zipes, et al., 2005; ASNC, 2007).

ERNA/MUGA: In equilibrium RVG studies, data are recorded in a computer system synchronized with the R wave of the patient's ECG, similar to ECG-gated SPECT. It is used to determine global and regional measures of ventricular function (primarily LV function) at rest and/or during exercise stress or pharmacologic intervention. These measures of ventricular function may include evaluations of ventricular wall motion, EF, and other parameters of systolic and diastolic function. Most commonly, Tc-99m labeling is applied to red blood cells (ASNC, 2008).

First-pass Radionuclide Angiography or Ventriculography: First-pass can also assess LV and right ventricular (RV) function at rest or during stress (evaluation of wall motion, ejection fraction [EF], and other

systolic and diastolic parameters); also to assess and measure left-to-right shunts. First pass studies are very rarely performed any more. They have been replaced by RVG (Zipes, et al., 2005; ASNC, 2006).

Pre-angiography Probability of Coronary Artery Disease (CAD): Physicians should utilize standard methods of risk assessment (e.g., ACC/AHA Multiple-Risk-Factor Assessment [Age, Gender, and Symptoms]; Framingham Risk Score calculation). The ACC (Hendel, et al., 2006) notes that physicians should refer to the ACC/AHA Scientific Statement: Assessment of Cardiovascular Risk by Use of Multiple-Risk-Factor Assessment Equations (Grundy, et al., 1999).

American College of Cardiology Foundation (ACCF)/American Society of Nuclear Cardiology (ASNC): ACCF/ASNC Appropriateness Criteria for SPECT Myocardial Perfusion Imaging (SPECT MPI) complements existing guidelines and performance measures, examining indications for SPECT MPI in the context of scientific evidence, physician judgment, patient specifics and the health care environment (Brindis, et al., 2005). The Working Group devised clinical scenarios to score each indication. They were rated as follows:

- “Appropriate” test for that specific indication (test is generally acceptable and is a reasonable approach for the indication).
- “Uncertain” or possibly appropriate test for that specific indication (Test may be generally acceptable and may be a reasonable approach for the indication. Uncertainty also implies that more research and/or patient information is needed to classify definitively the indication as appropriate and to update the criteria.)
- “Inappropriate” test for that specific indication (Test is not generally acceptable and is not a reasonable approach for the indication.)

The panel of experts from the ACC and ASNC rated 52 indications. The experts ranked 27 indications appropriate (52%) and 12 possibly appropriate or uncertain (23%), recommending reimbursement for those 39 indications (75%). They found 13 indications to be inappropriate (25%) and encourage physicians to prepare to document exceptions when ordering a SPECT MPI for one of those indications.

The ACCF/ASNC appropriateness review of SPECT MPI resulted in the following 52 indications:

Detection of CAD: Symptomatic, Evaluation of Chest Pain Syndrome, SPECT MPI is:

- Appropriate, if intermediate pretest probability of CAD and ECG interpretable and able to exercise
- Appropriate, if intermediate pretest probability of CAD and ECG uninterpretable or unable to exercise
- Appropriate, if high pretest probability of CAD and ECG interpretable and able to exercise
- Appropriate, if high pretest probability of CAD and ECG uninterpretable OR unable to exercise
- Uncertain, if low pretest probability of CAD and ECG uninterpretable or unable to exercise
- Inappropriate, if low pretest probability of CAD and ECG interpretable and able to exercise

Detection of CAD: Symptomatic, Acute Chest Pain (in Reference to Rest Perfusion Imaging), SPECT MPI is:

- Appropriate, if Intermediate pretest probability of CAD and ECG—no ST elevation AND initial cardiac enzymes negative
- Inappropriate, if high pretest probability of CAD and ECG—ST elevation

Detection of CAD: Symptomatic, New-Onset/Diagnosed Heart Failure With Chest Pain Syndrome, SPECT MPI is:

- Appropriate, if intermediate pretest probability of CAD

Detection of CAD: Asymptomatic (Without Chest Pain Syndrome), SPECT MPI is:

- Inappropriate, if low CHD risk (Framingham risk criteria)
- Uncertain, if moderate CHD risk (Framingham)

Detection of CAD: Asymptomatic (Without Chest Pain Syndrome), New-Onset or Diagnosed Heart Failure or LV Systolic Dysfunction Without Chest Pain Syndrome, SPECT MPI is:

- Appropriate, if moderate CHD risk (Framingham) and no prior CAD evaluation AND no planned cardiac catheterization

Detection of CAD: Asymptomatic (Without Chest Pain Syndrome), Valvular Heart Disease Without Chest Pain Syndrome, SPECT MPI is:

- Uncertain, if moderate CHD risk (Framingham) and to help guide decision for invasive studies

Detection of CAD: Asymptomatic (Without Chest Pain Syndrome), New-Onset Atrial Fibrillation, SPECT MPI is:

- Uncertain, if low CHD risk (Framingham) and part of the evaluation
- Appropriate, if high CHD risk (Framingham) and part of the evaluation

Detection of CAD: Asymptomatic (Without Chest Pain Syndrome), Ventricular Tachycardia, SPECT MPI is:

- Appropriate, if moderate to high CHD risk (Framingham)

Risk Assessment: General and Specific Patient Populations, Asymptomatic, SPECT MPI is:

- Inappropriate, if low CHD risk (Framingham)
- Uncertain, if moderate CHD risk (Framingham)
- Appropriate, if moderate to high CHD risk (Framingham) and high-risk occupation (e.g., airline pilot)
- Appropriate, if high CHD risk (Framingham)

Risk Assessment With Prior Test Results, Asymptomatic OR Stable Symptoms, Normal Prior SPECT MPI Study, SPECT MPI is:

- Inappropriate, if normal initial RNI study and high CHD risk (Framingham) and annual SPECT MPI study
- Appropriate, if normal initial RNI study and high CHD risk (Framingham) and repeat SPECT MPI study after two years or greater

Risk Assessment With Prior Test Results, Asymptomatic OR Stable Symptoms, Abnormal Catheterization OR Prior SPECT MPI Study, SPECT MPI is:

- Inappropriate, if known CAD on catheterization OR prior SPECT MPI study in patients who have not had revascularization procedure and symptomatic OR stable symptoms and less than one year to evaluate worsening disease
- Appropriate, if known CAD on catheterization or prior SPECT MPI study and in patients who have not had revascularization procedure and greater than or equal to two years to evaluate worsening disease

Risk Assessment With Prior Test Results, Worsening Symptoms, Abnormal Catheterization OR Prior SPECT MPI Study, SPECT MPI is:

- Appropriate, if known CAD on catheterization OR prior SPECT MPI study

Risk Assessment With Prior Test Results, Asymptomatic, CT Coronary Angiography, SPECT MPI is:

- Uncertain, if stenosis of unclear significance

Risk Assessment With Prior Test Results Asymptomatic, Prior Coronary Calcium Agatston Score, SPECT MPI is:

- Appropriate, if Agatston score greater than or equal to 400
- Inappropriate, if Agatston score less than 100

Risk Assessment With Prior Test Results, UA/NSTEMI, STEMI, or Chest Pain Syndrome, Coronary Angiogram, SPECT MPI is:

- Appropriate, if stenosis of unclear significance

Risk Assessment With Prior Test Results, Duke Treadmill Score, SPECT MPI is:

- Appropriate, if intermediate Duke treadmill score and Intermediate CHD risk (Framingham)

Risk Assessment: Preoperative Evaluation for Non-Cardiac Surgery, Low-Risk Surgery, SPECT MPI is:

- Inappropriate, if Preoperative evaluation for non-cardiac surgery risk assessment

Risk Assessment: Preoperative Evaluation for Non-Cardiac Surgery, Intermediate-Risk Surgery, SPECT MPI is:

- Inappropriate, if Minor to intermediate perioperative risk predictor and normal exercise tolerance (greater than or equal to 4 METS)
- Appropriate, if Intermediate perioperative risk predictor or poor exercise tolerance (less than four METS)

Risk Assessment: Preoperative Evaluation for Non-Cardiac Surgery, High-Risk Surgery, SPECT MPI is:

- Uncertain, if minor perioperative risk predictor an normal exercise tolerance (greater than or equal to four METS)
- Appropriate, if minor perioperative risk predictor and poor exercise tolerance (less than four METS)
- Inappropriate, if asymptomatic up to one year post-normal catheterization, noninvasive test, or previous revascularization

Risk Assessment: Following Acute Coronary Syndrome STEMI—Hemodynamically Stable, SPECT MPI is:

- Appropriate, if Thrombolytic therapy administered and not planning to undergo catheterization

Risk Assessment: Following Acute Coronary Syndrome STEMI—Hemodynamically Unstable, Signs of Cardiogenic Shock, or Mechanical Complications, SPECT MPI is:

- Inappropriate, if Thrombolytic therapy administered

Risk Assessment: Following Acute Coronary Syndrome UA/NSTEMI—No Recurrent Ischemia or No Signs of HF, SPECT MPI is:

- Appropriate, if not planning to undergo early catheterization

Risk Assessment: Following Acute Coronary Syndrome ACS—Asymptomatic Post Revascularization (PCI or CABG), SPECT MPI is:

- Inappropriate, if Routine evaluation prior to hospital discharge

Risk Assessment: Post-Revascularization (PCI or CABG), Symptomatic, SPECT MPI is:

- Appropriate, if Evaluation of chest pain syndrome

Risk Assessment: Post-Revascularization (PCI or CABG), Asymptomatic, SPECT MPI is:

- Uncertain, if asymptomatic prior to previous revascularization and less than five years after CABG
- Uncertain, if symptomatic prior to previous revascularization and less than five years after CABG
- Appropriate, if asymptomatic prior to previous revascularization and greater than or equal to five years after CABG
- Appropriate, if symptomatic prior to previous revascularization an greater than or equal to five years after CABG
- Uncertain, if asymptomatic prior to previous revascularization and less than two years after PCI
- Inappropriate, if symptomatic prior to previous revascularization and less than two years after PCI
- Uncertain, if asymptomatic prior to previous revascularization and greater than or equal to two years after PCI
- Uncertain, if symptomatic prior to previous revascularization and greater than or equal to two years after PCI

Assessment of Viability/Ischemia, Ischemic Cardiomyopathy (includes SPECT Imaging for Wall Motion and Ventricular Function), SPECT MPI is:

- Appropriate, if Known CAD on catheterization and patient eligible for revascularization

Evaluation of Ventricular Function, Evaluation of Left Ventricular Function, SPECT MPI is:

- Appropriate, if non-diagnostic echocardiogram

Evaluation of Ventricular Function, Use of Potentially Cardiotoxic Therapy (e.g., Doxorubicin), SPECT MPI is:

- Appropriate, if baseline and serial measurements

American Society of Nuclear Cardiology (ASNC): The ASNC Information Statement “ASNC review of the ACCF/ASNC appropriateness criteria for single-photon emission computed tomography myocardial perfusion imaging (SPECT MPI)” (Ward, et al., 2007) requests updating of the ACC SPECT Appropriateness Criteria (Brindis, et al., 2005), suggesting the addition of 6 new indications and the modification of the definitions for “chest pain syndrome” and “CHD high risk.”

ASNC’s “Imaging Guidelines for Nuclear Cardiology Procedures” (2008) addresses some of the following points:

MPI SPECT is preferable to planar for myocardial perfusion scintigraphy. Myocardial Perfusion SPECT evaluates regional myocardial perfusion and function. The majority of stress myocardial perfusion radionuclide studies currently are acquired as gated SPECT data. However, there is mounting evidence that the information content of the post-stress acquisition may be different from that of the resting data, most likely due to post-ischemic stunning of myocardium. Providing that there is adequate count density, particularly with regard to the lower dose acquisitions, both stress and rest SPECT perfusion studies may be acquired as gated data sets. Because of the substantial benefit of the information obtained, gated studies of ventricular function should be a routine part of myocardial perfusion SPECT. Exercise is the preferred stress modality in patients who are able to exercise to an adequate workload (at least 85% of age-adjusted maximal predicted heart rate and five estimated metabolic equivalents of exercise (METs) (ASNC, 2007).

Exercise stress test indications:

- detection of obstructive CAD in:
 - patients with an intermediate pretest probability of CAD based on age, gender and symptoms, and in
 - patients with high risk factors for CAD (e.g. diabetes mellitus, peripheral or cerebral vascular disease).
- risk stratification of post-myocardial infarction patients before discharge (submaximal test at 4–6 days), early (symptom limited at 14–21 days) or late (symptom limited at 3–6 weeks) after discharge.
- risk stratification of patients with chronic stable CAD into a low-risk category that can be managed medically, or into a high-risk category that should be considered for coronary revascularization.
- risk stratification of low-risk acute coronary syndrome patients (without active ischemia and/or heart failure 6–12 hours after presentation), and of intermediate-risk acute coronary syndrome patients 1–3 days after presentation (without active ischemia and/or heart failure symptoms).
- risk stratification before noncardiac surgery in patients with known CAD or those with high-risk factors for CAD.
- to evaluate the efficacy of therapeutic interventions (anti-ischemic drug therapy or coronary revascularization) and in tracking subsequent risk based on serial changes in myocardial perfusion in patients with known CAD (ASNC, 2008)

Absolute contraindications:

- high-risk unstable angina. However, patients with suspected unstable angina at presentation, who are otherwise stable and pain-free, can undergo exercise stress testing.
- decompensated or inadequately controlled congestive heart failure
- uncontrolled hypertension (blood pressure > 200/110 mm of Hg)
- uncontrolled cardiac arrhythmias (causing symptoms or hemodynamic compromise)
- severe symptomatic aortic stenosis
- acute pulmonary embolism
- acute myocarditis or pericarditis
- acute aortic dissection
- severe pulmonary hypertension
- acute myocardial infarction (< 4 days)
- acutely ill for any reason (ASNC, 2008)

Relative contraindications:

- known left main coronary artery stenosis
- moderate aortic stenosis
- hypertrophic obstructive cardiomyopathy or other forms of outflow tract obstruction
- significant tachyarrhythmias or bradyarrhythmias
- high-degree atrioventricular block
- electrolyte abnormalities
- mental or physical impairment leading to inability to exercise adequately
- if combined with imaging, patients with complete left bundle branch block (LBBB), permanent pacemakers and ventricular pre-excitation (W-P-W) should preferentially undergo pharmacological vasodilator stress test (not dobutamine stress test) (ASNC, 2008)

Exercise stress testing has a lower diagnostic value in patients who cannot achieve an adequate heart rate and blood pressure response due to a noncardiac physical limitation such as pulmonary, peripheral vascular, musculoskeletal abnormalities or due to lack of motivation. These patients should be considered for pharmacologic stress with myocardial perfusion imaging (ASNC, 2008).

Equilibrium Radionuclide Angiocardigraphy (ERNA)—Planar ERNA is used to determine global and regional measures of ventricular function (primarily LV function) at rest and/or during exercise stress or pharmacologic intervention. These measures of ventricular function may include evaluations of ventricular wall motion, ejection fraction (EF), and other parameters of systolic and diastolic function. SPECT ERNA is used to determine global and regional measures of ventricular function (primarily LV function) at rest and/or during pharmacologic intervention. These measures of ventricular function may include evaluations of ventricular wall motion, EF, and other parameters of systolic and diastolic function. The following sections provide a technical description of the techniques to acquire and process the data necessary to assess parameters of ventricular performance (ASNC, 2008).

First-Pass Radionuclide Angiography (FPRNA)—FPRNA is performed to assess LV and right ventricular (RV) function at rest or during stress (evaluation of wall motion, EF, and other systolic and diastolic parameters); and to assess and measure left-to-right shunts (2006).

American College of Cardiology/American Heart Association/European Society of Cardiology (ACC/AHA/ESC): The ACC/AHA/ESC 2006 Guidelines for Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death states:

Regarding left ventricular function and imaging, MRI, cardiac computed tomography (CT), or radionuclide angiography can be useful in patients with ventricular arrhythmias when echocardiography does not provide accurate assessment of LV and RV function and/or evaluation of structural changes.

Myocardial perfusion SPECT using exercise or pharmacological agents is applicable for a selected group of patients who are suspected of having ventricular arrhythmias triggered by ischemia and who are unable to exercise or have resting ECG abnormalities that limit the accuracy of ECG for ischemia detection. Myocardial perfusion SPECT can also be used to assess viability in patients with LV dysfunction due to prior MI. Accurate quantification of LVEF is possible with gated radionuclide angiography (multiple gated acquisition scan) and thus this technique may be helpful in patients for whom this measurement is not available with echocardiography.

The American College of Cardiology key data elements and definitions for measuring the clinical management and outcomes of patients with acute coronary syndromes (Cannon, et al., 2001) provides the following definitions for ischemia results of stress test (whether an exercise tolerance or pharmacological):

- Positive: On an exercise tolerance test, the patient developed either:
 - Both ischemic discomfort and ST shift greater than or equal to 1 mm (0.1 mV) (horizontal or downsloping) or
 - New ST shift greater than or equal to 2 mm (0.2 mV) (horizontal or downsloping) believed to represent ischemia even in the absence of ischemic discomfort

If the patient had an equivalent type of exercise test (e.g., exercise thallium or MIBI test, stress echocardiography, or dipyridamole, thallium, or adenosine radioisotope scan) that showed definite evidence of ischemia (e.g., an area of clear reversible ischemia), this should be considered a positive test.

- Negative: No evidence of ischemia (i.e., no typical angina pain and no ST shifts)
- Equivocal: Either:
 - Typical ischemic pain but no ST shift greater than or equal to 1 mm (0.1 mV) (horizontal or downsloping) or
 - ST shift of 1 mm (0.1 mV) (horizontal or downsloping) but no ischemic discomfort

Multiple Myeloma

Using complete clinical and biochemical evaluations as the gold standard, the sensitivity of 99mTc-MIBI was 77% (Mele, et al., 2007). Tc-99m bone scanning is inferior to conventional radiography and should not be routinely used, as abnormalities on bone scan only correlate with sites of blastic change and thus lytic disease

can be missed (Abeloff, et al., 2004). “Bone scintigraphy has no place in the routine investigation of myeloma, as CT is more sensitive” (Smith, et al., 2006).

Scintimammography/ Breast-specific Gamma Imaging (BSGI)

Scintigraphy of the breast is a nuclear imaging procedure, also known as scintimammography, and includes planar and/or SPECT. Scintimammography is performed with a gamma camera after intravenous administration of radionuclide tracers and provides physiologic data. Scintimammography has been proposed to be used adjunctively with mammography as a method to improve patient selection for breast biopsy in individuals with suspicious/nondiagnostic mammography results or palpable breast lesions.

Miraluma[®], a 99m Tc sestamibi kit, is manufactured by Bristol-Myers Squibb Medical Imaging, Inc. (New York, NY) and is FDA approved for planar imaging as a second-line diagnostic drug after mammography to assist in the evaluation of breast lesions in patients with an abnormal mammogram or a palpable breast mass. Miraluma[®] is not indicated for breast cancer screening, to confirm the presence or absence of malignancy, and it is not an alternative to biopsy.

One of the largest scintimammography studies conducted was a multicenter prospective cohort clinical trial evaluating the efficacy of scintimammography with 99m Tc sestamibi for the diagnosis of breast cancer (Sampalis, et al., 2003). All 1243 women underwent mammography and scintimammography. The histopathology showed malignant breast disease for 201 (16%) of the patients in the sample. Compared to pathology results, scintimammography results showed a sensitivity of 93%, specificity of 87%, PPV of 58%, NPV of 98%, and an accuracy of 88%.

Scintimammography use may involve difficulty in spatially correlating images obtained from the large gamma cameras and a lack of sensitivity for subcentimeter lesions. Breast-specific gamma imaging (BSGI) uses a dedicated small field-of-view system proposed to detect and localize small lesions (Zhou, et al., 2008). Brem et al. (2008) conducted a retrospective review, comparing pathology results to 99m Tc sestamibi scintimammography results. Brem et al. utilized a small-field-of-view breast-specific gamma camera in 146 patients. A total of 167 lesions underwent biopsy, of which 83 were malignant. BSGI results were sensitivity 96.4%, specificity 59.5%, positive predictive value 68.8% and negative predictive value 94.3%.

Preliminary BSGI studies have demonstrated a high sensitivity and moderate specificity to help detect breast cancers. Adequate comparative data with other breast imaging modalities including breast MRI are needed. It is not yet known whether BSGI will improve cancer detection relative to existing imaging modalities. Additional studies are needed with larger sample sizes to further evaluate BSGI as an adjunctive breast imaging modality. Future studies are needed to validate its impact on patient survival, by evaluating its use in specific patient population subsets, with various radiopharmaceuticals, and in conjunction with and compared to other adjunctive imaging techniques such as ultrasound and MRI.

American Cancer Society (ACS): The ACS guidelines for breast cancer screening state that potential new technologies are being investigated primarily as diagnostic adjuncts to mammography. Some, such as scintimammography, positron emission tomography, and electrical impedance imaging, have received FDA approval as diagnostic adjuncts to mammography. None of these new technologies has successfully undergone clinical testing that would justify its use in screening for breast cancer. Other technologies on the list are still being investigated in the laboratory setting and are not yet ready to begin clinical evaluation (Smith, et al., 2003). On its public website, the ACS states that scintimammography “cannot distinguish cancer from non-cancerous lesions as accurately as routine mammography, and is not used as a screening test. Some radiologists believe it is sometimes useful in looking at suspicious areas found by regular mammograms. However, studies of the test have yielded varying results. The general consensus is that this test is less able to detect cancer than mammography, especially when the tumor is still small and most likely to be curable. For these reasons, the exact role of this test remains unclear. Current research is aimed at improving the technology and evaluating its use in specific situations such as in the dense breasts of younger women” (September 2007).

American College of Radiology (ACR): The American College of Radiology (ACR) practice guideline for the performance of tumor scintigraphy states that Tl 201 and ^{99m}Tc sestamibi imaging may be useful in helping to differentiate benign from malignant breast masses.

Society of Nuclear Medicine (SNM): The Society of Nuclear Medicine (SNM, 2004) procedure guideline for breast scintigraphy states “no consensus has been reached regarding the utility of SPECT breast imaging; therefore, no parameters for SPECT imaging or processing are included.” It states the sensitivity, specificity, and accuracy of this test depend upon several factors, including the size of the breast tumor being imaged. The sensitivity of this test for tumors smaller than one centimeter (cm) in diameter is very low with nuclear medicine cameras in current use. It does list the following “examples of clinical or research applications:”

- to evaluate breast cancer in patients in whom mammography is nondiagnostic, equivocal, or difficult to interpret (e.g., the presence of scar tissue, mammographically dense breast tissue, implants, or severe dysplastic disease)
- to assist in identifying multicentric and multifocal carcinomas in patients with tissue diagnosis of breast cancer
- may be useful to evaluate the effectiveness of neoadjuvant chemotherapy for breast carcinoma

The SNM lists the following as “issues requiring further clarification:”

- Further study is needed to determine the characteristics of the population most likely to benefit from breast scintigraphy.
- No consensus has been reached as to the efficacy of routine SPECT imaging.
- The usefulness of other radiopharmaceuticals for breast scintigraphy has not been established.
- The usefulness of breast scintigraphy for all indications included here requires further study.

Summary

Evidence in the published, peer-reviewed scientific literature, textbooks, and current clinical practice support nuclear imaging, including single-photon emission computed tomography (SPECT) as a proven and well-established imaging modality. Some studies have demonstrated that the information obtained by SPECT/CT is more accurate in evaluating patients than that obtained from either SPECT or CT alone. Specific clinical applications depend on the specific radiopharmaceutical being used. Nuclear imaging including SPECT may be utilized when other imaging studies are inconclusive or contraindicated. Along with oncologic and cardiac indications, nuclear imaging with SPECT has proven helpful in the management of bone, brain, gastrointestinal, lung, endocrine and renal and urinary disorders. SPECT has proven helpful in patients with suspected or known infection and inflammatory processes.

Nuclear imaging has not been proven to be of diagnostic value in chronic fatigue syndrome, multiple myeloma, neuropsychiatric disorders, scrotal tumors, chronic scrotal inflammation or cryptorchidism, or for screening for coronary artery disease.

There is insufficient evidence in the published peer-reviewed scientific literature supporting the diagnostic utility of scintimammography including breast-specific gamma imaging (BSGI).

Coding/Billing Information

Note: This list of codes may not be all-inclusive.

Covered when medically necessary:

CPT®* Codes	Description
78000	Thyroid uptake; single determination
78001	Thyroid uptake; multiple determinations
78003	Thyroid uptake; stimulation, suppression or discharge (not including initial uptake studies)
78006	Thyroid imaging, with uptake; single determination
78007	Thyroid imaging, with uptake; multiple determinations
78010	Thyroid imaging; only
78011	Thyroid imaging; with vascular flow
78015	Thyroid carcinoma metastases imaging; limited area (e.g., neck and chest only)
78016	Thyroid carcinoma metastases imaging; with additional studies (e.g., urinary recovery)
78018	Thyroid carcinoma metastases imaging; whole body

78020	Thyroid carcinoma metastases uptake
78070	Parathyroid imaging
78075	Adrenal imaging, cortex and/or medulla
78102	Bone marrow imaging; limited area
78103	Bone marrow imaging; multiple areas
78104	Bone marrow imaging; whole body
78110	Plasma volume, radiopharmaceutical volume-dilution technique (separate procedure); single sampling
78111	Plasma volume, radiopharmaceutical volume-dilution technique (separate procedure); multiple samplings
78120	Red cell volume determination (separate procedure); single sampling
78121	Red cell volume determination (separate procedure); multiple samplings
78122	Whole blood volume determination, including separate measurement of plasma volume and red cell volume (radiopharmaceutical volume-dilution technique)
78130	Red cell survival study;
78135	Red cell survival study; differential organ/tissue kinetics, (e.g., splenic and/or hepatic sequestration)
78140	Labeled red cell sequestration, differential organ/tissue, (e.g., splenic and/or hepatic)
78185	Spleen imaging only, with or without vascular flow
78190	Kinetics, study of platelet survival, with or without differential organ/tissue localization
78191	Platelet survival study
78195	Lymphatics and lymph nodes imaging
78201	Liver imaging; static only
78202	Liver imaging; with vascular flow
78205	Liver imaging (SPECT)
78206	Liver imaging (SPECT); with vascular flow
78215	Liver and spleen imaging; static only
78216	Liver and spleen imaging; with vascular flow
78220	Liver function study with hepatobiliary agents, with serial images
78223	Hepatobiliary ductal system imaging, including gallbladder, with or without pharmacologic intervention, with or without quantitative measurement of gallbladder function
78230	Salivary gland imaging
78231	Salivary gland imaging; with serial images
78232	Salivary gland function study
78258	Esophageal motility
78261	Gastric mucosa imaging
78262	Gastroesophageal reflux study
78264	Gastric emptying study
78270	Vitamin B-12 absorption study (e.g., Schilling test); without intrinsic factor
78271	Vitamin B-12 absorption study (e.g., Schilling test); with intrinsic factor
78272	Vitamin B-12 absorption studies combined, with and without intrinsic factor
78278	Acute gastrointestinal blood loss imaging
78282	Gastrointestinal protein loss
78290	Intestine imaging (e.g., ectopic gastric mucosa, Meckel's localization, volvulus)
78291	Peritoneal-venous shunt patency test
78300	Bone and/or joint imaging; limited area
78305	Bone and/or joint imaging; multiple areas
78306	Bone and/or joint imaging; whole body
78315	Bone and/or joint imaging; three phase study
78320	Bone and/or joint imaging; tomographic (SPECT)
78414	Determination of central c-v hemodynamics (non-imaging) (e.g., ejection fraction with probe technique) with or without pharmacologic intervention or exercise, single or multiple determinations
78428	Cardiac shunt detection
78445	Non-cardiac vascular flow imaging (i.e., angiography, venography)

78457	Venous thrombosis imaging, venogram; unilateral
78458	Venous thrombosis imaging, venogram; bilateral
78460	Myocardial perfusion imaging; (planar) single study, at rest or stress (exercise and/or pharmacologic), with or without quantification
78461	Myocardial perfusion imaging; multiple studies, (planar) at rest and/or stress (exercise and/or pharmacologic), and redistribution and/or rest injection, with or without quantification
78464	Myocardial perfusion imaging; tomographic (SPECT), single study (including attenuation correction when performed), at rest or stress (exercise and/or pharmacologic), with or without quantification
78465	Myocardial perfusion imaging; tomographic (SPECT), multiple studies, (including attenuation correction when performed), at rest and/or stress (exercise and/or pharmacologic) and redistribution and/or rest injection, with or without quantification
78466	Myocardial imaging, infarct avid, planar; qualitative or quantitative
78468	Myocardial imaging, infarct avid, planar; with ejection fraction by first pass technique
78469	Myocardial imaging, infarct avid, planar; tomographic SPECT with or without quantification
78472	Cardiac blood pool imaging, gated equilibrium; planar, single study at rest or stress (exercise and/or pharmacologic), wall motion study plus ejection fraction, with or without additional quantitative processing
78473	Cardiac blood pool imaging, gated equilibrium; multiple studies, wall motion study plus ejection fraction, at rest and stress (exercise and/or pharmacologic), with or without additional quantification
78478	Myocardial perfusion study with wall motion, qualitative or quantitative study (List separately in addition to code for primary procedure)
78480	Myocardial perfusion study with ejection fraction (List separately in addition to code for primary procedure)
78481	Cardiac blood pool imaging, (planar), first pass technique; single study, at rest or with stress (exercise and/or pharmacologic), wall motion study plus ejection fraction, with or without quantification
78483	Cardiac blood pool imaging, (planar), first pass technique; multiple studies, at rest and with stress (exercise and/ or pharmacologic), wall motion study plus ejection fraction, with or without quantification
78494	Cardiac blood pool imaging, gated equilibrium, SPECT, at rest, wall motion study plus ejection fraction, with or without quantitative processing
78496	Cardiac blood pool imaging, gated equilibrium, single study, at rest, with right ventricular ejection fraction by first pass technique (List separately in addition to code for primary procedure)
78580	Pulmonary perfusion imaging, particulate
78584	Pulmonary perfusion imaging, particulate, with ventilation; single breath
78585	Pulmonary perfusion imaging, particulate, with ventilation; rebreathing and washout, with or without single breath
78586	Pulmonary ventilation imaging, aerosol; single projection
78587	Pulmonary ventilation imaging, aerosol; multiple projections (e.g., anterior, posterior, lateral views)
78588	Pulmonary perfusion imaging, particulate, with ventilation imaging, aerosol, one or multiple projections
78591	Pulmonary ventilation imaging, gaseous, single breath, single projection
78593	Pulmonary ventilation imaging, gaseous, with rebreathing and washout with or without single breath; single projection
78594	Pulmonary ventilation imaging, gaseous, with rebreathing and washout with or without single breath; multiple projections (e.g., anterior, posterior, lateral views)
78596	Pulmonary quantitative differential function (ventilation/perfusion) study
78600	Brain imaging, less than 4 static views
78601	Brain imaging, less than 4 static views; with vascular flow
78605	Brain imaging, minimum 4 static views

78606	Brain imaging, minimum 4 static views; with vascular flow
78607	Brain imaging, tomographic (SPECT)
78610	Brain imaging, vascular flow only
78615	Cerebral vascular flow (Code deleted 12/31/07)
78630	Cerebrospinal fluid flow, imaging (not including introduction of material); cisternography
78635	Cerebrospinal fluid flow, imaging (not including introduction of material); ventriculography
78645	Cerebrospinal fluid flow, imaging (not including introduction of material); shunt evaluation
78647	Cerebrospinal fluid flow, imaging (not including introduction of material); tomographic (SPECT)
78650	Cerebrospinal fluid leakage detection and localization
78660	Radiopharmaceutical dacryocystography
78700	Kidney imaging morphology
78701	Kidney imaging morphology; with vascular flow
78707	Kidney imaging morphology; with vascular flow and function; single study without pharmacological intervention
78708	Kidney imaging morphology; with vascular flow and function; single study, with pharmacological intervention (e.g., angiotensin converting enzyme inhibitor and/or diuretic)
78709	Kidney imaging morphology; with vascular flow and function; multiple studies, with and without pharmacological intervention (e.g., angiotensin converting enzyme inhibitor and/or diuretic)
78710	Kidney imaging morphology, tomographic (SPECT)
78725	Kidney function study, non-imaging radioisotopic study
78730	Urinary bladder residual study. (List separately in addition to code for primary procedure)
78740	Ureteral reflux study (radiopharmaceutical voiding cystogram)
78761	Testicular imaging; with vascular flow
78800	Radiopharmaceutical localization of tumor or distribution of radiopharmaceutical agent(s); limited area
78801	Radiopharmaceutical localization of tumor or distribution of radiopharmaceutical agent(s); multiple areas
78802	Radiopharmaceutical localization of tumor or distribution of radiopharmaceutical agent(s); whole body, single day imaging
78803	Radiopharmaceutical localization of tumor or distribution of radiopharmaceutical agent(s); tomographic (SPECT)
78804	Radiopharmaceutical localization of tumor or distribution of radiopharmaceutical agent(s); whole body, requiring two or more days imaging
78805	Radiopharmaceutical localization of inflammatory process; limited area
78806	Radiopharmaceutical localization of inflammatory process; whole body
78807	Radiopharmaceutical localization of inflammatory process; tomographic (SPECT)
78890	Generation of automated data: interactive process involving nuclear physician and/or allied health professional personnel; simple manipulations and interpretation, not to exceed 30 minutes
78891	Generation of automated data: interactive process involving nuclear physician and/or allied health professional personnel; complex manipulations and interpretation, exceeding 30 minutes

ICD-9-CM Diagnosis Codes	Description
	Multiple/varied codes

Experimental/Investigational/Unproven/Not Covered:

HCPCS Codes	Description
S8080 [†]	Scintimammography (radioimmunosintigraphy of the breast), unilateral, including supply of radiopharmaceutical

[†]Note: Experimental, investigational, unproven and not covered for any diagnosis when used to report scintimammography, including breast-specific gamma imaging (BSGI).

ICD-9-CM Diagnosis Codes	Description
186.9	Malignant neoplasm of other and unspecified testis
203.00-203.01	Multiple myeloma
222.4	Benign neoplasm of scrotum
604.9	Other orchitis, epididymitis, and epididymo-orchitis, without mention of abscess
608.4	Other inflammatory disorder of male genital organs
752.51	Undescended testis
780.71	Chronic fatigue syndrome
	Multiple/varied codes

*Current Procedural Terminology (CPT®) © 2007 American Medical Association: Chicago, IL.

References

1. Abeloff MD, Armitage JO, Niederhuber JE, McKenna WG., editors. Abeloff: Clinical Oncology, 3rd ed., Orlando: Churchill Livingstone, Inc.; 2004.
2. Aberle DR, Chiles C, Gatsonis C, Hillman BJ, Johnson CD, American College of Radiology Imaging Network. Imaging and cancer: research strategy of the American College of Radiology Imaging Network. Radiology. 2005 Jun;235(3):741-51.
3. Abidov A, Hachamovitch R, Rozanski A, Hayes SW, Santos MM, Sciammarella MG, et al. Prognostic implications of atrial fibrillation in patients undergoing myocardial perfusion single-photon emission computed tomography. J Am Coll Cardiol. 2004 Sep 1;44(5):1062-70.
4. American Academy of Neurology Summary of Evidence-based Guideline for Clinicians. Parkinson Disease. Accessed August 2008. Available at URL address: http://aan.com/professionals/practice/guidelines/PD_Clinicians_Sum.pdf
5. American Academy of Neurology Practice parameter: Screening and diagnosis of autism. August 2000. Reaffirmed July 2006. Accessed July 2008. Available at URL address: <http://www.aan.com/go/practice/guidelines>
6. American Academy of Pediatrics, Rose SR; Section on Endocrinology and Committee on Genetics, American Thyroid Association, Brown RS; Public Health Committee, Lawson Wilkins Pediatric Endocrine Society, et al. Update of newborn screening and therapy for congenital hypothyroidism. Pediatrics. 2006 Jun;117(6):2290-303.
7. American Academy of Pediatrics. Practice Guideline Diagnosis and Evaluation of the Child with Attention-Deficit/Hyperactivity Disorder. May 2000. Accessed August 2008. Available at URL address: <http://aappolicy.aappublications.org/>
8. American Association of Clinical Endocrinologists. Medical guidelines for clinical practice for the evaluation and treatment of hyperthyroidism and hypothyroidism. Amended 2006. Accessed August 2008. Available at URL address: <http://www.aace.com/pub/guidelines/>

9. American Association of Clinical Endocrinologists. Medical guidelines for clinical practice for the diagnosis and management of thyroid nodules. 2006. Accessed August 2008. Available at URL address: <http://www.aace.com/pub/guidelines/>
10. American Association of Clinical Endocrinologists and the American Association of Endocrine Surgeons position statement on the diagnosis and management of primary hyperparathyroidism. 2005. Accessed August 2008. Available at URL address: <http://www.aace.com/pub/pdf/guidelines/HyperparathyroidPS.pdf>
11. American Association of Clinical Endocrinologists and the American Association of Endocrine Surgeons Medical/Surgical Guideline for Clinical Practice: Management of Thyroid Carcinoma. 2001. Accessed August 2008. Available at URL address: <http://www.aace.com/pub/guidelines/>
12. American Cancer Society. Detailed Guide: Breast Cancer: What's New in Breast Cancer Research and Treatment? Revised 9/13/2007. Accessed September 2008. Available at URL address: http://www.cancer.org/docroot/CRI/content/CRI_2_4_6X_Whats_new_in_breast_cancer_research_and_treatment_5.asp
13. American Cancer Society. Mammograms and Other Breast Imaging Procedures. Revised 9/13/2007. Accessed September 2008. Available at URL address: http://www.cancer.org/docroot/CRI/content/CRI_2_6X_Mammography_and_other_Breast_Imaging_Procedures_5.asp
14. American College of Radiology Practice Guideline for the performance of cardiac scintigraphy. Effective 10/1/2004. Accessed July 2008. Available at URL address: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/cardiac_scintigraphy.aspx
15. American College of Radiology Practice Guideline for the performance of gastrointestinal scintigraphy. Effective 10/1/2005. Accessed July 2008. Available at URL address: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/gi_scintigraphy.aspx
16. American College of Radiology Practice Guideline for the performance of adult and pediatric hepatobiliary scintigraphy. Effective 10/1/2003. Accessed July 2008. Available at URL address: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/hepatobiliary_scintigraphy.aspx
17. American College of Radiology Practice Guideline for the performance of scintigraphy for infections and inflammation. Effective 10/1/2004. Accessed July 2008. Available at URL address: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/infections_inflammation.aspx
18. American College of Radiology Practice Guideline for the performance of liver/spleen scintigraphy. Effective 10/1/2005. Accessed July 2008. Available at URL address: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/liver_spleen_scintigraphy.aspx
19. American College of Radiology Practice Guideline for the performance of parathyroid scintigraphy. Effective 10/1/2004. Accessed July 2008. Available at URL address: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/parathyroid_scintigraphy.aspx
20. American College of Radiology Practice Guideline for the performance of pulmonary scintigraphy. Effective 10/1/2004. Accessed July 2008. Available at URL address: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/pulmonary_scintigraphy.aspx
21. American College of Radiology Practice Guideline for the performance of adult and pediatric radionuclide cystography. Effective 10/1/2005. Accessed July 2008. Available at URL address:

http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/radionuclide_cystography.aspx

22. American College of Radiology Practice Guideline for the performance of adult and pediatric renal scintigraphy. Effective 10/1/2003. Accessed July 2008. Available at URL address:
http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/renal_scintigraphy.aspx
23. American College of Radiology Practice Guideline for the performance of scrotal scintigraphy. Effective 10/1/2004. Accessed July 2008. Available at URL address:
http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/scrotal_scintigraphy.aspx
24. American College of Radiology Practice Guideline for the performance of single photon emission computed tomography (SPECT) brain perfusion and brain death studies. Effective 10/1/2007. Accessed July 2008. Available at URL address:
http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/ct_spect_brain_perfusion.aspx
25. American College of Radiology Practice Guideline for the performance of adult and pediatric skeletal scintigraphy (bone scan). Effective 10/1/2007. Accessed July 2008. Available at URL address:
http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/skeletal_scintigraphy.aspx
26. American College of Radiology Practice Guideline for the performance of thyroid scintigraphy and uptake measurements. Effective 10/1/2004. Accessed July 2008. Available at URL address:
http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/thyroid_scintigraphy.aspx
27. American College of Radiology Practice Guideline for the performance of tumor scintigraphy (with Gamma cameras). Effective 10/1/2005. Accessed July 2008. Available at URL address:
http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/nuc_med/tumor_scintigraphy.aspx
28. American Psychiatric Association Practice Guideline. Treatment of Patients With Alzheimer's Disease and Other Dementias. October 2007. Accessed July 2008. Available at URL address:
http://www.psych.org/psych_pract/treatg/pg/prac_guide.cfm
29. American Psychiatric Association. Practice Guideline for the Psychiatric Evaluation of Adults, Second Edition. May 2006. Accessed July 2008. Available at URL address:
http://www.psych.org/psych_pract/treatg/pg/prac_guide.cfm
30. American Society of Nuclear Cardiology. Imaging Guidelines for Nuclear Cardiology Procedures. Revised 2008. Accessed August 2008. Available at URL address: http://www.asnc.org/section_73.cfm
<http://www.asnc.org/imageuploads/ImagingGuidelinesInstrumentation111607.pdf>
<http://www.asnc.org/imageuploads/RadiationDosimetry-August2008.pdf>
31. Ashwal S, Russman BS, Blasco PA, Miller G, Quality Standards Subcommittee of the American Academy of Neurology; Practice Committee of the Child Neurology Society. Practice parameter: diagnostic assessment of the child with cerebral palsy: report of the Quality Standards Subcommittee of the American Academy of Neurology and the Practice Committee of the Child Neurology Society. *Neurology*. 2004 Mar 23;62(6):851-63.
32. Bar-Shalom R, Yefremov N, Guralnik L, Keidar Z, Engel A, Nitecki S, et al. SPECT/CT using ⁶⁷Ga and ¹¹¹In-labeled leukocyte scintigraphy for diagnosis of infection. *J Nucl Med*. 2006 Apr;47(4):587-94.
33. Bensimhon DR, Adams GL, Whellan DJ, Pagnanelli RA, Trimble M, HF-ACTION Trial Investigators. Effect of exercise training on ventricular function, dyssynchrony, resting myocardial perfusion, and clinical

outcomes in patients with heart failure: a nuclear ancillary study of Heart Failure and A Controlled Trial Investigating Outcomes of Exercise TraiNing (HF-ACTION); design and rationale. *Am Heart J.* 2007 Jul;154(1):46-53.

34. Berman DS, Shaw LJ, Hachamovitch R, Friedman JD, Polk DM, Hayes SW, et al. Comparative use of radionuclide stress testing, coronary artery calcium scanning, and noninvasive coronary angiography for diagnostic and prognostic cardiac assessment. *Semin Nucl Med.* 2007 Jan;37(1):2-16. Review.
35. Brem RF, Floerke AC, Rapelyea JA, Teal C, Kelly T, Mathur V. Breast-specific gamma imaging as an adjunct imaging modality for the diagnosis of breast cancer. *Radiology.* 2008 Jun;247(3):651-7.
36. Brindis RG, Douglas PS, Hendel RC, Peterson ED, American College of Cardiology Foundation Quality Strategic Directions Committee Appropriateness Criteria Working Group; American Society of Nuclear Cardiology; American Heart Association. ACCF/ASNC appropriateness criteria for single-photon emission computed tomography myocardial perfusion imaging (SPECT MPI): a report of the American College of Cardiology Foundation Quality Strategic Directions Committee Appropriateness Criteria Working Group and the American Society of Nuclear Cardiology endorsed by the American Heart Association. *J Am Coll Cardiol.* 2005 Oct 18;46(8):1587-605. Review. Erratum in: *J Am Coll Cardiol.* 2005 Dec 6;46(11):2148-50. Accessed August 2008. Available at URL address:
<http://www.acc.org/qualityandscience/clinical/pdfs/SPECTMPIACPubFile.pdf>
<http://www.acc.org/qualityandscience/clinical/pdfs/CorrectionFinal.pdf>
<http://www.acc.org/qualityandscience/clinical/pdfs/AppropriatenessGuideSPECTMPI.pdf>
37. Bunyaviroch T, Aggarwal A, Oates ME. Optimized scintigraphic evaluation of infection and inflammation: role of single-photon emission computed tomography/computed tomography fusion imaging. *Semin Nucl Med.* 2006 Oct;36(4):295-311. Review.
38. Cannon CP, Battler A, Brindis RG, Cox JL, Ellis SG, Every NR, et al. American College of Cardiology key data elements and definitions for measuring the clinical management and outcomes of patients with acute coronary syndromes. A report of the American College of Cardiology Task Force on Clinical Data Standards (Acute Coronary Syndromes Writing Committee). *J Am Coll Cardiol.* 2001 Dec;38(7):2114-30. Accessed August 2008. Available at URL address:
http://www.acc.org/qualityandscience/clinical/data_standards/ACS/pdf/ACS_clinicaldata.pdf
39. Chowdhury FU, Scarsbrook AF. The role of hybrid SPECT-CT in oncology: current and emerging clinical applications. *Clin Radiol.* 2008 Mar;63(3):241-51. Epub 2008 Jan 14. Review.
40. Duke Treadmill Score. Accessed August 2008. Available at URL address:
<http://www.cardiology.org/tools/medcalc/duke/>
41. European Heart Rhythm Association; Heart Rhythm Society, Zipes DP, Camm AJ, American College of Cardiology, American Heart Association Task Force, European Society of Cardiology Committee for Practice Guidelines, et al. ACC/AHA/ESC 2006 guidelines for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: a report of the American College of Cardiology/American Heart Association Task Force and the European Society of Cardiology Committee for Practice Guidelines (Writing Committee to Develop Guidelines for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death). *J Am Coll Cardiol.* 2006 Sep 5;48(5):e247-346.
42. Even-Sapir E, Flusser G, Lerman H, Lievshitz G, Metser U. SPECT/multislice low-dose CT: a clinically relevant constituent in the imaging algorithm of nononcologic patients referred for bone scintigraphy. *J Nucl Med.* 2007 Feb;48(2):319-24.
43. Filippi L, Schillaci O. Usefulness of hybrid SPECT/CT in 99mTc-HMPAO-labeled leukocyte scintigraphy for bone and joint infections. *J Nucl Med.* 2006 Dec;47(12):1908-13.
44. Fraser AG, European Association of Echocardiography; Working Groups on Cardiovascular Magnetic Resonance, Computers in Cardiology, and Nuclear Cardiology, of the European Society of Cardiology; European Association of Nuclear Medicine; Association for European Paediatric Cardiology. The future of

cardiovascular imaging and non-invasive diagnosis. A joint statement from the European Association of Echocardiography, the Working Groups on Cardiovascular Magnetic Resonance, Computers in Cardiology, and Nuclear Cardiology, of the European Society of Cardiology, the European Association of Nuclear Medicine and the Association for European Paediatric Cardiology. *Eur J Nucl Med Mol Imaging*. 2006 Aug;33(8):955-9.

45. Gayed IW, Kim EE, Broussard WF, Evans D, Lee J, Broemeling LD, et al. The value of 99mTc-sestamibi SPECT/CT over conventional SPECT in the evaluation of parathyroid adenomas or hyperplasia. *J Nucl Med*. 2005 Feb;46(2):248-52.
46. Goetz CG, editor. *Goetz: Textbook of Clinical Neurology*, 2nd ed., St. Louis: W.B. Saunders; 2003.
47. Grainger RG, Allison D, editors. *Grainger & Allison's Diagnostic Radiology: A Textbook of Medical Imaging* 4th Ed., London: Churchill Livingstone, Inc.; 2001.
48. Grundy SM, Pasternak R, Greenland P, Smith S Jr, Fuster. AHA/ACC scientific statement: Assessment of cardiovascular risk by use of multiple-risk-factor assessment equations: a statement for healthcare professionals from the American Heart Association and the American College of Cardiology. *J Am Coll Cardiol*. 1999 Oct;34(4):1348-59
49. Horger M, Bares R. The role of single-photon emission computed tomography/computed tomography in benign and malignant bone disease. *Semin Nucl Med*. 2006 Oct;36(4):286-94. Review.
50. Ingui CJ, Shah NP, Oates ME. Infection scintigraphy: added value of single-photon emission computed tomography/computed tomography fusion compared with traditional analysis. *J Comput Assist Tomogr*. 2007 May-Jun;31(3):375-80.
51. Kertai MD, Boersma E, Bax JJ, Heijnenbroek-Kal MH, Hunink MG, L'italien GJ, et al. A meta-analysis comparing the prognostic accuracy of six diagnostic tests for predicting perioperative cardiac risk in patients undergoing major vascular surgery. *Heart*. 2003 Nov;89(11):1327-34.
52. Klocke FJ, Baird MG, Lorell BH, Bateman TM, American College of Cardiology, American Heart Association Task Force on Practice Guidelines; American Society for Nuclear Cardiology. ACC/AHA/ASNC guidelines for the clinical use of cardiac radionuclide imaging--executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASNC Committee to Revise the 1995 Guidelines for the Clinical Use of Cardiac Radionuclide Imaging). *Circulation*. 2003 Sep 16;108(11):1404-18.
53. Knopman DS, DeKosky ST, Cummings JL, Chui H, Corey-Bloom J, Relkin N, et al. Practice parameter: diagnosis of dementia (an evidence-based review). Report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology*. 2001 May 8;56(9):1143-53. Accessed July 2008. Available at URL address: <http://www.aan.com/go/practice/guidelines>
54. Latchaw RE, Yonas H, Hunter GJ, Yuh WT, Ueda T, Sorensen AG, Sunshine JL, Biller J, Wechsler L, Higashida R, Hademenos G; Council on Cardiovascular Radiology of the American Heart Association. Guidelines and recommendations for perfusion imaging in cerebral ischemia: A scientific statement for healthcare professionals by the writing group on perfusion imaging, from the Council on Cardiovascular Radiology of the American Heart Association. *Stroke*. 2003 Apr;34(4):1084-104.
55. Lavelly WC, Goetze S, Friedman KP, Leal JP, Zhang Z, Garret-Mayer E, et al. Comparison of SPECT/CT, SPECT, and planar imaging with single- and dual-phase (99m)Tc-sestamibi parathyroid scintigraphy. *J Nucl Med*. 2007 Jul;48(7):1084-9. Epub 2007 Jun 15. Erratum in: *J Nucl Med*. 2007 Sep;48(9):1430.
56. Lip GY. Coronary artery disease and ischemic stroke in atrial fibrillation. *Chest*. 2007 Jul;132(1):8-10.
57. Lokshyn S, Mewis C, Kuhlkamp V. Atrial fibrillation in coronary artery disease. *Int J Cardiol*. 2000 Jan 15;72(2):133-6.

58. McNeill R, Sare GM, Manoharan M, Testa HJ, Mann DM, Neary D, et al. Accuracy of single-photon emission computed tomography in differentiating frontotemporal dementia from Alzheimer's disease. *J Neurol Neurosurg Psychiatry*. 2007 Apr;78(4):350-5.
59. Mele A, Offidani M, Visani G, Marconi M, Cambioli F, Nonni M, et al. Technetium-99m sestamibi scintigraphy is sensitive and specific for the staging and the follow-up of patients with multiple myeloma: a multicentre study on 397 scans. *Br J Haematol*. 2007 Mar;136(5):729-35.
60. Mendez MF, Shapira JS, McMurtray A, Licht E, Miller BL. Accuracy of the clinical evaluation for frontotemporal dementia. *Arch Neurol*. 2007 Jun;64(6):830-5.
61. Ment LR, Bada HS, Barnes P, Grant PE, Hirtz D, Papile LA, et al. Practice parameter: neuroimaging of the neonate: report of the Quality Standards Subcommittee of the American Academy of Neurology and the Practice Committee of the Child Neurology Society. *Neurology*. 2002 Jun 25;58(12):1726-38.
62. Metz LD, Beattie M, Hom R, Redberg RF, Grady D, Fleischmann KE. The prognostic value of normal exercise myocardial perfusion imaging and exercise echocardiography: a meta-analysis. *J Am Coll Cardiol*. 2007 Jan 16;49(2):227-37.
63. Mieres JH, Shaw LJ, Arai A, Budoff MJ, Flamm SD, Cardiac Imaging Committee, Council on Clinical Cardiology, and the Cardiovascular Imaging and Intervention Committee, Council on Cardiovascular Radiology and Intervention, American Heart Association. Role of noninvasive testing in the clinical evaluation of women with suspected coronary artery disease: Consensus statement from the Cardiac Imaging Committee, Council on Clinical Cardiology, and the Cardiovascular Imaging and Intervention Committee, Council on Cardiovascular Radiology and Intervention, American Heart Association. *Circulation*. 2005 Feb 8;111(5):682-96.
64. Mourad O, Palda V, Detsky AS. A comprehensive evidence-based approach to fever of unknown origin. *Arch Intern Med*. 2003 Mar 10;163(5):545-51.
65. Mowatt G, Brazzelli M, Gemmell H, Hillis GS, Metcalfe M, Vale L; Aberdeen Technology Assessment Review Group. Systematic review of the prognostic effectiveness of SPECT myocardial perfusion scintigraphy in patients with suspected or known coronary artery disease and following myocardial infarction. *Nucl Med Commun*. 2005 Mar;26(3):217-29.
66. National Institute for Health and Clinical Excellence. Clinical Guideline 35. Parkinson's disease. June 2006. Accessed August 2008. Available at URL address: <http://guidance.nice.org.uk/http://www.nice.org.uk/guidance/index.jsp?action=download&o=30087>
67. National Institute for Health and Clinical Excellence. Clinical Guideline 42. Dementia. November 2006. Accessed August 2008. Available at URL address: <http://guidance.nice.org.uk/http://www.nice.org.uk/guidance/index.jsp?action=download&o=30320>
68. National Heart, Lung, and Blood Institute, Risk Assessment Tool for Estimating Your 10-year Risk of Having a Heart Attack. Not dated. Accessed July 2008. Available at URL address: <http://hp2010.nhlbihin.net/atp/iii/calculator.asp>
69. Newburger JW, Takahashi M, Gerber MA, Gewitz MH, Committee on Rheumatic Fever, Endocarditis, and Kawasaki Disease, Council on Cardiovascular Disease in the Young, American Heart Association, et al. Diagnosis, treatment, and long-term management of Kawasaki disease: a statement for health professionals from the Committee on Rheumatic Fever, Endocarditis, and Kawasaki Disease, Council on Cardiovascular Disease in the Young, American Heart Association. *Pediatrics*. 2004 Dec;114(6):1708-33.
70. Panjrath GS, Jain D. Monitoring chemotherapy-induced cardiotoxicity: role of cardiac nuclear imaging. *J Nucl Cardiol*. 2006 May-Jun;13(3):415-26. Review.

71. Perri M, Erba P, Volterrani D, Lazzeri E, Boni G, Grosso M, et al. Octreo-SPECT/CT imaging for accurate detection and localization of suspected neuroendocrine tumors. *Q J Nucl Med Mol Imaging*. 2008 May 16. [Epub ahead of print]
72. Radiology Society of North America (RSNA). Nuclear Medicine. Cardiac Nuclear Medicine. Last updated January 2008. Accessed August 2008. Available at URL address: <http://www.radiologyinfo.org/en/sitemap/category.cfm?category=nm>
73. Radiology Society of North America (RSNA). Children's (Pediatric) Nuclear Medicine. Last updated January 2008. Accessed August 2008. Available at URL address: <http://www.radiologyinfo.org/en/sitemap/category.cfm?category=nm>
74. Radiology Society of North America (RSNA). Nuclear Medicine. General Nuclear Medicine. Last updated January 2008. Accessed August 2008. Available at URL address: <http://www.radiologyinfo.org/en/sitemap/category.cfm?category=nm>
75. Radiology Society of North America (RSNA). Lymphoscintigraphy. Last updated January 2008. Accessed August 2008. Available at URL address: <http://www.radiologyinfo.org/en/sitemap/category.cfm?category=nm>
76. Radiology Society of North America (RSNA). Thyroid Scan and Uptake. Last updated January 2008. Accessed August 2008. Available at URL address: <http://www.radiologyinfo.org/en/sitemap/category.cfm?category=nm>
77. Reyes E, Loong CY, Harbinson M, Rahman S, Prvulovich E, Ell PJ, et al. A comparison of Tl-201, Tc-99m sestamibi, and Tc-99m tetrofosmin myocardial perfusion scintigraphy in patients with mild to moderate coronary stenosis. *J Nucl Cardiol*. 2006 Jul;13(4):488-94.
78. Rispler S, Keidar Z, Ghersin E, Roguin A, Soil A, Dragu R, et al. Integrated single-photon emission computed tomography and computed tomography coronary angiography for the assessment of hemodynamically significant coronary artery lesions. *J Am Coll Cardiol*. 2007 Mar 13;49(10):1059-67
79. Sampalis FS, Denis R, Picard D, Fleiszer D, Martin G, Nassif E, et al. International prospective evaluation of scintimammography with 99m Tc sestamibi. *Am J Surg*. 2003 Jun;185(6):544-9
80. Smith RA, Saslow D, Sawyer KA, Burke W, Costanza ME, Evans WP et al. American Cancer Society guidelines for breast cancer screening: update 2003. *CA Cancer J Clin*. 2003 May-Jun;53(3):141-69.
81. Smith A, Wisloff F, Samson D; UK Myeloma Forum; Nordic Myeloma Study Group; British Committee for Standards in Haematology. Guidelines on the diagnosis and management of multiple myeloma 2005. *Br J Haematol*. 2006 Feb;132(4):410-51
82. Society of Nuclear Medicine Procedure Guideline for 99mTc-Exametazime (HMPAO)-Labeled Leukocyte Scintigraphy for Suspected Infection/Inflammation. Approved June 2004. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/HMPAO_v3.pdf
83. Society of Nuclear Medicine Procedure Guideline for Bone Scintigraphy. Approved June 2003. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/pg_ch34_0403.pdf
84. Society of Nuclear Medicine Procedure Guideline for Brain Death Scintigraphy. Approved February 2003. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/pg_ch20_0403.pdf
85. Society of Nuclear Medicine Procedure Guideline for Brain Perfusion single photon emission computed tomography (SPECT) using Tc-99m radiopharmaceuticals. Approved February 1999. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/pg_ch21_0403.pdf
86. Society of Nuclear Medicine Procedure Guideline for Breast Scintigraphy. Approved June 2004. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/Breast_v2.0.pdf

87. Society of Nuclear Medicine Procedure Guideline for Gallium Scintigraphy in Inflammation. Approved June 2004. Accessed July 2008. Available at URL address:
http://interactive.snm.org/docs/Gallium_Scintigraphy_in_Inflammation_v3.pdf
88. Society of Nuclear Medicine Procedure Guideline for Gallium Scintigraphy in the Evaluation of Malignant Disease. Approved June 2001. Accessed July 2008. Available at URL address:
http://interactive.snm.org/docs/pg_ch23_0403.pdf
89. Society of Nuclear Medicine Procedure Guideline for Gastric Emptying and Motility. Approved June 2004. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/pg_ch08_0403.pdf
90. Society of Nuclear Medicine Procedure Guideline for Gated Equilibrium Radionuclide Ventriculography. Approved June 2002. Accessed July 2008. Available at URL address:
http://interactive.snm.org/docs/pg_ch01_0403.pdf
91. Society of Nuclear Medicine Procedure Guideline for General Imaging. Approved May 2004. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/General_Imaging_v3.0.pdf
92. Society of Nuclear Medicine Procedure Guideline for Hepatic and Splenic Imaging. Approved July 2003. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/pg_ch10_0403.pdf
93. Society of Nuclear Medicine Procedure Guideline for Hepatobiliary Scintigraphy. Approved June 2001. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/pg_ch11_0703.pdf
94. Society of Nuclear Medicine Procedure Guideline for ¹¹¹In Leukocyte Scintigraphy for Suspected Infection/Inflammation. Approved June 2004. Accessed July 2008. Available at URL address:
http://interactive.snm.org/docs/Leukocyte_v3.pdf
95. Society of Nuclear Medicine Procedure Guideline for Lung Scintigraphy. Approved February 2004. Accessed July 2008. Available at URL address:
http://interactive.snm.org/docs/Lung%20Scintigraphy_v3.0.pdf
96. Society of Nuclear Medicine Procedure Guideline for Myocardial Perfusion Imaging. Approved June 2002. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/pg_ch02_0403.pdf
97. Society of Nuclear Medicine Procedure Guideline for Parathyroid Scintigraphy. Approved June 2004. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/Parathyroid_v3.0.pdf
98. Society of Nuclear Medicine Procedure Guideline for Radionuclide Cystography in Children. Approved January 2003. Accessed July 2008. Available at URL address:
http://interactive.snm.org/docs/pg_ch32_0703.pdf
99. Society of Nuclear Medicine Procedure Guideline for Renal Cortical Scintigraphy in Children. Approved June 2003. Accessed July 2008. Available at URL address:
http://interactive.snm.org/docs/pg_ch32_0403.pdf
100. Society of Nuclear Medicine Procedure Guideline for diagnosis of Renovascular Hypertension. Approved June 2003. Accessed July 2008. Available at URL address:
http://interactive.snm.org/docs/pg_ch16_0403.pdf
101. Society of Nuclear Medicine Procedure Guideline for SPECT/CT Imaging. Approved May 2006. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/jnm32961_online.pdf
102. Society of Nuclear Medicine Procedure Guideline for Somatostatin Receptor Scintigraphy with ¹¹¹In Pentetretotide. Approved February 2001. Accessed July 2008. Available at URL address:
http://interactive.snm.org/docs/pg_ch27_0403.pdf

103. Society of Nuclear Medicine Procedure Guideline for Thyroid Scintigraphy. Approved February 1999. Accessed July 2008. Available at URL address: http://interactive.snm.org/docs/pg_ch05_0403.pdf
104. Society of Nuclear Medicine Procedure Guideline for Extended Scintigraphy for Differentiated Papillary and Follicular Thyroid Cancer. Approved September 2006. Accessed July 2008. Available at URL address: [http://interactive.snm.org/docs/Scintigraphy%20for%20Differentiated%20Thyroid%20Cancer%20V3%200%20\(9-25-06\).pdf](http://interactive.snm.org/docs/Scintigraphy%20for%20Differentiated%20Thyroid%20Cancer%20V3%200%20(9-25-06).pdf)
105. Society of Nuclear Medicine Procedure Guideline for Thyroid Uptake Measurement. Approved September 2006. Accessed July 2008. Available at URL address: <http://interactive.snm.org/docs/Thyroid%20Uptake%20Measure%20v3%200.pdf>
106. Stollman NH, Raskin JB. Diagnosis and management of diverticular disease of the colon in adults. Ad Hoc Practice Parameters Committee of the American College of Gastroenterology. *Am J Gastroenterol*. 1999 Nov;94(11):3110-21. Accessed July 2008. Available at URL address: <http://gi.org/physicians/clinicalupdates.asp#guidelines>
107. Suchowersky O, Reich S, Perlmutter J, Zesiewicz T, Gronseth G, Weiner WJ; Quality Standards Subcommittee of the American Academy of Neurology. Practice Parameter: diagnosis and prognosis of new onset Parkinson disease (an evidence-based review): report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology*. 2006 Apr 11;66(7):968-75. Accessed July 2008. Available at URL address: <http://www.aan.com/go/practice/guidelines>
108. Temmerman OP, Raijmakers PG, Berkhof J, Hoekstra OS, Teule GJ, Heyligers IC. Accuracy of diagnostic imaging techniques in the diagnosis of aseptic loosening of the femoral component of a hip prosthesis: a meta-analysis. *J Bone Joint Surg Br*. 2005 Jun;87(6):781-5.
109. Termaat MF, Raijmakers PG, Scholten HJ, Bakker FC, Patka P, et al. The accuracy of diagnostic imaging for the assessment of chronic osteomyelitis: a systematic review and meta-analysis. *J Bone Joint Surg Am*. 2005 Nov;87(11):2464-71.
110. Utsunomiya D, Shiraishi S, Imuta M, Tomiguchi S, Kawanaka K, Morishita S, et al. Added value of SPECT/CT fusion in assessing suspected bone metastasis: comparison with scintigraphy alone and nonfused scintigraphy and CT. *Radiology*. 2006 Jan;238(1):264-71. Epub 2005 Nov 22.
111. Van Der Horst-Schrivers AN, Jager PL, Boezen HM, Schouten JP, Kema IP, et al. Iodine-123 metaiodobenzylguanidine scintigraphy in localising pheochromocytomas--experience and meta-analysis. *Anticancer Res*. 2006 Mar-Apr;26(2B):1599-604.
112. Vasbinder GB, Nelemans PJ, Kessels AG, Kroon AA, de Leeuw PW, van Engelshoven JM. Diagnostic tests for renal artery stenosis in patients suspected of having renovascular hypertension: a meta-analysis. *Ann Intern Med*. 2001 Sep 18;135(6):401-11.
113. Waldemar G, Dubois B, Emre M, Georges J, McKeith IG, Rossor M, et al. Recommendations for the diagnosis and management of Alzheimer's disease and other disorders associated with dementia: EFNS guideline. *Eur J Neurol*. 2007 Jan;14(1):e1-26. Review.
114. Ward RP, Al-Mallah MH, Grossman GB, Hansen CL, Hendel RC, American Society of Nuclear Cardiology, et al. American Society of Nuclear Cardiology review of the ACCF/ASNC appropriateness criteria for single-photon emission computed tomography myocardial perfusion imaging (SPECT MPI). *J Nucl Cardiol*. 2007 Nov-Dec;14(6):e26-38.
115. Whiteside SP, Port JD, Abramowitz JS. A meta-analysis of functional neuroimaging in obsessive-compulsive disorder. *Psychiatry Res*. 2004 Nov 15;132(1):69-79
116. Zhou M, Johnson N, Blanchard D, Bryn S, Nelson J. Real-world application of breast-specific gamma imaging, initial experience at a community breast center and its potential impact on clinical care. *Am J Surg*. 2008 May;195(5):631-5; discussion 635. Epub 2008 Apr 2.

117. Zipes DP, Libby P, Bonow RO, Braunwald E., editors. Zipes: Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine, 7th ed., St. Louis: W.B. Saunders; 2005.

Policy History

Pre-Merger Organizations	Last Review Date	Policy Number	Title
CIGNA HealthCare	10/15/2008	0169	Nuclear Imaging including Single-Photon Emission Computed Tomography (SPECT)

"CIGNA" and the "Tree of Life" logo are registered service marks of CIGNA Intellectual Property, Inc., licensed for use by CIGNA Corporation and its operating subsidiaries. All products and services are provided exclusively by such operating subsidiaries and not by CIGNA Corporation. Such operating subsidiaries include Connecticut General Life Insurance Company, CIGNA Behavioral Health, Inc., Intracorp, and HMO or service company subsidiaries of CIGNA Health Corporation and CIGNA Dental Health, Inc. In Arizona, HMO plans are offered by CIGNA HealthCare of Arizona, Inc. In California, HMO plans are offered by CIGNA HealthCare of California, Inc. and Great-West Healthcare of California, Inc. In Connecticut, HMO plans are offered by CIGNA HealthCare of Connecticut, Inc. In North Carolina, HMO plans are offered by CIGNA HealthCare of North Carolina, Inc. In Virginia, HMO plans are offered by CIGNA HealthCare Mid-Atlantic, Inc. All other medical plans in these states are insured or administered by Connecticut General Life Insurance Company.

Connecticut General Life Insurance Company has acquired the business of Great-West Healthcare from Great-West Life & Annuity Insurance Company (GWLA). Certain products continue to be provided by GWLA (Life, Accident and Disability, and Excess Loss). GWLA is not licensed to do business in New York. In New York, these products are sold by GWLA's subsidiary, First Great-West Life & Annuity Insurance Company, White Plains, N.Y.